GW - 1

WORK PLANS

1999

6.4 MONITORING WELL INSTALLATION

The proper placement of monitoring wells is critical to collection of valid and representative groundwater samples. Selected drilling equipment will be decontaminated prior to use. Screens will be set at the appropriate depth and wells thoroughly developed. The installation of monitoring wells will be conducted using a hollow-stem auger drilling technique. All drilling at the Giant Refinery site will be conducted following the ASTM Standard Guide Designation D5784-95; drilling procedures are discussed in Appendix A. Decontamination procedures for field activities are described in ASTM Standard Guide Designation D5088-90 and discussed in Appendix A. Following these Standards will reduce measurement error. The rationale for the placements of the wells, which appears in Table 2, addresses and minimizes sampling design error. Total study error, the sum of measurement and sampling design error, is thereby kept to a minimum.

6.5 SEEP SAMPLING POINT INSTALLATION

Water seepage along the cliff between the San Juan River and Hammond Ditch has necessitated three unique procedures to install sampling points. Seep sampling point 1 (Seep 1 on Plate 4) employs a simple method to direct surface flow from a small spring into a discharge tube. We dug a small basin at the discharge point, inserted the plastic tube into the basin and placed gravel and cobbles over and around the tube. Water now flows through the tube, permitting uniform sampling of this location.

We used a fall-protection safety harness to install the sampling tubes at Seeps 2 and 3, which are located in the middle of a sheer cliff. At these locations, the basin into which the plastic tube is inserted was excavated into the Nacimiento Formation. Cobbles and gravel hold the sampling tubes in place.

Seep 4 is constructed in a manner similar to Seep 1. At this site, however, a sampling tube was not necessary because the sampling point is readily accessible. We used a well bailer as the sampling tube for this site.

Groundwater also seeps to the surface due west of the Refinery. Here Hicks Consultants installed a temporary drive point to permit uniform sampling of groundwater. This location, Seep 5, serves to define the lateral extent of hydrocarbons north of MW-12.

6.6 RISK ASSESSMENT UPDATE

We will use hydrogeologic data, collected as discussed above; predictive modeling data, generated as discussed below; and demographic/ecological data for the updated risk assessment. Collection of demographic and ecological data is straightforward. County records supply information on current land ownership and zoning. Data from the State Engineer's Office should identify most water supply wells in the area. Published reports identify endangered species and sensitive habitats. We will perform a field inspection to verify the results of the records search.

6.7 BIOPLUME III SIMULATION MODELING

The documentation for the BIOPLUME III simulation modeling is available upon request. Hicks Consultants will provide a copy of the instruction manual, or the reader may obtain a copy directly from www.epa.gov/ada/models.html. Whereas some input parameters may be identical to previous simulations conducted by others, our model will be calibrated to the 14 years of groundwater data at the Refinery.

6.8 REPORT PREPARATION

All reports, including QA progress reports, adhere to the following process:

1. Prepare Table of Contents, List of Figures, List of Tables, List of Appendices.
2. Prepare data tables and draft figures.
3. Prepare first draft text.

4. Peer review of first draft including comparison of text with figures and tables.
5. Modification of text, figures and tables as dictated by peer review.
6. Technical edit, final correlation of data, figures and text.
7. Final draft document assembly and review by R. Hicks.
8. Review by client.
9. Respond to comments, additional editing, prepare final report.
10. Submit to appropriate agencies.

All data placed in tables for the report will meet QA/QC requirements or will be flagged for use with caution. The peer-review will spot check each table, comparing the information on the table with original data from field books, laboratory reports, etc. Figures presenting data are derived from the tables described above.

Dr. Laura Gutman edits all documents for Hicks Consultants. Her resume is in Appendix B.

TABLES

Table 1
Previous Site Investigations

Date	Title	Author	Summary
8-5-85	RCRA 3013 Final Workplan	Bloomfield Refining Company	A Comprehensive Groundwater Study Proposal to determine the extent of the hydrocarbon plume. Monitor wells MW-1 through MW-6 installed in February 1984 in preparation for the workplan submittal.
6-2-86	Report on Subsurface Hydrocarbon Data	Bloomfield Refining Company	This study first identified hydrocarbons outside of the refinery boundaries. Bloomfield Refining Company installed monitoring wells MW-7 through MW-10.
8-20-86	Final Closure Plan for the API Wastewater Ponds, Landfill, and Landfill Pond at the Bloomfield Refinery	Engineering Science	This study provides data on waste material and underlying soils associated with these solid waste management units. All analytical results were consistent with clean closure for all of the subject areas.
2-6-87	A Final Report on Section 3013 Administrative Order Work Elements	Engineering Science	Identification of hydrocarbons in the unsaturated zone.
4-4-88	Site Investigation and Remedial Action Conceptual Design for the Bloomfield Refining Company	Geoscience Consultants, Ltd. (GCL)	Computer modeling determined that a three well recovery system would be optimal to minimize further hydrocarbon migration.
8-3-89	Final Report on Soil Vapor Survey, Well Installation and Hydrocarbon Recovery System	Geoscience Consultants Ltd. (GCL)	Hydrocarbons are evident south of the site on BLM land. The study proposed a recovery well system to minimize hydrocarbon migration from the refinery.
2-11-92	Interim Measures Work Plan	Groundwater Technology (GTI)	The proposed Interim Measures were: install two additional recovery wells, implement a pumping system, survey wells, gauge liquid levels in the wells, perform startup tests for the two new recovery wells and monitoring of all new equipment.
3-29-93	RCRA Facility Investigation (RFI)-Task 1 and Task II	GTI	The report describes surface and subsurface conditions and provides a draft work plan to conduct the RFI.
2-2-94	RFI-Phase I-Soil Gas Survey	GTI (subcontracted to Burlington Environmental)	The highest levels of hydrocarbons are the areas around the flare, the roadway south of Tanks 11 and 12, and the area surrounding Tanks 24 and 28.
4-22-94	RFI-Phase II-Soil Boring Investigation	GTI (Drilling contracted to Western Technologies)	The area around the product loading area was not found to be significantly impacted by a product release or to be a hydrocarbon source area.
6-23-94	RFI-Phase III-Well Installation/1st Groundwater Sampling Event	GTI	All wells not containing SPH were sampled (16). See analytical table for specific results.
9-30-94	RFI-Phase III-2nd Groundwater Sampling Event	GTI	All wells not containing SPH were sampled (16). See analytical table for specific results.

Table 1, cont.

Date	Title	Author	Summary
7-30-94	RFI- Phase IV-Uppermost Aquifer Hydraulic Testing and Modeling	GTI	Values calculated for transmissivity and hydraulic conductivity were indicative of a high-permeability saturated zone. Fast accumulation of SPH in the cone-of-depression during pumping indicated that dual liquid removal is an alternative for the collection of the SPH.
8-16-94	RFI-Phase IV-Soil Vapor Extraction/Air Sparging Pilot Studies	GTI (Subcontracted drilling to Layne Environmental Services)	Calculated effective radii of influence for the shallow zone ranged from 2 feet to 36 feet. Any vapors generated as a result of sparging can be captured and contained by the vacuum system. Hydrocarbon mass removal rates ranged from .20 lb./hr to 5.5 lb./hr.
8-14-94	RFI-Phase V-Stream and Sediment Sampling	GTI	Stream and sediment sample analysis show no significant impact to the Hammond Ditch or the San Juan River.
12-21-95	Human Health and Ecological Risk Assessment	GTI	There are no unacceptable risks to human health and environment unless the shallow unsaturated zone is used for potable water.
12-21-95	Corrective Measures Study	GTI	A summary using the previous investigations to determine the best course of action at the GRC site. The study recommended air sparging, SPH recovery and vapor extraction.

Table 2
Soil Borings, Soil Sampling, Monitor Well Installation and Seep Sampling Points

Sampling Point	Location	Parameters Tested	Rationale
Cliffside Seep S1	NE of flare	Water: BTEX	Groundwater from the Jackson Lake Terrace deposits flows from seeps along the cliff between the Hammond Irrigation Ditch and the San Juan River. These flows must be tested for petroleum hydrocarbons.
Cliffside Seep S2	N of flare and MW-24	Water: BTEX	As above
Cliffside Seep S3	W of flare	Water: BTEX	As above
Cliffside Seep S4	West of S3, N of P-1	Water: BTEX	As above
Seep S5	N of MW-12, W of P-1	Water: BTEX	A man-made excavation created a groundwater seep in this area. A sampling point in this area will determine the northwestern extent of hydrocarbons in the Jackson Lake Terrace deposits.
MW-39	E of RW-23	Water: BTEX	Well MW-7 penetrates the Nacimiento Formation. Three wells are required to determine the general hydraulic gradient in Nacimiento Formation and to characterize water quality in this unit across the Refinery. This well in addition to MW-7 and MW-44 will define the hydraulic gradient in the Formation.
MW-43	Between NOWP and	Soil: BTEX, PAHs, metals Groundwater: BTEX, PAHs, metals	In previous AOCs, the EPA suggests that the NOWP and/or SOWP may have contributed hazardous waste constituents to groundwater. This soil and groundwater sampling point will add data to assist in the determining if these RCRA units contributed hydrocarbons or other constituents to groundwater.
MW-44	Near MW-30	Water: BTEX	Well MW-7 penetrates the Nacimiento Formation. Three wells are required to determine the general hydraulic gradient in Nacimiento Formation and to characterize water quality in this unit across the Refinery. This well in addition to MW-7 and MW-39 will define the hydraulic gradient in the Formation.
SB-1	South of RW-23 and north of RW-22	Soil: BTEX, PAHs, metals Groundwater: BTEX, PAHs, metals	Shallow hand auger borings in this area show petroleum hydrocarbons in soil. Tanks within this berm overflowed and leaked. Results of the analyses will be compared to results of borings near the NOWP and SOWP in order to assist with determining the source(s) of subsurface hydrocarbons
SB-2	Between the NOWP and SOWP, west side of ponds	Soil: BTEX, PAHs, metals Groundwater: BTEX, PAHs, metals	In previous AOCs, the EPA suggests that the NOWP and/or SOWP may have contributed hazardous waste constituents to groundwater. This soil sampling point will add data to assist in the determining if these RCRA units contributed hydrocarbons or other constituents to groundwater.
HA-1	East of RW-18, west of NOWP	Soil: BTEX, PAHs, metals Groundwater: BTEX, PAHs, metals	In this area that formerly housed aboveground storage tanks, product overflow and tank leakage is documented. Results of the analyses will be compared to results of borings near the NOWP and SOWP in order to assist with determining the source(s) of subsurface hydrocarbons

Table 3
Working Hypotheses

•	• Null Hypothesis	• Alternative Hypothesis
•	• If subsurface petroleum hydrocarbons originated from hazardous waste management units and/or solid waste management units, then RCRA and the NMHWMR must regulate site restoration activities.	• If subsurface petroleum hydrocarbons originated from storage tank leakage and product spills, then site restoration activities must be regulated by the WQCC.
•	• If existing data and the field programs proposed herein do not adequately characterize the magnitude and extent of petroleum hydrocarbons and permit the selection of an appropriate abatement strategy, then further investigation is required	• If existing data and the field programs proposed herein adequately characterize the magnitude and extent of petroleum hydrocarbons and permit the selection of an appropriate abatement strategy, then further investigation is not required
•	• If the risk to human health and the environment increases over time to unacceptable levels under an abatement strategy that employs natural restoration over most of the site, then the existing hydrocarbon/groundwater recovery system must be expanded to capture additional subsurface hydrocarbons.	• If the risk to human health and the environment does not increase over time to unacceptable levels under an abatement strategy that employs natural restoration over most of the site, then the existing hydrocarbon/groundwater recovery system may remain status quo or shut down.

Table 4
Data Sources for Abatement Plan Investigation

Elevation Measurements	Sources of Data
Groundwater in Jackson Lake Terrace Sediments	Direct measurement and previous reports
Groundwater in Nacimiento Formation	Direct measurement and previous reports
Groundwater in San Juan River Sediments	Previous reports and future observation points
Separate Phase Hydrocarbon (SPH) in monitor wells	Direct measurement and previous reports
Top of Nacimiento Formation/base of Jackson Lake Terrace Sediments	Direct measurement and previous reports
Top of Jackson Lake Sediments	Direct measurement and previous reports
Geologic and Hydrologic Observations and Measurements	
Lithology of saturated zone	Previous reports and direct observation
Lithology of unsaturated zone	Previous reports and direct observation
Hydraulic conductivity and storage coefficient of Jackson Lake Sediments	Previous reports and published values
Hydraulic conductivity and storage coefficient of Nacimiento Formation	Previous reports and published values
Location of groundwater recharge areas (natural and artificial)	Direct observation
Location of groundwater discharge areas (natural and artificial)	Direct observation
Human Health and Ecological Risk Inventory	
Property ownership	County records
Source of drinking water	State Engineer Records, interviews and inspections
Zoning and land use	County records
Proposed or anticipated changes to status quo (e.g. future lining of Hammond Ditch)	Interviews of zoning officials and county planners
Endangered species	Published reports
Sensitive habitats	Direct observation
Groundwater Chemistry	
Benzene, Toluene, Ethylbenzene and Xylenes (BTEX)	Direct sampling followed by analysis and previous reports
Naphthalene	Direct sampling followed by analysis and previous reports
Total Dissolved Solids (TDS)	Direct sampling followed by analysis and previous reports
Field Parameters: Temperature, Conductance, pH	Direct sampling followed by analysis and previous reports
Intrinsic Remediation Parameters: Dissolved Oxygen, Sulfate, Nitrate, Ferrous/Ferric Iron, Methane, Manganese	Direct sampling followed by analysis and previous reports
Arsenic, Barium, Chromium and Lead	Direct sampling followed by analysis and previous reports
Additional Cations and Anions: Sodium, Calcium, Chloride, Carbonate	Direct sampling followed by analysis and previous reports
Soil and Sediment Chemistry	
Benzene, Toluene, Ethylbenzene and Xylenes (BTEX)	Direct sampling followed by analysis and previous reports
Naphthalene,	Direct sampling followed by analysis and previous reports
Total Organic Carbon	Direct sampling followed by analysis and previous reports
Arsenic, Barium, Chromium and Lead	Direct sampling followed by analysis and previous reports

Table 5
Decision Rules and Action Levels for Selected Data

Parameter of Interest	Action Level	Decision Rule
Off-site Groundwater Chemistry	WQCC Standards, MCLs (SDWA)	If concentrations at a place of potential future use (e.g. supply well, spring) exceed action levels, then a remedy must be proposed to a regulatory agency.
Soil Chemistry Near RCRA Units	RCRA TC limits	If concentrations of hazardous constituents in soil cause classification of soil as RCRA characteristic, Hazardous Waste Regulations will govern corrective actions associated with that soil
Groundwater Chemistry near RCRA Units	RCRA Groundwater Standards	If concentrations of hazardous waste constituents beneath or down gradient from RCRA units are statistically greater than concentrations up gradient from these units, then a release from these units is probable.
Groundwater Chemistry near RCRA Units	Soil Chemistry Near RCRA Units	If concentrations of hazardous waste constituents beneath or down gradient from RCRA units are statistically similar to soil chemistry from these units, then a release from these units is probable.
Groundwater Chemistry near Storage Tanks or Process Units	Soil Chemistry near Storage or Process Units	If concentrations of hydrocarbon constituents beneath or down gradient from Storage Tanks or process units are statistically similar to soil chemistry near these units, then a release from these units is probable.
Rate of Change, Hydrocarbons in Groundwater	Increasing Concentration	If hydrocarbon concentrations are declining over time then groundwater pumping and/or natural restoration are the active mechanisms accounting for this decline.
SPH in recovery wells	0.25 feet	If SPH in any recovery well is less than 0.25 feet then we will recommend that the pumping system in that well be shut down.
Benzene concentrations	WQCC Standard and MCL	If a calibrated aquifer simulation model (Bioplume III) predicts that the selected remedy will meet the action level within an acceptable timeframe then the agency may approve the selected remedy

APPENDIX A

APPENDIX A

Procedures for Hollow-Stem Auger Drilling and Monitor Well Installation . 26
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PROCEDURES FOR HOLLOW-STEM AUGER DRILLING AND MONITORING WELL INSTALLATION

This plan describes the work to be performed during soil boring and monitor well installation using hollow-stem auger drilling techniques.

SOIL BORING

Prior to the drilling company mobilizing the drill rig to the site, a utility survey will be conducted to ensure that borehole sites are not located over buried pipes or electric lines. Soil boring and lithologic sampling will be conducted at each location at the site. Drilling will be performed using a large-diameter hollow-stem auger. All drilling equipment will be steam-cleaned before initiation of drilling at each borehole. The steam cleaner, capable of generating water temperatures of at least 160°F, will be supplied by the drilling contractor. The on-site geologist will log core soil samples. Other field notes will be made in a bound field notebook.

MONITOR WELL INSTALLATION

All monitoring wells will be drilled with a hollow-stem auger drill rig. Prior to starting each well, personnel will steam clean the rig and all drilling tools in the decontamination area. A decontamination pad will be constructed on the Giant Refinery site for this purpose.

The well casings for the wells will be composed of 2-inch, flush joint, polyvinyl chloride (PVC) pipe, pre-cleaned and prepackaged by the manufacturer. The screen, a 10-foot riser pipe, and a 5-foot capped tailpipe will be composed of PVC. The well will have a 10-foot PVC screen, six feet of sand pack, one foot of time release bentonite and 20 feet of Portland grout. The monitor well screens will be placed at the air/water interface, extending to 3 feet above the static water level and 7 feet below.

After the well casing has been installed, the auger flights will be retrieved in 5-foot intervals. Pre-cleaned and prepackaged 8/12 or 10/20 silica sand will be poured down the auger annulus to fill the void left as each 5-foot flight is removed. This sand, combined with a small volume of formational sand that may slough into the borehole during retraction of the auger column, will provide the filter pack for the well screen. The sand will be placed to a level of 2 to 5 feet above the top of the screen. A 2- to 3-foot thickness of less permeable 20/40 sand will be placed directly above the gravel pack to protect it from bentonite and cement slurry intrusion.

The wellhead will be completed with the installation of a flush-to-grade concrete slab and waterproof steel vault. A certified land surveyor will survey the locations and elevations of the monitoring wells.

All construction activities will be performed in accordance with accepted industry standards, following a health and safety plan designed by R.T. Hicks Consultants Health and Safety Officer Ron Beethe, a certified industrial hygienist.

WELL DEVELOPMENT

Well development will be conducted in one or two phases: bailing and pumping. In the first phase, water will be bailed from the well to remove large amounts of clay and silt. Bailing will also serve as a verification of proper well alignment. During the second phase of well development, a 2-inch submersible pump will be installed in the well and operated from several different levels within the screened interval. If low well yields are encountered in a well, an air-driven ejector pump may be used to develop the wells. We will consider the well fully developed when the indicator parameters of pH, temperature and electrical conductance of water sampled from the well have stabilized over three consecutive measurements. Stability of parameters will be allowed to vary + 0.2 units for the pH, + 50 umhos for the conductivity, and + 1° C for the temperature. Wells that do not stabilize within a reasonable amount of development (within 1.5 times the volume of water introduced to the formation) will be examined on a case-by-case basis. On-site Hicks Consultants personnel will determine the cause of the problem (such as pump rate variation or particular aquifer characteristics) and document the problem and solution in the field notebook. The volume of water introduced to the borehole will be calculated from beginning drilling fluid volume and final mud pit fluid volumes. All produced water will be contained in the same pits used to contain drilling fluids. Cuttings and fluid will be disposed of in accordance with applicable regulations.

PROCEDURES FOR COLLECTING SOIL SAMPLES FROM DRILLING ACTIVITIES

Sampling of soil borings may be collected during field drilling operations to further delineate horizontal and vertical hydrocarbon constituent effects. However, analytical analyses and collection of soil boring samples are not included in the Abatement Plan and will be collected only if the samples will provide sufficient information to further delineate and quantify effected zones. Should collection and analysis of boring samples be required, the boring holes will be drilled with a hollow-stem auger drill equipped with 5-foot sections of a continuous coring device. Soil samples will be collected from the base of each 5-foot interval until the water table or clay aquitard is encountered. The ASTM standards for Hollow-Stem Auger drilling will be used as guidelines for these drilling activities.

Soil samples may be analyzed for benzene, toluene, ethylbenzene and xylenes (BTEX) and semi-volatile organic compounds (SVOC), using SW846 Methods 8021 (or 8260) and 8270 respectively. Standard operating procedures for QA; sample control, custody, and management; equipment calibration; equipment decontamination; analytical laboratory and field QA/QC; data management; and preventative maintenance are provided below.

PROCEDURES FOR DECONTAMINATION OF GROUNDWATER SAMPLING EQUIPMENT

To prevent contamination of samples or monitoring wells, all sampling equipment must be thoroughly cleaned prior to each use.

Unless documentation states otherwise, any equipment, either new or previously used, should be assumed to be contaminated and should undergo the level of decontamination appropriate to its intended use and construction.

Sampling equipment dedicated to a particular well will be cleaned prior to installation and after any maintenance requiring its removal from the well. Other equipment will be cleaned prior to use at each individual site. The procedures for cleaning field equipment are described in the SOP for groundwater sampling.

The contract laboratory provides all containers used for the collection of samples. These containers are prepared by an independent company and sent to the laboratory with a certificate stating that they are clean.

These procedures are designed to fully comply with the requirements of RCRA groundwater monitoring.

REFERENCES

US Environmental Protection Agency, 1986a. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*

US EPA, 1996b. *Test Methods for Evaluating Solid Waste: EPA report SW-846; Volume I: Physical/Chemical Methods*

PROCEDURES FOR PURGING & SAMPLING MONITOR WELLS

Procedures to be used in purging and sampling wells for determination of water quality and potential contamination are described herein. These procedures are consistent with Federal regulations and specifically designed to comply with groundwater monitoring requirements under the Resource Conservation and Recovery Act (RCRA).

HEALTH & SAFETY COMPLIANCE

All personnel will read and sign the site-specific Health & Safety Plan before sampling can begin. Additionally, there will be an on-site H & S meeting to go over the Plan before on-site personnel will be allowed to start any work.

OUTLINE OF GENERAL PROCEDURES

PREPARATIONS FOR SAMPLING

Before proceeding to the field area, all necessary equipment and supplies should be on hand. To the extent possible, all equipment and supplies should be decontaminated before proceeding.

Equipment and supplies needed for collecting representative groundwater samples include:

- An electronic water level indicator
- Distilled water and washing containers
- Brushes and laboratory soap
- Heavy plastic bags
- Paper towels or clean rags
- Zip bags
- Latex gloves
- A submersible pump
- A hose to direct any discharge, and containers to receive the discharge
- Plastic sheet film
- A graduated bucket

- Bottom-filling Teflon bailers and cord
- All necessary sample containers with appropriate preservative
- Thermometer
- Specific conductance meter
- Field logbook
- Ice and cooler for samples
- Waterproof pens (fine-point and ultrafine-point)
- Chain-of-custody forms
- A watch for use in determining pumping rates
- At least four 5-gallon buckets

Before any procedures begin, the area around the well must be covered with plastic sheeting. Avoiding any type of contamination is important. Have all necessary equipment ready.

Record weather conditions and the time in the field book. Record well number and parameters to be tested. Write all important field conditions in the field notebook. Write anything unusual in the book. It is very easy to recall any field activity when it is written in a field book. Take pictures if necessary.

DETERMINING WATER LEVEL

Using a water level probe or other suitable device, measure the depth to water (DTW) in the well. Lower an electronic sounder into the well. When the alarm sounds, adjust the tape until the exact water level is apparent. Record the water level. If approximate total depth (TD) of the well is not known, it will also be necessary to measure TD with the probe. Lower the tape carefully until it softly hits the bottom of the well; adjust the tape until the exact depth is apparent. Record the depth. Wash the probe properly.

DETERMINING VOLUME OF WATER TO BE PURGED FROM THE WELL

Normally, at least three casing volumes of water are purged from the well. Purge volumes are determined as follows:

- Measure the inside diameter of the casing. Convert to feet.
- Find the inside radius by dividing the diameter by 2.

- Determine one casing volume in cubic feet (Vcf) by calculating:

$$Vcf = ((r)^2(TD-DTW))$$

- Determine one casing volume in gallons by multiplying Vcf by 7.48 gals/ft^3
- Multiply by 3 to determine total volume of water to be pumped from the well.

When purging low yield wells, pump the well once to dryness. Samples should be collected as soon as the well recovers. When full recovery exceeds three hours, samples should be collected as soon as sufficient water volume is available.

PURGING THE WELL

Currently, standards allow for several types of equipment and methods for purging wells. The two we will be using are:

- Disposable bailers
- A small submersible pump manufactured by Geotest

At no time during the purging should the evacuation rate be high enough to cause the groundwater to cascade back into the well; this causes excessive aeration and potential stripping of volatile constituents.

The actual volume of purged water can be measured by several acceptable methods.

- When bailers are used to purge, the actual volume of each bailer's contents can be measured using a calibrated bucket.
- If a pump is used for purging, the pump rate can be determined by using a bucket and stopwatch. The necessary volume can then be reached by timing the purge.

Monitor temperature and specific conductance of the water purged until these parameters have stabilized by the time three casing volumes have been withdrawn. If stabilization has not been achieved by that time, continue purging until it is achieved.

DISPOSAL OF PURGED WATER

Dispose of pumped water in a manner that poses no threat of further contamination to any surface or to the groundwater.

INITIAL SAMPLING FOR FIELD PARAMETERS

Begin sampling by withdrawing water from the well using a disposable bailer or pump. Place the first water withdrawn in a clean bucket that has been rinsed with the well water. Use this sample for field measurement of temperature and specific conductance.

DETAILED DESCRIPTION OF SAMPLE COLLECTION PROCEDURES

GENERAL CONSIDERATION

The technique used to withdraw a groundwater sample from a well should be selected based on a consideration of the parameters that will be analyzed. To maximize the probability that groundwater samples are representative of the aquifer, it is important to avoid physically altering or chemically contaminating the samples during collection, withdrawal and containerization.

The preferred sampling device for all parameters is a disposable bottom filling bailer.

General sampling procedures include the following:

- Clean sampling equipment should not be placed directly on the ground. Use a drop cloth or feed line from clean reels.
- Slowly lower sampling equipment into the well to avoid degassing of the water and damage to the equipment.
- Check the operation of the bailer check valve assemblies to confirm free operation.

Samples are collected and contained in the order prescribed in Table A-1. The table lists the preferred sample collection order for the groundwater parameters. Volatilization of sample parameters can be a problem if samples are collected inappropriately. With the exception of dissolved metals collection, which requires a disposable filter that fits on the pump effluent tube, samples will always be taken in the order listed in Table A-1.

Table A-1
Preferred Order of Sample Collection

1. Volatile Organic Compounds (VOA)
2. Methane
3. Semi-Volatile Organic Compounds (SVOC)/ Polynuclear Aromatic Hydrocarbons (PAH)
4. Other Parameters (various)
    - Nitrate
    - Sulfide
    - Cations
    - Anions
    - Other Metals

COLLECTION OF VOLATILE ORGANIC SAMPLES

Collection of samples for volatile organic analysis (VOAs) should be taken from the first bailer removed from the well after purging, immediately following collection of the sample for field analysis and dissolved metals. Two people are needed to collect the sample. One person should retrieve the bailer from the well and place the bottom over a VOA container (40-ml vial) held by the second person. The second person should insert the bottom-emptying device into the bailer, bring the vial to the tip of the bottom-emptying device and tilt the vial to approximately 60 degrees from vertical. As the vial is filled, the second person should return the sample vial to the vertical position.

Fill the vial until it just has a positive meniscus. Cap the vial and invert. If a bubble exists, discard and repeat.

CONTAINERS

Collect all samples using the standard methods described in ASTM Standard D4448-85a. Preserve all samples in approved laboratory containers. The specific containers and preservatives used for each analyte are outlined in Table A-2. These containers are supplied, with preservative, by a certified laboratory. A laboratory container supply company supplies all containers.

Table A-2
Sample Container Requirements for Giant Refinery

Matrix	Analysis	Volume	Containers & Preservative
Water	Volatile Organic Compounds	80 ml	2-40 ml glass w/HCl
Water	Semi-Volatile Organic Compounds/ Polynuclear Aromatic Compounds	2 or 3 Liters	2 or 3-1 Liter Amber glass
Water	Metals or Cations	500 ml	500 ml plastic w/HNO_3
Water	Anions	250 ml	250 ml plastic
Water	Nitrate (if sample cannot get to the lab within 48 hours)	100 ml	100 ml plastic w/ H_2SO_4
Water	Methane	120 ml	3-40 ml glass or crimp tops
Soil	Volatile Organic Compounds	80 grams	4 oz glass w/Teflon lined cap
Soil	Semi-Volatile Organic Compounds/ Polynuclear Aromatic Compounds	150 grams	8 oz glass w/Teflon lined cap
Soil	Metals	50 grams	4 oz glass

LABELING

All labeling must be done immediately after the collection. Recording of the sample number (based on year-month-day-time in 24-hour clock), sample collection location, samplers and client must be recorded on the label of the sample. The samples must then be placed in a plastic bag and immediately put in a cooler with sufficient ice to keep them cool.

MEASURING DEPTH TO WATER

After collection and preservation of all samples, measure the depth to water (DTW), using the sounder probe. Wash the probe properly. See the next section for decontamination procedures.

DECONTAMINATION

To decontaminate the pump, it is necessary to have at least four labeled 5-gallon buckets. No solvents should be used unless necessary. The use of three different pumps makes decontamination with solvents less necessary. When cleaning the pump, no parts of the pump should touch the ground. Be certain to wash all areas of the pump that have touched well water with laboratory soap. Wash the pump, while holding all of its tubing, above the Dirty Effluent Bucket. After transferring the pump to the Wash Bucket, pump laboratory soap through the tubing. After pumping sufficient soap through the tubing, personnel must transfer the pump to the Clean Wash Bucket. Run clean DI water through the tubing until the water runs completely clear. Do all decontamination of dirty equipment this way. This method of decontamination is proven. Hicks Consultants have taken samples from a monitor well with a high concentration of BTEX, decontaminated the pump in the aforementioned manner, and then taken BTEX samples from a well with ND results for the same parameters.

REFERENCES

US Code of Federal Regulations, 1983. 40 CFR 264.97
US Environmental Protection Agency, 1986a *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*

US Environmental Protection Agency, 1986b. *Test Methods for Evaluating Solid Waste. EPA Report SW-846; Volume I Physical/ Chemical Methods*

ASTM Standards Relating to Environmental Site Characterization 1997, D4448-85a

PROCEDURES FOR CALIBRATION OF FIELD INSTRUMENTS

Calibration of field instruments is very important. The calibration should occur before fieldwork starts. To properly prepare, examine any rental equipment, and read instruction manuals before any fieldwork.

THE DISSOLVED OXYGEN PROBE—YSI MODEL 85

Calibration of the dissolved oxygen probe must occur before use. The sponge inside the instrument's calibration chamber must remain wet. Insert the probe into the calibration chamber

Turn the instrument on by pressing the on/off button on the front of the instrument. Press the MODE button until dissolved oxygen is displayed in mg/L or % (percent). Wait for the dissolved oxygen and temperature readings to stabilize (usually about 15 minutes).

Use two fingers to press and release both the UP ARROW and DOWN ARROW buttons at the same time.

The LCD will prompt you to enter the local altitude in hundreds of feet (i.e., 40 indicates 40,00 feet). Use the arrow keys to increase or decrease the altitude. When the proper altitude appears on the LCD, press the ENTER button once.

The instrument should now display CAL in the lower left of the display, the calibration value should be displayed in the lower right of the display, and the current % reading (before calibration) should be on the main display. Make sure that the current % reading (large display) is stable, then press the ENTER button. The display should read SAVE, then should return to the Normal Operation Mode.

Other calibrations of the YSI Model 85 are occasional. Read the manual to determine if any other adjustments are necessary.

APPENDIX B

Mr. Hicks is a nationally certified professional geologist with over 22 years of experience in hydrogeology, geochemistry, remedial actions, and site characterization. He implements projects throughout North America, and is a registered geologist in four states. He has served as an expert witness and project manager in numerous environmental matters, ranging from cost allocation issues on Superfund sites to due diligence for the oil and gas industries. He specializes in working with the legal, real estate and oil and gas industry to acquire, insure, finance, and obtain permits for environmentally impaired sites.

He previously served as a supervising hydrogeologist in the permitting section of the New Mexico Environment Department where he co-authored the Underground Injection Control Regulations. For BDM Environmental, he managed Environmental Protection Agency (EPA) enforcement support projects. He employs his knowledge and experience in regulatory matters to assist private and public sector clients develop strategies consistent with the risks at a site, the budget of the client, and the mandates of the regulations and laws. Mr. Hicks has written a number of professional papers and presented seminars on oil field produced water management, waste management, phased remedial actions, geochemistry, and groundwater contamination. Some of Mr. Hicks' accomplishments are:

- Performed an environmental audit and then developed cost estimates for remediation/restoration of petroleum hydrocarbons and other constituents at a gasoline plant in New Mexico and an oil field in Colorado. The estimates provided were used to create a "fair market value" for these environmentally impaired sites and incorporated into the sales documents.
- Mr. Hicks provided management and technical oversight for a redevelopment project near downtown San Francisco. An abandoned brewery in an industrial area was converted to single-family residential property. This process required building demolition, asbestos abatement, subsurface characterization, risk assessment, and development of a remedial/permitting strategy for documented soil and groundwater contamination. Coordination of environmental requirements with the demolition and grading specifications minimized construction cost.
- For the Navajo Artesia Refinery, Giant Bloomfield Refinery, Giant Ciniza Refinery, EPNG San Juan Natural Gas Processing Plant, ATA Pipeline and the GPM Linham Ranch Natural Gas Processing Plant, Mr. Hicks developed regulatory permits and performed environmental site investigations. Mr. Hicks is currently working toward elimination of a discharge plan requirement for ARCO's Empire Abo Gas Plant.
- As the Expert Witness for the Four Corners Gas Producers Association, he presented testimony before the New Mexico Oil Conservation Commission hearing on produced water disposal. The project involved field testing that demonstrated a lack of impact due to produced water disposal in unlined pits.

Education:

M.S., Geology, University of New Mexico, 1981

B.S., Geology, Beloit College, 1975

Registrations and Certifications:

AIPG Certified Professional Geological Scientist, No. 6777

Arizona Professional Geologist, No. 19483

California Registered Geologist, No. 4468

Virginia Professional Geologist, No. 2801 001024

Wyoming Professional Geologist, No. PG-2147

New Mexico Certified Scientist (Underground Storage Tank Bureau)

New Mexico Certified Radiation Safety Consultant, No. 411-6

- Implemented a remedial action and closure of an oil field in Colorado. This project involved the characterization of soil and groundwater impacts associated with a 50-year old field. Groundwater was addressed through intrinsic remediation (natural attenuation). Because the soil contained Naturally Occurring Radioactive Materials (NORM), special treatment and regulatory permitting was required.

- Working with an architect and planner, Mr. Hicks completed a public sector project to convert a former rail yard to an inter-modal transport facility in Albuquerque, New Mexico. The environmental due diligence process was integrated with the plans for the facility to accelerate site development. The architect can integrate any remediation of site soils with the construction process. A risk-based remedial strategy for suspected groundwater contamination is expected to result in a "no-action/natural restoration" program..

- Served as a technical member of Sandia National Laboratories' Independent Review Team (Red Team) for a complete audit of DOE's UMTRA and the Lawrence Livermore Laboratory's groundwater restoration programs. The team members recommended significant re-engineering of both programs, resulting in projected savings of more than $400M.

- Acted as quality assurance officer for more than 25 environmental restoration projects in the past three years. He focuses his effort on ensuring that the proposed technology addresses the risks posed by the contamination while not creating an unnecessary economic burden. Wherever "intrinsic remediation " (no action) may be appropriate, Mr. Hicks challenges the engineers to be certain that nature is not a better remedial technology.

- The buyer of an active New Mexico manufacturing plant believed an environmental escrow account of $3,000,000 would be sufficient to address all outstanding issues at the site. The seller retained Mr. Hicks to develop a plan to address the concerns of the buyer. His initial assessment indicated that a careful investigative program could remedy the matters. If necessary, a risk-based "intrinsic remediation" approach would follow the investigation. Mr. Hicks not only assisted in reducing the escrow amount but also worked toward regulatory closure for a total cost of $150,000.

  He provided expert witness testimony in a case involving the release of petroleum hydrocarbons from an Underground Storage Tank in New Mexico. At this site, decades of releases resulted in the abandonment of two municipal supply wells of a small community. Mr. Hicks directed the investigation and developed a remedial response that included drilling an alternative water supply well to reduce the owner's liability. Significant litigation support was required to obtain appropriate insurance coverage for environmental costs.

Most Recent Publications:

Do Nothing Clean-ups
Randall T. Hicks and
Rais Rizvi,
Civil Engineering, September, 1996

Natural Attenuation of Petroleum Hydrocarbons: 12 Years of Data
Fourth Annual Conference on Natural Attenuation, Pasadena, California, 1998

Relevant Experience:

Exploration geologist and University research assistance for uranium ore deposits, 1975-1980

State environmental regulator, 1980-1983

Founder and Vice President of Geoscience Consultants (later BDM Environmental), 1983-1996

Michelle Gallagher Hunter
Staff Scientist

Ms. Hunter is a Staff Scientist with three years of experience in the environmental field. She is currently involved in projects in New Mexico, Colorado and California. She has served as a support scientist for a variety of projects ranging from site characterization and risk assessment to stream and wildlife biology. Ms. Hunter's project experience includes:

- Ms. Hunter has initiated large field investigations at petroleum sites in New Mexico and Texas. In addition to planning and implementing field sampling programs, Ms. Hunter has an excellent understanding of laboratory analysis and methodology.
- Ms. Hunter helped to organize and implement a comprehensive industrial hygiene study at a large semi-conductor facility and cleanroom. The study included air monitoring and sampling both inside and outside of the cleanroom.
- Ms. Hunter is responsible for organizing and conducting the semi-annual field programs for two sites in eastern New Mexico. Additionally, she is responsible for writing the monitoring report to the New Mexico Environment Department for each field event.
- Ms. Hunter helped implement a field program for a landowner on the Navajo River in Colorado. The Bureau of Reclamation sent a field crew to drill and collect samples along the river to rule out any contamination from Bureau activities. Ms. Hunter helped to initiate the program and reviewed the analytical data.
- Ms. Hunter is currently conducting research concerning river fauna in Colorado. After an initial review of existing documents pertaining to the river, Ms. Hunter will initiate a study of the current river conditions. The results the study will help implement a revitalization program in the river.
- Ms. Hunter has extensive experience with laws governing and the associated enforcing agencies specifically pertaining to RCRA issues. In addition to RCRA administrative law, Ms. Hunter has an extended understanding of EPA documents and directories.
- Ms. Hunter was responsible for the QA/QC program at an EPA site in New Mexico. The site was a RCRA facility under Administrative Orders. Because contamination had migrated off-site, QA/QC sampling protocol was required both on and off the site. All data generated at the site was carefully reviewed using QA/QC controls specific to the site.
- Ms. Hunter has performed several Phase I site assessments for residential and commercial properties following ASTM standards.

<u>Education and Training:</u>

B.S., Biological Science
University of New Mexico, 1995

40 Hour Hazardous Waste Operations and Emergency Response 29 CFR 1910.12
August 1998

Asbestos Inspector
40 CFR 763 No. 100898-01

<u>Relevant Experience:</u>

Laboratory Analyst, Assistant Project Manager, and QA/QC Officer, Assaigai Analytical Laboratories , Albuquerque New Mexico 1995-1997

Student Intern; Geoscience Consultants, Albuquerque New Mexico 1990-1991

Melissa D. Snodgrass
Staff Engineer

Ms. Snodgrass is an Engineer with three years of experience in site remediation, fluid dynamics, hydrocarbon fate and transport, and air quality permitting. She is involved in projects in Texas, New Mexico, Colorado and California and is a registered EIT in New Mexico. She has served as a support engineer and project manager for a variety of projects ranging from wastewater characterization and site remediation to air emissions inventories and permit applications. Ms. Snodgrass' project experience includes the following:

- The sale of a roofing paper plant in Albuquerque raised questions regarding the need for a water discharge permit. Ms. Snodgrass organized and implemented a wastewater sampling plan to assess the effluent being discharged to the POTW. Ms. Snodgrass provided a characterization of the effluent stream, an estimation of the annual fees for discharging with no pretreatment and recommendations for pretreatment possibilities.

- To gain closure on the site of a reclaimed oil field, paraffin from seven open pits and impacted surface soil from a number of well heads had to be remediated. Ms. Snodgrass designed and constructed a soil cell for intrinsic remediation with aeration that allowed for the consolidation and containment of the hydrocarbons and impacted soils. The soil cell effectively eliminated any environmental risk from the hydrocarbons while avoiding large disposal or remediation costs.

- Ms. Snodgrass was the project manager for the creation of SPCC plans for over fifty sites belonging to a national oil and gas company. Each site was evaluated according to the criteria listed in 40 CFR Part 112. Support was given for those sites not meeting the criteria and a SPCC plan was created for the remaining sites. Ms. Snodgrass coordinated all site visits and authored the final SPCC plans.

- The EPA allotted funds for the New Mexico Indian Pueblos to perform comprehensive air emissions inventories. Difficulties in data gathering made the investigations costly and time consuming. Ms. Snodgrass created an emissions inventory model based on general default values that could be adjusted to reflect the emissions of any pueblo. The model allowed the pueblos to create their own inventories and provided a planning tool to demonstrate the effects of growth on pueblo-wide air emissions.

Education and Training:

Graduate studies, Environmental and Water Resources Engineering, University of Texas at Austin, 1995

B.S., Civil Engineering, Stanford University, 1995

40 Hour Hazardous Waste Operations and Emergency Response 29 CFR 1910.12 No. 082997-02

Registrations and Certifications:

New Mexico Engineer Intern,
No. 5281

Radiation Safety Officer

Relevant Experience:

Independent Contractor, Energy Consultant to PNM Gas Services, 1997

Danita Whelan
Staff Engineer

Ms. Whelan is a Staff Engineer with three years of experience in the environmental field. She is currently involved in projects in New Mexico, Utah and California. She has served as a support engineer for a variety of projects ranging from site characterization and risk assessment to sample collection and report preparation. Ms. Whelan's project experience includes the following:

- Ms. Whelan has served as Hicks Consultants Quality Assurance/Quality Control Engineer for data collection design. She is the resident statistical expert and her expertise is used in following the protocol outlined in EPA document QA/G-4 Guidance for the Data Quality Objectives Process.

- Ms. Whelan has participated in a field-sampling event at an abandoned refinery site on the New Mexico, Texas, Mexico border. The data will be used to determine whether the site has been adequately characterized; if more sampling is required, she will conduct another field sampling event.

- Ms. Whelan has helped to implement an industrial hygiene survey at a large semi-conductor facility. The study included air monitoring and sampling both inside and outside of class 10,000 and class 100 cleanrooms.

- Ms. Whelan is responsible for organizing and conducting the semi-annual field programs for a site in northern New Mexico. Additionally, she will assist in writing the monitoring report to the New Mexico Environment Department for this field event.

- After an initial site investigation, Ms. Whelan is currently evaluating improvement options to the existing sewer system in a mobile home park in Santa Fe, NM. She will conduct a cost-benefit analysis for each improvement option and report these options to the client.

- Ms. Whelan is currently assisting the contract engineer in modeling the behavior of a hydrocarbon plume using Bioplume III Simulation Model. The model will be used to evaluate remediation of the site by natural attenuation.

Education and Training:

B.S., Chemical Engineering,
Summa cum Laude
University of Kentucky, 1996

M.S. Civil and
Environmental Engineering,
University of Kentucky,
Expected Graduation Date,
May 1999

40 Hour Hazardous Waste
Operations and Emergency
Response 29 CFR 1910.12
December 1998

Relevant Experience:

Student Intern Eastman
Chemical Company, Kingsport,
TN Summer, 1993
Spring, 1994
Undergraduate Research
Assistant University of
Colorado, Boulder, CO
Summer, 1995

R.T. HICKS CONSULTANTS, LTD.

Laura Gutman, Ph.D.
Technical Editor

Dr. Gutman is a graphic designer, writer and technical editor. In addition to working with Hicks Consultants, where she is responsible for editing and graphic design of all reports, she teaches graphic design for the University of New Mexico's Continuing Education program, and works as an independent contractor designing books and newsletters. Dr. Gutman's relevant experience includes:

- She has written, illustrated, designed and published three children's books, and one computer software manual.
- During her work as Desktop Publishing Coordinator for a large advertising agency (Competitive Edge, Albuquerque), she participated in the design, illustration and publishing of several marketing books.
- She wrote and designed an article on business opportunities in New Mexico for *Inc.* magazine.
- She has developed curriculum and materials for a wide range of computer and design courses at the University of New Mexico. She is currently helping develop curriculum for UNM Continuing Education's Graphic Design & Multimedia professional certificate program.

Education and Training:

Ph.D., English, St. Andrews University (Scotland), 1988

B.U.S., University of Albuquerque, 1979

Relevant Experience:

Desktop Publishing Coordinator, Competitive Edge Advertising Agency, 1990–1992

Freelance graphic designer and editor, 1992–

Instructor and Macintosh Coordinator, UNM Continuing Education Computer Program, 1994–

R.T. HICKS CONSULTANTS, LTD.

4665 Indian School NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738

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JUL 16 1999
CONSERVATION

July 14, 1999

Mr. Warren Arthur
RCRA Technical Section – Enforcement Branch
Environmental Protection Agency-Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

RE: Administrative Order on Consent, Docket No. VI-303-H

Dear Mr. Arthur:

On behalf of San Juan Refining Company, a wholly owned subsidiary of Giant Industries, we enclose the application for renewal of Groundwater Discharge Plan GW-1. We submitted this permit document to the New Mexico Oil Conservation Division (NMOCD) on July 6, 1999 and submit this copy to the Environmental Protection Agency as a courtesy. We also enclose a copy of the investigation proposal, which was approved by NMOCD in March 1999 and an errata sheet for Volume II of the Discharge Plan. After NMOCD's review of the permit renewal application and approval of GW-1, San Juan Refining Company will submit a revised Corrective Measures Study to your office to fulfill their obligations under the existing 3008(h) Order.

As required by the New Mexico Water Quality Control Commission (WQCC) Regulations, Volume I of the renewal application for GW-1 describes the methods used for managing waste and wastewater. Volume II describes the hydrogeologic conditions at the Bloomfield Refinery and proposes an abatement strategy to restore groundwater quality. The proposed abatement strategy also required by the WQCC Regulations, addresses petroleum hydrocarbons and other constituents released by the Refinery from non-RCRA sources.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T. Hicks
Principal

cc: Lynn Shelton, Bloomfield Refinery
John Stokes, Bloomfield Refinery
Kim Bullerdick, Giant
Ned Kendrick, Montgomery and Andrews
Wayne Pierce, New Mexico Oil Conservation Division

ERRATA: Discharge Plan Application

Volume II, Page 35, Section 4.7.2

In ~~March 1997~~October 1996, the US Fish and Wildlife Service conducted a test to measure possible…

July 5, 1999

RECEIVED
JUL 15 1999
Environmental Bureau
Oil Conservation Division

Volume II:

Discharge Plan Application, Site Investigation and Abatement Plan

GIANT BLOOMFIELD REFINERY

Prepared for:

Giant Refining Company
P.O. Box 159
Bloomfield, New Mexico 87413

R.T. HICKS CONSULTANTS, LTD.
4665 INDIAN SCHOOL NE, SUITE 106, ALBUQUERQUE, NM 87110

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1 Executive Summary

For their Bloomfield Refinery, San Juan Refining Company, a wholly owned subsidiary of Giant Industries of Delaware, authorized R.T. Hicks Consultants, Ltd., to:

- evaluate existing environmental data
- conduct additional field programs
- evaluate feasible environmental remedies
- select an appropriate abatement option
- revise and update the existing Discharge Plan
- create an Abatement Plan to supplement the Discharge Plan
- address outstanding environmental commitments outlined in an EPA 3008(h) Administrative Order

This submission is Volume II of the renewal application for groundwater Discharge Plan (GW-1) for the San Juan Refining Company's Bloomfield Refinery (the Refinery). Volume I of the Discharge Plan addresses wastewater discharges from the Refinery. Volume II addresses abatement of hydrocarbons and other constituents of concern in groundwater. Under separate cover to the US EPA, San Juan Refining Company will submit the revised Corrective Measure Study, which is the only outstanding commitment under the 3008(h) Administrative Order.

Since 1984, the Refinery site has been the subject of numerous field investigations, most of which generated reports. We examined a 15-year record of surface water sampling, a 12-year record of soil and waste sampling, and a 13-year record of groundwater sampling, as well as the interpretations of these programs in the existing reports. These previous data and soil and water data, acquired in 1998–1999, are all presented, discussed and interpreted in this document.

Although we relied on data collected by previous site workers, our conclusions and recommendations are significantly different than those presented by others in previous documents. One reason for the difference of opinions between past submissions and those presented in this document is the evaluation of the April 1999 sampling program. In April, as suggested by the New Mexico Oil Conservation Division, we sampled 44 wells for over 80 analytes. Such an intensive sampling event had never occurred at the Refinery. The program yielded a significant body of data. Much of these data contrasted with conclusions and opinions previously advanced by other site workers. The conclusions in this submission use the new data while honoring past results. Another factor that contributes to the divergence of opinions is a large body of technical work conducted by the EPA and others on the efficacy of monitored natural attenuation of constituents of concern. Authors of previous submissions (e.g. Groundwater Technology, Inc., 1995) did not have access to more recent information regarding the effectiveness of monitored natural attenuation at sites with a relatively low risk profile.

Based on our evaluation during the 1998–1999 period, we make the following findings:

1. Five lithologic units crop out at or near the Refinery. In descending order they are:
   - San Juan River Alluvium (present only north of the Refinery along the San Juan River)
   - Quaternary apron deposits
   - eolian sand and silt (loess?)
   - Jackson Lake Terrace sand and gravel
   - Tertiary Nacimiento Formation
2. The San Juan River Alluvium is saturated and is recharged by the river and, to a lesser extent, by springs emanating from the Jackson Lake Terrace.
3. Leakage of water from Hammond Ditch (an irrigation canal) and the Refinery raw water storage ponds (untreated water pumped directly from the San Juan River) recharge the underlying Jackson Lake Terrace.
4. Jackson Lake Terrace groundwater infiltrates into the uppermost 5–10 feet of the otherwise unsaturated Nacimiento Formation.
5. The eolian silt and sand that underlies the Refinery is unsaturated.

6. Navajo Dam controls flow in the San Juan River, located about 20 miles upstream from the Refinery.

7. The Refinery maintains water in Hammond Ditch along the north edge of the Refinery during the winter, when irrigation flow ceases.

8. An unnamed arroyo cuts through the entire Jackson Lake Terrace east of the Refinery. Because the arroyo is not in contact with the Jackson Lake Terrace, natural recharge from the north is not possible.

9. An unnamed arroyo south of the Refinery periodically recharges the Jackson Lake Terrace.

10. Sampling of surface water from Hammond Ditch and San Juan River did not detect volatile or semi-volatile hydrocarbons.

11. Sampling of sediments from Hammond Ditch detected petroleum hydrocarbons at concentrations below regulatory limits.

12. A sample of hydrocarbon-stained alluvium obtained from the bank of the San Juan River did not detect volatile organic compounds.

13. Soil samples obtained in 1985 from below the liners of the North and South Oily Water Ponds (NOWP and SOWP) did not exhibit characteristics of Hazardous Waste as defined in the Resource Conservation and Recovery Act (RCRA).

14. Hydrocarbon-stained soil is evident beneath documented releases of petroleum hydrocarbons in the petroleum storage areas and crude processing area.

15. The hydraulic conductivity of the Jackson Lake Terrace is less than 1 E-5 m/s.

16. Throughout the period of groundwater level measurements (1985–1999), groundwater in the Jackson Lake Terrace flows from east to west.

17. The hydraulic gradient is less than 0.002 beneath the Refinery storage and processing areas.

18. The hydraulic gradient west of the Refinery is 0.015.

19. The saturated thickness of the Jackson Lake Terrace is as much as 8 feet in an area south of the Refinery processing area and is less than 4 feet beneath certain areas of the Refinery storage and processing areas.

20. Separate phase hydrocarbons (SPH) once flowed from the Refinery to the seeps along the Nacimiento Formation cliff, north of the Refinery, and thence into the San Juan River Alluvium.

21. Due to hydrocarbon recovery efforts and other actions at the Refinery, SPH is restricted to the Refinery area.

22. The following constituents of concern exceed WQCC groundwater standards in at least 5 of the 44 wells sampled during the April 1999 field program: 1,2 dichoroethane, naphthalene, 1-methylnaphthalene, aluminum, boron, barium, benzene, toluene, ethylbenzene, xylenes, chloride, total dissolved solids, sulfate, cobalt, chromium, iron, manganese, nitrate, and lead.

23. In general, samples from one or more groundwater monitoring wells located up-gradient from Refinery storage and processing areas exceed WQCC standards for: boron, chloride, total dissolved solids, sulfate, manganese, nitrate

24. The highest concentrations of aluminum, barium, iron, lead, cobalt and chromium generally are coincident with the highest concentrations of petroleum hydrocarbons.

25. The samples for metals were acidified in the field and not filtered.

26. Between 1994 and 1999, the extent of benzene in groundwater has remained essentially unchanged.

27. Between 1985 and 1999, groundwater samples show:

    - benzene is generally not detected in wells up gradient from Refinery storage and processing areas
    - benzene concentrations beneath or adjacent to documented petroleum release sites remain relatively predictable
    - benzene concentrations decline in wells located several hundred feet down-gradient from documented hydrocarbon release sites

28. Between 1985 and 1999, groundwater samples show:

- TDS is about 2000 mg/l in wells up gradient from Refinery storage and processing areas
- TDS concentrations beneath or adjacent to documented petroleum release sites remain relatively predictable, about 2000 mg/l
- Samples were not regularly collected for TDS from wells located several hundred feet down-gradient from documented hydrocarbon release sites

29. Between 1985 and 1999, groundwater samples show:
    - sulfate is about 600 mg/l in wells up gradient from Refinery storage and processing areas
    - sulfate concentrations beneath or adjacent to documented petroleum release sites range from 117 mg/l to below the limit of detection
    - Samples were not regularly collected from wells located several hundred feet down-gradient from documented hydrocarbon release sites
30. In 1991 (prior to full-scale operation of the hydrocarbon recovery system), SPH was detected in an roughly triangular area 1800 feet (east-west) by 1800 feet (north-south)
31. In 1999, seven wells detected SPH within an oblong area 1000 feet by 325 feet.
32. Along the Nacimiento cliff north of the Refinery, benzene and other petroleum hydrocarbons continue to seep from the Jackson Lake Terrace into the San Juan River Alluvium.

Considering these data, we draw the following conclusions regarding the site characteristics:

A. The groundwater flow regime has not changed over time at the Refinery site.

B. With the exception of an observed decline in benzene concentrations, groundwater chemistry has remained stable over time.

C. The concentrations of electron acceptors (oxygen, nitrate, sulfate) in groundwater in wells up gradient from the Refinery storage and processing areas is sufficient to cause microbial and chemical oxidation of petroleum hydrocarbons.

D. A testing program is required to determine if the observed decline in SPH thickness is due to clogging of older hydrocarbon recovery wells or operation of the hydrocarbon recovery system.

E. Continued removal of SPH from groundwater and natural oxidation of dissolved-phase hydrocarbons effectively mitigates migration of benzene and other petroleum hydrocarbons to the south and west.

F. If the current concentration decline continue, groundwater south and west of the Refinery storage and processing areas will exhibit less than 10 ug/l benzene before 2010 (MW-11).

G. Data are insufficient to determine if oxidation of hydrocarbons will occur in the San Juan River Alluvium.

H. Boron, chloride, total dissolved solids, sulfate, manganese, nitrate are above WQCC numerical standards in wells up gradient of Refinery storage and processing areas. The analytical record does not suggest that Refinery operations, such as the former spray irrigation disposal area or the former evaporation ponds, caused this condition. The concentrations of these constituents in groundwater are a natural condition.

I. Concentrations above WQCC numerical standards for aluminum, barium, iron, lead, cobalt and possibly chromium are coincident with SPH and/or benzene concentrations above 1000 ug/l. Investigation into the provenance of these constituents indicates that they were not released from the Refinery but were released from Jackson Lake Terrace sediments in response to the anaerobic conditions created by the release of petroleum hydrocarbons. After hydrocarbons are removed from groundwater and oxidizing conditions return, the concentration of these constituents will decline.

J. Petroleum hydrocarbons in groundwater are the only constituents of concern that warrant abatement.

We used the protocol outlined in the EPA's guidelines for conducting Corrective Measure Study (CMS) to examine several abatement alternatives. Our evaluation considered:

- the site characteristics (hydrogeology, topography, etc.)
- the characteristics of the constituents of concern (toxicity, mobility, etc.)
- the cost of the remedial strategies,
- the present and likely future human and environmental exposure
- the performance, reliability, implementability and safety of the abatement alternatives

The proposed abatement option consists of continued removal of SPH, monitored natural attenuation and, in the area north of the Refinery, a hydraulic barrier between the San Juan River and the adjacent alluvium.

2 Introduction

2.1 Location and Access

The San Juan Refining Company Bloomfield Refinery (the Refinery) is located south of Bloomfield, New Mexico in San Juan County, latitude N36° 41′ 87″, longitude W107° 58′ 70″ (see Plate 1). The Abatement Plan Investigation study area (Study Area) consists of the Refinery processing areas, storage tanks and waste management areas, as well as adjacent areas which exhibit subsurface petroleum hydrocarbons. Some of the waste management units are in the northeast quadrant of Section 26, T29N and R11W. The processing and storage areas are in the east central portion of Section 27, T29N, R11W. Previously installed monitor wells define an area south of the Refinery where petroleum hydrocarbons are present in the subsurface. Studies also define an area north of the Refinery, along the San Juan River, where subsurface hydrocarbons exist. Plate 2 shows the property owned by San Juan Refining Company with respect to Sections 26 and 27.

The Refinery is located on a bluff 120 feet above the south side of the San Juan River. Plate 3 shows the Refinery and the Study Area of this investigation. The top of the bluff is relatively flat, at an elevation of 5,540 feet above sea level. An unnamed arroyo flows toward the San Juan River on the southern and western edges of the Study Area. East of the Study Area, a well-defined arroyo cuts a small canyon from the bluff to the San Juan River. Hammond Ditch, an unlined irrigation ditch, lies on the bluff between the limit of the Jackson Lake Terrace (also called the Nacimiento Cliff in this document) and the Refinery. The cover of this report is a view east near Seep S-4, showing Hammond Ditch and the Refinery.

Portions of the Study Area are associated with the following activities (as indicated in Plate 4):

- Petroleum processing
- Crude and product storage
- Crude unloading and product loading
- Waste management (closed units and existing facilities)
- Offices and non-petroleum material storage

2.2 Site Description and History

Plate 4 is a map of the Refinery, created in November 1998 and representing conditions as they have existed for most of the site's existence. As Plate 4 shows, Refinery offices are on the western end of the facility, along with warehouse space, maintenance areas, raw (clean) water ponds for temporary storage of fresh water from the San Juan River, and one storage yard containing used material (e.g. pipe, valves). The former drum storage area, identified as a solid waste management unit (SWMU) by the EPA, is also in this area. Processing units, located north of the Refinery offices, include the crude unit, fluidized catalytic polymerization unit and hydrodesulfurization unit. Several product storage tanks are present east of the processing area. The API separator and wastewater treatment ponds are east of the processing area. The wastewater treatment ponds are the north oily water pond (NOWP) and the south oily water pond (SOWP), both identified by the EPA as RCRA hazardous waste management units.

In the central portion of the Study Area, aboveground storage tanks (ASTs) occupy a large portion of Refinery property. South of the Refinery and across Sullivan Road are terminals for loading product and off-loading crude, gas storage and the hazardous waste storage area.

The eastern portion of the Study Area contains closed and operational waste management facilities. Until the end of 1994, Refinery personnel used two clay-lined evaporation ponds and a spray irrigation area to treat and dispose of wastewater. Until the end of 1998 (as Plate 4 shows), two double-lined five-acre evaporation ponds and a Class I underground injection well handled all Refinery wastewater. (It should be noted that in late 1998—after Plate 4 was created—the former evaporation ponds were converted into new Raw Water Ponds. Compare Plate 20 which shows the configuration of the new Raw Water Ponds with Plate 4, which shows the former evaporation ponds.) The former spray irrigation area is closed and overlaid by an office complex. The fire training area and the former landfill are also located at the eastern end of the facility.

Plate 4 also shows monitoring wells south of the Refinery fence line and west of the crude unloading and product loading area. These wells define an area where petroleum hydrocarbons exist in groundwater. The US Bureau of Land Management (BLM) controls this part of the Study Area. Subsurface hydrocarbons also exist north and west of the processing area, between the San Juan River and the cliff that defines the limit of the Jackson Lake Terrace deposits. This area is owned by San Juan Refining Company.

A complete history of the Refinery, including improvements, expansions, spills and investigations, is provided in the March 1993 "RCRA Facility Investigation–Task I: Description of Current Conditions" report (Groundwater Technology, Inc. (GTI).) Local entrepreneur Kimball Campbell originally constructed the facility as a crude topping unit in the late 1950s. O.L. Garretson bought the facility in the early 1960s, renamed it Plateau, Inc., and sold it in 1964 to Suburban Propane of New Jersey. As a protective filing, Plateau applied in November 1980 for a RCRA Part A Permit as a generator of hazardous waste and as a Treatment, Storage and Disposal (TSD) facility. In 1982, Plateau petitioned for reclassification under a generator-only status. Bloomfield Refining Company (BRC) acquired the facility from Suburban Propane (Plateau) on October 31, 1984. Facility ownership was transferred to San Juan Refining Company on October 4, 1995.

2.3 Previous Investigations

Between 1984 and 1990, the former owner of the Refinery, Bloomfield Refining Company (BRC), contracted with several environmental consultants to install thirteen groundwater monitoring wells (MW-1 through MW-13), three recovery wells (RW-1 through RW-3) and three piezometers. These investigators also carried out a conductivity survey and a soil vapor survey to assist in placement of the wells. These field campaigns were conducted in accordance with New Mexico Water Quality Control Commission (WQCC) Discharge Plan requirements, a RCRA 3013 Administrative Order investigation, and a RCRA 3008 Order and Consent Agreement to close certain land disposal facilities. Some elements of the field investigations also supported a voluntary effort to recover separate-phase hydrocarbons (SPH). To that end, BRC installed six additional SPH recovery wells (RW-14 through RW-19), two monitoring wells (MW-20 and MW-21) and an inoperable air sparging well now labeled MW-24. All of these wells are displayed on Plate 4.

In December 1992, BRC signed an Administrative Order on Consent (AOC) with the EPA. This Order required several work elements, including a RCRA Facility Investigation and a Corrective Measure Study. In order to fulfill the requirements in the AOC order, BRC contracted with Groundwater Technology, Inc. (GTI). In the course of their work, GTI and Layne Environmental installed two recovery wells (RW-22 and RW-23) and ten monitoring wells (MW-25 through MW-34).

In 1995, San Juan Refining Company (a wholly-owned subsidary of Giant Industries, Delaware) purchased the Refinery. In 1997, Refinery personnel caused the installation of three monitoring wells (MW-40 through MW-42) south of the processing units to monitor hydrocarbon distribution within the Refinery. Refinery personnel also had four monitoring wells (MW-35 through MW-38) installed on Bureau of Land Management property adjacent to the Refinery, as a voluntary action to delineate the southern extent of hydrocarbons in groundwater.

In March 1997, Refinery personnel contracted with Precision Engineering to investigate an area adjacent to the San Juan River. Eleven borings identified hydrocarbons in recent alluvial sediments. These hydrocarbons appear to have flowed from cliffside seeps, through the talus slope and into the alluvium.

Table 1 provides a summary of previous site investigations.

Following are more detailed descriptions of work performed in response to various orders and voluntary initiatives.

2.3.1 RCRA 3008 Order Investigation (1985)

In November 1985, in accordance with a RCRA 3008 Compliance Order, BRC closed the south and north oily water wastewater ponds (SOWP and NOWP), the onsite landfill, and the landfill runoff pond. Sediment and some underlying soil were removed from the unlined SOWP and NOWP and a synthetic liner was installed in each. Engineering Science sampled the material removed from the ponds; subsequent analytical results showed that the material did not meet criteria for classification as hazardous waste (reactivity, ignitability, explosivity or toxic characteristics).

In October 1985, Engineering Science collected and analyzed soil samples from each of the oily water ponds from beneath the recently installed synthetic liners. The analytical results demonstrated that the material beneath the ponds did not exhibit hazardous waste constituents (Engineering Science, 1986).

During this same investigation, Engineering Science also sampled the landfill runoff pond, which had been created as a result of blockage of an arroyo during construction of Hammond Ditch. Again, the results were consistent with the requirements for clean closure for the unit as required by the 3008 order.

The EPA issued closure approval for the NOWP, SOWP and the landfill runoff pond in January 1994. To date the EPA has not issued a closure letter for the onsite landfill.

2.3.2 New Mexico Oil Conservation Division Discharge Plan GW-1 (1984)

In 1983, the New Mexico Oil Conservation Division (NMOCD) required numerous wastewater dischargers, including the Bloomfield Refinery, to submit Groundwater Discharge Plans. In 1984, NMOCD approved the first of these Water Quality Control Commission Regulation discharge permits, GW-1, for the Bloomfield Refinery. The plan, prepared by Refinery personnel, described their waste management practices and demonstrated that procedures at the Refinery would not cause a violation of the WQCC Regulations.

In 1984, as a matter of policy, NMOCD did not exercise regulatory authority over groundwater abatement matters if other state or federal regulatory agencies were exercising regulatory jurisdiction at the facility. At this time, the EPA was addressing groundwater issues under the Resource Conservation and Recovery Act (RCRA). Therefore, the NMOCD restricted application of the WQCC Regulations to current Refinery discharges.

The discharge plan has been renewed every five years, up to the present.

2.3.3 RCRA 3013 Order Investigation (1985)

In April 1985, the EPA issued a 3013 Order requiring a groundwater study at the site (Docket No. RCRA 3013-00-185), as well as analysis of surface water during low-flow conditions.

According to Engineering Science's final report (Engineering Science, 1987), the groundwater study included:

- an electrical resistivity survey
- installation of four groundwater monitoring wells (MW-7 through MW-10)
- monthly fluid level measurements

- quarterly groundwater sampling of wells MW-1 through MW-5 and MW-7 through MW-10 for a one-year period
- a series of slug tests

Surface water sampling was performed in Hammond Ditch and the San Juan River in April and July 1987, respectively. Engineering Science submitted the results to the EPA on September 14, 1987.

BRC finished all aspects of the order. The EPA released BRC from the order after submission of the final report.

2.3.4 Response to Inquiries from NMOCD (1988)

During the Discharge Plan (GW-1) renewal process in 1988, the NMOCD began to exercise their regulatory authority over petroleum hydrocarbons in groundwater. In response to various inquiries from the NMOCD, BRC engaged Geoscience Consultants, Ltd., (GCL) to conduct a soil vapor survey on BLM property located adjacent to the Refinery. Results of this study were detailed in a report submitted in August 1989 (GCL, 1989). During this field program, GCL installed three piezometers, two recovery wells and one monitoring well. GCL also converted MW-10 to a recovery well (RW-3). BRC then installed pneumatic skimmer pumps in nine recovery wells and on January 4, 1989 implemented a product recovery program.

The GCL report and other documents prepared by the previous owners of the Refinery were part of the 1989 renewal application for the Discharge Plan.

2.3.5 RCRA 3008(h) AOC (1992)

On December 31, 1992, the EPA issued another RCRA 3008 Administrative Order on Consent regarding the Refinery. This order required several work elements, as described below.

2.3.5.1 Interim Measures (IM) plan

An IM work-plan was submitted and received EPA approval in May 1993. Interim measures proposed in the plan included the installation of two additional recovery wells, surveying and gauging of all wells, deployment of pumping systems in the new wells (if appropriate) and startup of a hydrocarbon recovery operation. The "Interim Measures Report," dated March 3, 1994, describes these activities.

2.3.5.2 RCRA Facility Investigation (RFI)

In fulfillment of the RFI requirements, two reports ("Task I: Description of Current Conditions" and "Task II: RCRA Facility Investigation Work") were submitted, both in March 1993. GTI revised and resubmitted the RFI work-plan, and the EPA approved it in November 1993. As detailed in these reports, the RFI work was conducted in five phases:

Phase I: Soil Gas Survey

Phase II: Soil Boring Investigation

Phase III: Well Installation/Groundwater Sampling

Phase IV: Saturated Zone Testing

Phase IV: Soil Vapor Extraction/Air Sparging Pilot Studies

Phase V: Stream Sediment and Surface Water Sampling

2.3.5.3 Corrective Measure Study (CMS)

A RCRA Facility Investigation/ Corrective Measures Report was submitted in November 1994, summarizing each phase of the RFI and compiling and evaluating the data collected. After reviewing the document, the EPA recommended submission of a separate CMS along with additional groundwater characterization down-gradient of MW-34. GTI submitted the CMS in December 1995.

During a March 3, 1997, site visit by the EPA, San Juan Refining Company verbally petitioned the EPA to permit substantial revision of the CMS. Proposed revisions to the CMS will address recently identified hydrocarbons in the San Juan River Alluvium, and will provide a more thorough evaluation of intrinsic remediation (monitored natural attenuation) as a stand-alone restoration strategy.

2.3.6 Discharge Plan Renewal (1994)

In June of 1994, NMOCD approved the most recent Discharge Plan application for the Bloomfield Refinery. In addition to significant changes in wastewater management (e.g. closure of the spray irrigation area, closure of unlined evaporation ponds, installation of new lined evaportion ponds), Refinery personnel submitted all of the above-referenced GTI reports addressing hydrocarbons in groundwater.

2.4 Objectives

2.4.1 Determine Origins of Hydrocarbons in Soil and Groundwater

As a result of past Refinery activities, petroleum hydrocarbons are present in soil and groundwater beneath and adjacent to the Refinery. Identification of the original Refinery source(s) of the observed subsurface petroleum hydrocarbons will dictate which regulations will govern site restoration activities: RCRA, WQCC or New Mexico Hazardous Materials Management Regulations.

Since 1984, numerous field programs have provided groundwater chemistry data of the Study Area. Surprisingly, recent submissions to the EPA have not fully evaluated these fourteen years of data. Therefore, evaluation of existing data, as well as additional investigations, are required to define the origin of subsurface hazardous waste constituents, such as benzene.

2.4.2 Characterize extent, magnitude and fate of hydrocarbons

Previous investigations have defined the eastern and southern extent of subsurbace hydrocarbons, but not the northern or northwestern lateral extent, or the vertical extent.

Previous investigations presented a saturated zone simulation model (BIOPLUME II) that predicted continued migration of hydrocarbons in groundwater. This prediction is not consistent with site data. We will re-evaluate the fate and transport of hydrocarbons using a new model, BIOPLUME III, which is calibrated to site data.

2.4.3 Abatement Objectives

The groundwater abatement strategy presented in this report will address three objectives:

1. In the unsaturated zone, reduce concentrations of Refinery constituents of concern sufficiently to prevent migration into groundwater and subsequent impairment of groundwater at any place of withdrawal for present or reasonably foreseeable future use in accordance with Section 4103B of the WQCC regulations
2. In the saturated zone, reduce concentrations of Refinery constituents of concern sufficiently to eliminate toxic pollutants and concentrations in excess of the standards of Section 3103 of the WQCC regulations at any place of withdrawal for present or reasonably foreseeable future use
3. For surface water, sufficiently abate Refinery constituents of concern in the saturated and unsaturated zones to eliminate concentrations in excess of the WQCC surface water standards

2.5 Current Status of Abatement

In June 1988, Refinery owners installed two recovery wells (RW-1 and RW-2), three piezometers and one monitoring well (MW-10). MW-10 was converted to a third recovery well (RW-3), and air-operated skimmer pumps were installed in all three recovery wells. The system began operation in January 1989. In August 1990, the owners installed additional hydrocarbon recovery wells (RW-14 through RW-19). Each of these wells was equipped with a recovery pump to pipe SPH to the recovery system. Two additional recovery wells (RW-22 and RW-23) were installed in 1993 as part of the Interim Measures Work Plan implementation.

The skimmer pumps are set at the water table/SPH interface. Fluids from the wells are piped through coated and wrapped carbon steel sewer lines to the API separator. Recovered SPH returns to the refining process. Recovered groundwater discharges to the facility's wastewater treatment system, through the API separator to the RCRA wastewater treatment units and into the evaporation ponds south of the former Spray Irrigation Area. Water from the ponds is then disposed of down the injection well.

The pumps are approximately 3 feet long, $2^3/8$-inch diameter PVC or stainless steel with a top-fill port set at the SPH/water table interface. The pumps operate on a timed cycle, with an average pumping rate estimated at a maximum of $^1/2$ gallon per minute. Each pump fills for a set time; a timer then activates the pumping cycle and a compressor applies air to the pump, forcing the liquid to the surface.

Of the eleven recovery wells described above, four are no longer in use. Refinery personnel discontinued hydrocarbon recovery in RW-1 and RW-3 because they contained no SPH for several consecutive monitoring events. RW-22 and RW-23 did not contain SPH initially, and therefore were never equipped with pumping systems. The remaining seven wells (RW-2 and RW-14 through RW-19) are active and comprise the current hydrocarbon recovery system, though one of these is temporarily out of service and awaiting repairs. Of these active wells, RW-17 and RW-19 are equipped to pump only SPH, while the remaining wells pump both water and SPH. The system pumps a total of 1.5 to 2 gpm from the recovery wells.

Because only RW-18 exhibits SPH, Refinery personnel will discontinue use of all other recovery wells on NMOCD approval. Monitoring of SPH and water levels will continue, however; if SPH is detected in any well, Refinery personnel will re-activate the pump for that well.

2.6 Regulatory Considerations

Investigation and abatement of petroleum hydrocarbons and related constituents beneath and adjacent to the Bloomfield Refinery are subject to one or more of the following regulations:

- Water Quality Control Commission (WQCC) Regulations, which address non-RCRA waste management and abatement measures
- New Mexico Hazardous Waste Management Regulations (NMHWMR), which address management of hazardous waste and abatement of such releases
- Federal Regulations (40 CFR 264 and 265) promulgated under the Resource Conservation and Recovery Act (RCRA), which address compliance with previously-issued orders

2.6.1 Non-RCRA Waste Management and Abatement

The Refinery currently maintains a WQCC discharge plan permit with the NMOCD for management and disposal of non-RCRA waste. This discharge plan addresses many processes in the Refinery, including:

- active evaporation ponds
- Refinery sewer systems
- Class I non-hazardous waste injection well
- groundwater pumping to capture hydrocarbons associated with the past release of petroleum products from storage tanks

After termination of the 3008(h) AOC, abatement of subsurface petroleum hydrocarbons may proceed under either the NMHWMR or the WQCC Regulations (Subpart IV, Abatement Regulations).

2.6.2 RCRA Waste Management and Abatement

The Refinery also manages RCRA waste, currently operating under interim status pending approval of a Part A and Part B RCRA permit. RCRA waste managed by the Refinery includes API Separator Sludge (K051), Heat Exchanger Bundle Cleaning Sludge (K050), Leaded Tank Bottoms (K052), Primary Oil/Water/Solids Separation Sludge (F037), Ignitable Wastes (D001) and Benzene Toxic Wastes (D018) with generation potential. Permits to manage these wastes are issued by the New Mexico Environment Department under the NMHWM regulations.

2.6.3 Administrative Orders on Consent

As detailed above in section 2.3.5, in 1992 the EPA and BRC entered into an Administrative Order on Consent (AOC) pursuant to the authority of Section 3008(h) of the Solid Waste Disposal Act. The order suggests that petroleum hydrocarbons in the subsurface may have originated from the North and/or South Oily Water Ponds, which are considered hazardous waste management units, regulated under RCRA. As detailed above in section 2.3.5, the AOC requires three main work elements:

- implementation of interim measures to mitigate potential threats to human health or the environment
- RCRA Facility Investigation (RFI) to fully determine the nature and extent of any release(s) of hazardous waste or hazardous waste constituents at or from the Refinery
- Corrective Measure Study(CMS) to identify and evaluate alternatives for corrective action(s) to prevent or mitigate any migration of release(s) of hazardous waste or hazardous waste constituents at or from the facility

Hicks Consultants understands that all work elements up to and including submission of the Corrective Measure Study are complete. Refinery personnel have verbally petitioned the EPA to permit submission of a revised CMS. The EPA's selection of the abatement will presumably result in termination of the AOC. Depending on the origins of the observed subsurface hydrocarbons, abatement requirements will be incorporated into either a RCRA requirement or the NMOCD Discharge Plan. The EPA should also issue a closure letter for the onsite landfill.

2.6.4 Future Regulation of Abatement Activities

Abatement of soil and groundwater should proceed under NMHWMR if the proposed investigation determines that benzene or other hazardous waste constituents in groundwater originated from RCRA units, such as the North or South Oily Water Pond or identified solid waste management units.

Abatement should proceed under the WQCC Regulations if the source of benzene or other hazardous constituents in groundwater are determined to be spills from storage tanks or processing units. RCRA Subtitle C does not practically apply to such releases, as explained below.

First, the WQCC Regulations, not Federal statutes such as RCRA or CERCLA, administer responses to petroleum product releases from pipelines or bulk storage terminals. An excellent example of this division of authority between State and Federal administration is the South Valley Superfund Site. Here, petroleum hydrocarbon releases from a bulk terminal and a pipeline overlie groundwater subject to action under CERCLA. Although restoration of petroleum hydrocarbon spills is exempt from CERCLA, RCRA does not specifically exclude or exempt such activities. Nevertheless, at the South Valley Superfund Site and throughout New Mexico, restoration of petroleum product releases from pipelines and aboveground storage tanks (ASTs) is administered through the WQCC Regulations, not RCRA or CERCLA.

Second, although spilled petroleum hydrocarbon is a solid waste, it is not considered a hazardous waste. The Federal Register (54 FR 48494; November 22, 1989) states that "the materials [e.g. hydrocarbon spills] are solid wastes immediately on being spilled because they have been abandoned." The RCRA hotline reiterates this statement, as does the Region 6 EPA office in Dallas. Clearly, petroleum and soil (the spill) is a solid waste. However, petroleum products are not specifically listed as hazardous wastes in 40 CFR 261.32. Therefore, a mixture of soil and petroleum (the spill) is not defined as a hazardous waste by the so-called "mixture rule" (§261.3 (a)(2)(i)). The mixture of petroleum and the affected media (soil or groundwater) could be defined as a hazardous waste if testing showed that the mixture of soil and petroleum was ignitable, corrosive, reactive or toxic as indicated by the Toxicity Characteristic Leaching Procedure (TCLP) (see 40 CFR 261.10). The letters from the EPA listed below, and included in this report as Appendix A, suggest that petroleum hydrocarbon spills do not meet the criteria of characteristic hazardous waste:

- June 19, 1989, letter from Cannon to Jorling
- March 21, 1986, letter from Straus to Jackson

- November 1985, answer to RCRA/Superfund hotline question from customer service staff

Third, the petroleum product spill sites were never identified as solid waste management units (SWMUs) by any AOCs delivered to the Refinery. At a Treatment Storage and Disposal (TSD) facility, RCRA governs abatement only in response to releases from SWMUs.

Fourth, the EPA has a general policy concerning contaminated media from an unknown origin (61 FR 18779). If, after the owner has made a good faith effort to determine the origin of the contamination, the media do not exhibit hazardous characteristics, then the media is not subject to Subtitle C regulations. At present, data concerning the provenance of hydrocarbons in groundwater do not confirm releases from SWMUs or RCRA units. This study proposes additional evaluation to determine the provenance of these hazardous waste constituents in soil and groundwater.

Finally, an exclusion from RCRA does exist for certain types of product losses. 40 CFR 261.3 (a)(2)(iv)(C) amended at 63 FR 42184, August 6, 1998, effective February 8, 1999, states:

> *(D) A discarded commercial chemical product, or chemical intermediate listed in 261.33, arising from* de minimus *losses of these materials from manufacturing operation in which these materials are used as raw materials or are produced in the manufacturing process. For purposes of this paragraph (a)(2)(iv)(D),* de minimus *losses include those from normal material handling operation (e.g. spills from the unloading or transfer of materials from bins or other containers, leaks from pipes, valves or other devices used to transfer materials); minor leaks of processing equipment, storage tanks or containers....*

Spilled refined petroleum from storage tanks or spilled intermediate compounds created during the refining process are commercial chemical products. As demonstrated below, the release may be considered *de minimus*.

In 1995, GTI calculated the mass of the hydrocarbon plume as 68,000 gallons. If the hydrocarbons have been released over the 40 years of operation, the resulting rate of release is about 5.5 gallons/day. In 1966 the Refinery produced 172,200 gallons/day; the Refinery currently produces about 475,000 gallons/day of refined product. Using an average of these two production rates, the average daily loss of 5.5 gallons amounts to approximately 0.002 percent of their daily yield. Obviously, such a loss is *de minimus*.

3 Description of Modifications to Proposed Investigation

3.1 Modification to Field Programs

Hicks Consultants has conducted two comprehensive groundwater-sampling events at the Bloomfield Refinery, one in August 1998, the other in April 1999. Hicks Consultants' QA/QC Project Plan, submitted to NMOCD on February 8, 1999, details all sampling protocols.

Both of the two comprehensive sampling events called for analyzing each of the 44 groundwater wells and five seeps for aromatic and halogenated organic constituents, WQCC metals, total dissolved solids (TDS) and major cations and anions. In addition to these analyses, we conducted some in-field measurements of dissolved oxygen. Assaigai Analytical Laboratories performed all chemical analyses using EPA approved methods. Due to the volume of paper, chain of custody forms and laboratory reports are not included with this report, but are available on request.

The groundwater sampling events followed the protocol outlined in the QA/QC Project Plan with the following minor changes:

- Samples were not filtered during the April sampling event. We will obtain filtered samples from selected wells during the next sampling exercise.
- The dissolved oxygen probe quit functioning properly after roughly half of the wells were sampled. However, this setback was deemed relatively unimportant since the unsampled wells were those within the processing areas. Inside the processing area, where more than 6 inches of separate-phase hydrocarbons exist, we can safely assume dissolved oxygen values approach zero.

3.2 Elimination of Bioplume III Modeling

After evaluation of the groundwater chemical data, we conclude that Bioplume III modeling is not necessary to accurately characterize the extent, magnitude and fate of hydrocarbons at the Refinery. As the present report shows, the extent of hydrocarbons in groundwater is clearly identified in the 15 years of groundwater chemical data already collected at the Study Area. During this period, data show that hydrocarbons are not migrating beyond the existing monitor well network. Recent data demonstrate that hydrocarbon concentrations are declining over time in many wells. Data concerning the concentration of electron acceptors in groundwater support the hypothesis that natural attenuation is effective at the Refinery.

This Discharge Plan renewal will expire in 5 years; existing data suggest that five years is not sufficient time for natural attenuation to fully restore groundwater quality. Therefore, we maintain that Bioplume III modeling is not required for approval of this Discharge Plan renewal. We propose a groundwater-monitoring plan to provide additional data to demonstrate the efficacy of monitored natural attenuation. We propose a contingency plan if monitoring data show that the stability of the hydrocarbon plume is compromised and a threat to human health or the environment is likely.

However, Bioplume III Modeling is an effective tool to predict the time required for complete restoration of groundwater at the Refinery. We plan to conduct such modeling as partial fulfillment of requirements associated with the EPA Administrative Order on Consent issued to the previous Refinery owners. We will submit the result of the modeling effort to NMOCD when the effort is complete.

3.3 Elimination of Risk Assessment

We elected to eliminate the proposed risk assessment for the purpose of this Discharge Plan Application. As this report will show, monitored natural attenuation will effectively reduce concentrations of constituents of concern to within WQCC Standards. WQCC Regulations do not require an analysis of risk nor must evaluation of a Discharge Plan consider risk factors. Approval of a Discharge Plan is based on a demonstration that the WQCC Standards will be obtained within a reasonable time. Our analysis suggests that groundwater down-gradient of the Refinery property line will meet WQCC standards within 15 years. Therefore, a risk assessment is not warranted for the purposes of this Discharge Plan application.

4 Results of Investigation

4.1 Quality Assurance/Quality Control

4.1.1 Anomalous Data from Previous Investigations

The following data have not met Hicks Consultants' QA/QC criteria as outlined in the February 8, 1999 QA/QC project plan. Therefore, they have been excluded from our analyses and listed in this report as "anomalous:"

- BRC obtained the earliest analyses of surface water from Hammond Ditch (July 14, 1982) (see Table 2 for results). We are unsure of the location for the "HD Downstream" sample shown in Table 2, but believe the sample was obtained at the intersection of Sullivan Road and Hammond Ditch, immediately downstream from the Refinery. The sample labeled "HD upstream at Siphon" was probably obtained where Hammond Ditch crosses Sullivan Road upstream from the Refinery. The Refinery owners and NMOCD split samples, creating two samples at a location 150 yards downstream from Refinery and Sullivan Road. These samples detected volatile organic constituents in one sample downstream from the Refinery. Phenols showed higher concentration upstream from the Refinery than downstream, while TDS showed concentration one order of magnitude higher in samples 150 yards downstream of the Refinery than in samples adjacent to the Refinery. We cannot verify the sampling methods, nor can we conduct statistical testing of surface water samples due to the small number of samples taken from Hammond Ditch. We have elected to eliminate these results from consideration in this submission due to the lack of documentation regarding sampling techniques, laboratory QA/QC and the unusual TDS results.

- A 1986 sampling reported chlorine at 1,000 mg/l in MW-9; as this is an order of magnitude higher than any other chlorine concentration exhibited in that well over a 13-year period (see Plate 36), this result has been classified as anomalous.
- A 1988 sampling reported benzene at .23 ug/l in MW-13; as this well has never exhibited benzene in any other sampling event, and as this value is only slightly above the "non detect" limits for sampling, this result has been classified as anomalous.

4.1.2 Anomalous Data from This Investigation

During the April 1999 sampling event conducted by Hicks Consultants (see section 3.11.1 and Table 7), three samples fell outside the site characteristics, and were classified as anomalous:

- Naphthalene was detected in MW-34 at 69 µg/l; as no naphthalene was detected in adjacent wells, this result has been classified as anomalous.
- Sulfate was detected in RW-3 at 1,570 mg/l; as no other well in the area exhibited a concentration greater than 100 mg/l, this result has been classified as anomalous.
- Chromium was detected in MW-8 at 10 mg/l; as no other well exhibited concentrations over 1 mg/l, this result seems suspect. Therefore, Hicks Consultants will resample this well for chromium.
- Benzene was not detected in RW-17; as other wells in the processing and storage areas exhibited values over 1,000 µg/l, this result has been classified as anomalous.

All other data collected by Hicks Consultants and other investigators have met the QA/QC project plan criteria. Hicks Consultants has used these data to understand as completely as possible the site geology, the boundaries of soil and groundwater impairment, and the best remediation strategy.

4.2 Identification of Releases and Leaks

In the March 1993 RCRA Facility Investigation (RFI) GTI summarized the product releases at the Refinery. Those releases, as well as additional releases occurring after March 1993, are listed here:

DATE: November 7, 1984
INCIDENT: 880 barrels of Naptha spilled; 80 barrels were unrecovered.
LOCATION: Unspecified Storage Tank
ACTION: Spill was contained in tank dike, cleaned up, and returned to system.

DATE: May 19, 1985
INCIDENT: 140 barrels of diesel fuel spilled; 80 barrels were unrecovered.
LOCATION: Inside Tank 19 dike
ACTION: Produced was removed from tank; vacuum truck was used to recover product.

DATE: April 8–9, 1986
INCIDENT: 200 barrels of diesel fuel spilled from leaking rundown piping; 150 barrels were unrecovered.
LOCATION: Lower piperack east of crude unit
ACTION: Diesel rundown was routed to slop tank; vacuum was used to recover fuel; area was sanded.

DATE: February 24, 1987
INCIDENT: 290 barrels of regular gasoline spilled during blending; 5 barrels were unrecovered.
LOCATION: Inside unspecified tank dike
ACTION: Spill was cleaned up with vacuum truck; signage was added to alert personnel to spill hazards.

DATE: August 27, 1989
INCIDENT: 100 barrels of gasoline blend/intermediate water spilled; 1 barrel was unrecovered.
LOCATION: Inside Tank 22 dike
ACTION: Spill was cleaned up with vacuum truck.

DATE: March 8, 1991
INCIDENT: 180 barrels kerosene (Jet A) spilled during transfer; 60 barrels were unrecovered.
LOCATION: Inside Tank 26 dike
ACTION: Spill was cleaned up with vacuum truck.

DATE: June 15, 1995
INCIDENT: 100 barrels of wastewater spilled when injection well pump shut off; 20 barrels were unrecovered.
LOCATION: Evaporation ponds, contained within a dike
ACTION: Spill was cleaned up with vacuum truck.

DATE: March 25, 1996
INCIDENT: Level sensor on a truck failed during loading; a short caused a subsequent fire.
LOCATION: Loading rack area
ACTION: No cleanup was needed as the incident occurred on a concrete pad; fire consumed spill.

DATE: October 22, 1997
INCIDENT: 100 barrels of crude spilled when a truck unloaded without supervision; tank overfilled; 98 barrels were recovered.
LOCATION: Unloading area, contained within the dike
ACTION: Oil was vacuumed with truck; soil was treated in place.

DATE: January 9, 1998
INCIDENT: 70 barrels of water, sulfur and iron chelate spilled from concrete pad; 2 barrels spilled into Hammond Ditch; 50 barrels were recovered.
LOCATION: Hammond Ditch, South of Sullivan Road
ACTION: Excess water was vacuumed; soil was allowed to dry; TCLP samples were taken.

DATE: January 20, 1998
INCIDENT: 1,831 barrels of process waste water leaked when line broke; 1,821 barrels were recovered.
LOCATION: Due west of north lined evaporation pond.
ACTION: Dike was built to contain leak; flow of leak was diverted until line was repaired.

In addition to these documented losses, indirect documentation of product releases discovered while repairing storage tanks include:

- Tanks 6 and 7: 1987 – Tanks were decommissioned due to excessive leaks and repairs needed.
- Tank 17: February 1991 – Floor was repaired with 120 mils of fiberglass.
- Tank 18: May 1988 – Five holes were patched in epoxy-coated floor.
- Tank 19: July 1985 – Twenty-eight holes in floor were repaired; June 1990 – Sixty pits/holes in floor were repaired; June 1991 – Floor was replaced.
- Tank 20: November 1990 – Five holes were repaired.
- Tank 23: June 1992 – One hole in floor was repaired.
- Tank 24: May 1986 – Two coats of epoxy were added to floor to repair leaks.

- Tank 25: March 1986 – Two coats of epoxy were added to floor to repair leaks.
- Tank 26: February 1989 – Floor was coated with fiberglass/epoxy to repair leaks.
- Tank 29: January 1990 – Floor was replaced.
- Tank 30: December 1989 - Holes in floor were repaired; March 1992 – Holes in floor were repaired.
- Tank 31: March 1992 – Portion of floor was replaced due to corrosion.

4.3 Surface Geology

Plate 5 is a surface geologic map of the Bloomfield, New Mexico, area. The Tertiary Nacimiento Formation (brown) dominates the surface, forming mesas and broad tablelands. Within the northern and eastern portion of the area shown, the overlying San Jose Formation caps higher mesas. Quaternary alluvium fills the bottom of many tributaries to the San Juan River, such as Canyon Largo located east of Bloomfield.

Seven Quaternary alluvial deposits characterize the San Juan River valley. These are:

(1) Alluvium (Qal)

(2) Alluvial apron deposits (Qaa) typically adjacent to cliffs along the river

(3) Post-glacial terrace deposits (Qt)

(4) Jackson Lake Terrace deposits (Qt2)

(5) Late Bull Lake Terrace deposits (Qt3)

(6) Early Bull Lake Terrace deposits (Qt4)

(7) Pre-Wisconsin Terrace deposits (Qt5)

Exposures within the area of the Refinery are limited to the Nacimiento Formation, the Jackson Lake Terrace, apron deposits and San Juan River Alluvium.

As Plate 5 shows, the area south of the Refinery is mapped as Nacimiento Formation. The Nacimiento Formation forms a cliff more than 80 feet high along the south side of the San Juan River between NM Route 44

Figure 1: View looking west from Seep S-3 on Plate 4. The Nacimiento Formation forms the lower ¾ of the vertical cliff. The top of the cliff, on the left side of the photograph is what appears to be a cross section of a sand dune in the loess of the upper Jackson Lake Terrace. Below the dune is the 20–30 foot thick gravel unit.

and the Refinery. With the exception of this dramatic exposure (see Figure 1), the Nacimiento Formation is generally covered by soil, aeolian sand or slope wash.

The Refinery lies on a thin aeolian sand and loess unit that caps the Jackson Lake Terrace deposit. Geologic maps show the aeolian sand as part of the Jackson Lake Terrace (see Plate 5). The gravel, cobbles and sand of the Jackson Lake Terrace are exposed along the cliff on the south side of the San Juan River (Figure 1) and on both sides of the unnamed drainage due east of the Refinery fence line (Figure 2). The upper portion of the Jackson Lake Terrace also crops out south of the Study Area at the base of several rolling hills.

Within the Study Area, the apron deposits are restricted to a narrow exposure between the base of the Nacimiento Cliff and the San Juan River Alluvium. Although the Alluvium forms a broad plain on the north side of the River, on the south side of the River, within the Study Area, the alluvium is limited to a small sand and gravel bar deposit. The Refinery's water intake facility is located on this gravel bar.

4.4 Subsurface Geology

Three lithologic units below the fenced Refinery area are important: the eolian (windblown) sand deposit, the Jackson Lake Terrace and the Nacimiento Formation. Other lithologic units in the Study Area are the

Figure 2: View looking north from Sullivan Road, east of the Refinery. Here, the unnamed arroyo has removed the Jackson Lake Terrace and scoured the Nacimiento Formation. The white stake in the center of the photograph is about 5 feet below the contact between the two units.

quaternary apron deposits north of the Refinery and a small deposit of San Juan River Alluvium. The stratigraphic relationship between these five units is presented in Plates 6, 7 and 8. These plates are discussed later in this section.

The unit directly beneath the Refinery consists of eolian sand deposits and limited artificial fill. The eolian deposits are comprised of fine sand with smaller volumes of silt and clay. Where not augmented by fill, these deposits can be as thick as 10–15 feet. Typically, this unit is unsaturated.

The underlying Jackson Lake Terrace is comprised of cobbles, gravel and sand, varying in thickness from 0–20 feet. On the northeastern edge of the Study Area, where the unit is relatively thick, pre-Wisconsin erosion into the Nacimiento permitted a greater accumulation of these glacial outwash deposits and post-Wisconsin erosion is less than in other portions of the Study Area. In the southern portion of the Study Area, post-Wisconsin erosion has removed most of the unit and deposited alluvium in its stead. The lower portion of the Jackson Lake Terrace is generally saturated. This unit is unconsolidated and friable.

The Tertiary Nacimiento Formation consists of mudstone, siltstone and thin, discontinuous sandstone lenses. The unit ranges in color from gray to green. According to Stone and others (1983), the base of the Nacimiento Formation lies at an elevation of approximately 5,000 feet above sea level near Bloomfield. Therefore, the total thickness of the unit within the Study Area is about 500 feet. Although sandstone lenses produce sufficient quantities of water for limited domestic use at some locations within the San Juan Basin, the Nacimiento is considered a poor aquifer and a relatively good aquitard. In the Study Area, saturation of the Nacimiento Formation is limited to the uppermost few feet where groundwater infiltrates from the Jackson Lake Terrace.

Quaternary apron deposits exist north of the Refinery, at the base of the Nacimiento Formation cliff. This unit consists of large blocks of Nacimiento Formation mixed with eolian sand and slope wash from the Jackson Lake Terrace. The outcrop is less than 50 feet wide, and therefore does not appear on Plate 5. This unit is saturated only where water discharges from the Jackson Lake Terrace along the Nacimiento cliff. Water flows over the cliff and into the apron deposits, continuing its vertical flow to the underlying San Juan River Alluvium.

Within the Study Area, the San Juan River Alluvium is restricted to a small sand and gravel bar deposit on which the water intake facility exists. The unit is coarse-grained, highly permeable and unconsolidated. The water table in this unit is controlled by the stage of the adjacent San Juan River.

Plate 6 is a northeast-southwest cross-section of the area that also presents the 1998 water table. This section shows erosion of the Nacimiento near MW-1 and a thickening of the Jackson Lake Terrace. Near MW-29, where the top of the Nacimiento is relatively high, the Jackson Lake Terrace thins. Post-Wisconsin erosion also thinned the Jackson Lake Terrace near MW-11.

Plate 7 is a north-south profile from the San Juan River to the southern boundary of the Study Area. This plate shows that the Jackson Lake Terrace is a separate hydrogeologic unit from the San Juan River Alluvium displayed in SB4-397. As also shown in Plate 6, the saturated thickness of the Jackson Lake Terrace is only 3–4 feet where the top of the Nacimiento is relatively high (RW-3). Near Hammond Ditch, the saturated thickness of the Jackson Lake Terrace is greater due to leakage from the ditch.

Plate 8 is an east-west profile along the southern boundary of the Refinery. This cross-section shows relationships similar to those described above. The top of the Nacimiento Formation is high. The Jackson Lake Terrace is thin on the east side of the Refinery (compare with MW-29 in Plate 6). On the west side of the Refinery, note how leakage from Hammond Ditch and the Raw Water Ponds (P-1 is located adjacent to the Raw Water Ponds) causes elevation of the water table. This cross-section also shows how the water table intercepts the land surface at the man-made drainage west of the Refinery.

Plate 9 displays the elevation of the top of the Nacimiento Formation. The Jackson Lake Terrace lies on this erosional surface. The map suggests east-west scouring by the glacial outwash streams, especially on the southern portion of the Study Area, defined by the 5492 elevation. Nacimiento surface elevation above 5496 defines the southern edge of the paleo-channel; small "hills" or "islands" may have existed during initial deposition of the Jackson Lake Terrace. As discussed in more detail later in this report, this erosional surface partially controls the flow of groundwater perched on the Nacimiento Formation.

Appendix B contains the lithologic and well completion logs for all borings at the Refinery.

4.5 Surface Water Flow

The principal surface water body in the area is the San Juan River, which forms the northern border of the Study Area. The San Juan River originates within the San Juan Mountains of Colorado, about 100 miles northeast of Bloomfield. Navajo Dam, about 20 miles upstream from the Refinery, controls water flow in the river and also creates a trout fishery at the base of the dam. Despite the control exerted by the dam, periodic flooding of low-lying areas adjacent to the San Juan River can occur. Several large drainages, such as Gobanador Wash, empty into the San Juan River between Bloomfield and Navajo Dam. Local precipitation coupled with a large release from the dam can trigger localized flooding. The northern portion of the Study Area is subject to this infrequent flooding.

Navajo Dam also diverts water from the San Juan River for irrigation. Hammond Ditch is one such diversion, flowing from east to west across the northern portion of the Study Area. Water flows during the irrigation season, approximately April to October. The Refinery retains water within Hammond Ditch from October to April. A later section of this report discusses the influence of Hammond Ditch leakage to the underlying groundwater.

An unnamed drainage forms the eastern boundary of the Study Area (see Plate 3). This arroyo cuts a small canyon, in which are exposed several rock units. The observed units are, in descending order: the Jackson Lake

Terrace (about 15 feet thick) and the Nacimiento Formation (25 feet from The Jackson Lake Terrace contact to the canyon floor). Figure 2 is a photograph showing these relationships.

A second unnamed arroyo forms the southern and western boundary of the Study Area (see Plate 3). This second arroyo cuts a smaller canyon south of the Study Area that exposes the upper portion of the Jackson Lake Terrace. The original channel of this arroyo was modified by the construction of Hammond Ditch and Sullivan Road. The arroyo now flows beneath the ditch and along the south side of the road. The original channel lies on the north side of the road. A constriction in the arroyo channel exists at the intersection with Hammond Ditch. Floodwaters temporarily pool here.

Leakage from Hammond Ditch has created several small surface water bodies within the Study Area. Along the cliff face between the Refinery and the San Juan River, water flows from numerous seeps. Figure 3 shows one seep (Seep #2 sampling point) flowing from the Jackson Lake Terrace exposure onto the underlying Nacimiento Formation. The Refinery flare is in the upper right side of the photograph. Small pools of water are common near the cliff face. On the western margin of the Study Area, an excavation near a pipeline exposes the upper portion of the Jackson Lake Terrace and the groundwater table. Within this excavation, a small ephemeral pool of surface water is present, typically during the irrigation season. This area, like other seeps and pools caused by Hammond Ditch leakage, contains cattails, phreatophytes and the associated ecosystem.

Figure 3: View looking south from San Juan River to Seep S-2; the Refinery flare is in the upper right corner. In the center of the photograph, the Jackson Lake Terrace gravel rests upon the underlying Nacimiento Formation. The Nacimiento Formation is wet by groundwater seeping from the gravel. Iron and hydrocarbon stains are evident on the Nacimiento Formation.

4.6 Surface Water Chemistry

Hicks Consultants did not obtain any surface water samples during the field program. Table 2 presents analytical results of surface water samples obtained in earlier studies. Only Hammond Ditch and the San Juan River were sampled.

4.6.1 Hammond Ditch

Surface water sampling of Hammond Ditch began in 1982, with an investigation into suspected leakage of separate-phase hydrocarbons (SPH) from the Refinery into the ditch at or near the present North and South Oily Water Ponds; however, as discussed in section 4.1 above, the 1982 data cannot be adequately verified and we are not considering it in this report.

In 1986, Refinery staff collected two sets of samples: one on April 22 and another on April 28. Engineering Science summarized the protocol for this sampling event in the Final Report on Section 3013 Administrative Order (1987). The sample from April 22 represented the initial flow of water in Hammond Ditch for the irrigation season. Samples taken on April 28 represent water quality after seven days of flow. The initial flow from the sample downstream from the Refinery detected organic constituents. After seven days of flow, only Phenol was detected. Table 2 presents the results of this sampling.

In August 1994, GTI sampled 14 locations along Hammond Ditch (Plate 10). These samples are also summarized in Table 2. With the exception of methylene choride, the analyses did not detect any volatile or semi-volatile organic constituents. Lead and zinc were identified in two samples.

4.6.2 San Juan River

In 1987, BRC personnel sampled water from the San Juan River. Samples were obtained upstream from the Refinery and downstream at the New Mexico Highway 44 bridge. Of the downstream samples, those labeled “near side” were taken on the south side of the bridge; those labeled “far side” were taken on the north side.

During the 1994 RCRA Facility Investigation, GTI re-sampled the River. Three samples were obtained: SJ-1W, taken due north of the former evaporation ponds, represents “upstream” conditions; SJ-2W, obtained due north of the San Juan River intake for the Refinery, probably also represents upstream chemistry; SJ-3W, obtained adjacent to the location where SPH entered the river in the past, where the San Juan River Alluvial sediments truncate against the Nacimiento cliff face and the San Juan River, represents downstream conditions.

Table 2 presents the results of both sampling events. Neither event detected volatile or semi-volatile organic constituents. The 1987 event detected phenols in upstream and downstream samples and lead in two downstream samples. The lead concentration in samples taken at the NM Highway 44 Bridge are 1/100 of EPA's Ambient Water Quality Criteria (6.19 mg/l, for chronic exposure).

4.6.3 Seeps

Hicks Consultants and Refinery personnel sampled several seeps along the cliff north of the Refinery and in a constructed channel due west of the Refinery. Because these samples represent areas where groundwater intersects the ground surface, we have elected to discuss the results of these sampling events in the groundwater section, later in this document.

4.7 Sediment and Soil Chemistry

BRC personnel obtained the first sediment sample in 1982. Apparently, however, the laboratory tested only for sulfate, chloride and boron. Therefore this sample provides little benefit to our analysis.

Since 1982, numerous field programs have collected sediment samples from Hammond Ditch and the San Juan River. Several programs also collected soil samples in connection with installation of monitor wells, various solid waste management unit closures and other investigative programs. Plate 10 shows the location of soil sampling points. Table 3 presents the chemical analyses of these sampling events.

4.7.1 Hammond Ditch and San Juan River Sediment Samples

In 1994, in conjunction with the surface water sampling program for the RFI described above, GTI obtained sediment samples from 14 locations within Hammond Ditch and three locations (SJ-1, SJ-2 and SJ-3) along the San Juan River. The results of the San Juan River sampling program show no difference between upstream (SJ-1 and SJ-2) and downstream (SJ-3) analyses. GTI obtained 28 samples from Hammond Ditch at 14 locations. At each location, GTI collected one sample from the bottom of the ditch and a second sample from the south side of the embankment, presumably near the water. The results, presented in Table 3, reveal no obvious pattern. Of the VOCs, analyses detected only toluene in three samples: 5B, 7B and 9B. These three samples are west, north and east of the flare with sample HD-7B exhibiting the highest concentration (12 mg/kg). Only samples 4B and 9B detected an SVOC, phenanthrene, at concentrations below 2 mg/kg. Samples 4B and 10S detected total petroleum hydrocarbons (TPH) at concentrations of 540 and 240 mg/kg respectively. The remainder of the samples did not detect TPH. We saw no obvious trend or pattern to the analytical results of inorganic parameters (e.g. lead). All inorganic results are well below criteria which would cause classification of this material as "hazardous waste" under RCRA.

4.7.2 San Juan River Alluvium

In March 1997, the US Fish and Wildlife Service conducted a test to measure possible impacts to endangered species if the river flow was significantly reduced by drought and diversion for irrigation. A temporary, artificial low-flow condition was created at the site. Precision Engineering took eight borings of the San Juan River Alluvium north of the Nacimiento cliff and the Refinery flare, and from them extracted two samples which characterize the area where SPH entered the river during this unique low-flow period.

Samples were obtained from borings SB1-397 and SB2-397, both located along the road between the Refinery and the San Juan River intake ponds. These two borings are located close to the Nacimiento cliff, where groundwater from the Refinery area seeps over the cliff and into the colluvial landslide material (apron deposits) adjacent to the cliff and the underlying San Juan River Alluvium. The deeper of the two borings, SB2-397, shows TPH concentrations ranging between 1,400 mg/kg (at 6 feet depth) and 2,500 mg/kg (at 25 feet). The other boring, SB1-397, shows TPH at 317 mg/kg (at 10 feet).

Hicks Consultants obtained a sample of alluvium from where SPH entered the San Juan River. At the location sampled, the river had eroded into the alluvium, exposing a small area of black-stained material that exhibited a hydrocarbon odor. The analytical results show no VOCs (Table 3).

4.7.3 Samples Near Waste Management Units and Spill Sites

Prior to 1985, the NOWP and SOWP were unlined. In 1985, in response to the EPA's first 3008 Order, the previous owners of the Refinery installed plastic liners at these waste management units. The installation process consisted of removing accumulated sludge and some underlying soil to the Refinery landfill, then installing the liner.

In October 1985, Engineering Science collected 13 soil samples from beneath the plastic liners of the North and South Oily Water Ponds (see Table 4). Most of the samples were composite samples from several locations. Only one of these samples (see Table 4, APS1 and APS2) detected VOCs, showing 7.4 mg/kg xylene. Chromium and lead analyses from the samples also show concentrations well below that which would cause classification of this material as "hazardous waste" under RCRA. The highest lead and chromium concentrations are 27 mg/kg and 6 mg/kg respectively. We are aware that the EPA has registered concerns regarding the validity of these results. We do not possess the necessary QA/QC documents to verify these results; therefore, we will not employ them as a primary line of evidence for recommending a remediation strategy (see Section 4.1.1).

During the October 1985 field program, Engineering Science also collected samples of waste material in the landfill (e.g. Quadrant #1 Landfill, Table 4). We understand that this waste material is the visually stained soil that was under the sludge removed from the NOWP and SOWP prior to construction of the new lined ponds. We also understand that the previous owners removed the sludge from the NOWP and SOWP and hired another company to dispose of it properly offsite. This understanding is in contrast to the GTI reports, which state that the landfill contains sludge from the oily water ponds. Note that the lead and chromium values for this material are slightly higher than the concentrations of soil underlying the liner.

The berm formed by construction of Hammond Ditch caused a small impoundment of stormwater downhill from the Refinery landfill (see Plate 4). Engineering Science obtained several soil samples from the "landfill pond" identified on Table 4. Lead and chromium values from these soils are slightly higher than those obtained from the sludge and soil mixture.

In 1994, GTI collected 11 samples from 10 borings at or adjacent to "potential source areas identified by the USEPA during the 1987 inspection and in potential or suspected spill areas." Although neither SVOCs nor TPH were detected, two samples measured total BTEX concentrations below 0.1 mg/l, and a third sample detected methylene chloride at 0.11 mg/l. Results for inorganic parameters, such as lead, show no pattern with respect to location or concentrations that would classify this material as "hazardous waste" under RCRA.

Refinery personnel also collected a soil sample during the installation of MW-41, located due south of the Refinery processing area. We believe this sample was obtained within a sand zone at the base of the Jackson Lake Terrace. The sample shows a benzene concentration of 875 mg/kg. Other VOCs exceed 10,000 mg/kg; TPH is 1,900 mg/kg.

Hicks Consultants collected three soil samples within the Refinery: one adjacent to the SOWP, one between the flare and Tanks 2 and 3, and one at the location of former Tanks 6 and 7. Because standard soil sampling techniques have not successfully sampled the Jackson Lake Terrace cobbles , we obtained all samples from the sandy, aeolian unit that overlies the cobbles. We collected black-stained soil near Tanks 3 and 4 (SHB-4) and at the location of former Tanks 6 and 7 (SHB-1/ HA1). Both soil samples detected p/m xylene at concentrations above 200 mg/kg but did not detect any chromium or lead.

4.8 Hydraulic Characteristics

The aeolian sand that overlies the Jackson Lake Terrace is not saturated. This well-sorted, permeable unit easily transmits fluid from the land surface to the water table. GTI conducted several tests of air flow in this unit, but no one has conducted any tests to determine hydraulic conductivity of this aeolian unit. For the purpose of this study, we estimate a hydraulic conductivity of 1 x 10E-8 m/s. We derived this value from the average values published in Freeze and Cherry (1983) for silty loess.

The Jackson Lake Terrace has been the subject of numerous testing programs (see Table 5 for results from these programs). As Table 5 shows, single well tests conducted by Engineering Science and GCL show lower values than results from multiple well tests conducted by GTI (observing MP-3 and MP-4 during a pumping test of RW-19). All values appear several orders of magnitude lower than a typical clean sand or gravel unit, which, according to Freeze and Cherry (1983, p.29), should show a range of hydraulic conductivity between 1.0 E-3 m/s and 1.0 E-2 m/s.

Single well tests do not provide specific yield data. GTI calculated a specific yield of 0.015 (MP-3) and 0.003 (MP-4) from the pumping test of RW-19. Again, these values are lower than typical values for aquifers, which Freeze and Cherry (1983) suggest should yield values of 0.01–0.30.

No site-specific data exist for hydraulic conductivity of the Nacimiento Formation. The fact that the unit is not saturated more than several feet below the contact with the overlying Jackson Lake Terrace suggests that the vertical hydraulic conductivity is low. Evaluation of the unit in outcrop supports the general characterization of the unit as a poor aquifer and good aquitard.

4.9 Groundwater Flow

Potentiometric surface data available for analysis span 14 years (see Table 6), dating from February 1985, when Engineering Science began collecting monthly water level data from monitoring wells. Refinery staff installed the first five monitoring wells in February 1984, which suggests that earlier water level data exist; however, no such data are summarized in any reports evaluated by Hicks Consultants.

Due to the increased amount of sampling information now available, it is possible to revisit previous studies and more accurately interpret the data collected. Plates 11–14 depict the potentiometric surfaces during selected field programs from 1986 to 1999. Plate 11 shows the water table elevation from the most recent sampling event (March 1999); we employed recent well elevation survey data to establish the measuring point elevation at the top of casing. Plates 11–13 employ data from more than 40 groundwater measuring points (including two dry wells) over the 14-year period and therefore represent the most accurate depiction of the water table over the period of this study. Plates 11–13 show:

- groundwater flow from east to west
- a gentle hydraulic gradient (0.002) across the Refinery
- a moderate hydraulic gradient (0.006) southeast of the Refinery
- a steep hydraulic gradient (0.04) west and north of Hammond Ditch
- a groundwater “mound” adjacent to the western Raw Water Ponds
- a groundwater “mound” along the length of Hammond Ditch

These maps display a 2-foot contour interval and, for clarity, do not plot the actual head data at each well (see Table 6 for potentiometric surface elevations). The maps suggest a groundwater flow divide in the processing area (near MW-42), north of which groundwater flows toward the Nacimiento seeps, and south of which groundwater flows south, eventually discharging from the Study Area in the southwestern corner.

Due to the less comprehensive data available at the time, these relationships are less clear on drawings completed by previous consultants. We have used Plates 11–13 as references for re-interpreting earlier data. We were able to re-evaluate the eight data points collected in 1986 to reflect our current, more accurate understanding of the groundwater flow patterns. Plate 14 shows our current understanding applied to data collected in the past. Note that we used recent survey data to develop the water table elevation maps. Well elevation surveys used by previous consultants differ by one foot or more from the recent survey data employed in this report.

4.10 Saturated Thickness of The Jackson Lake Terrace

Plate 15 presents the saturated thickness of the Jackson Lake Terrace during the monitoring event of March 1999. Thicknesses are calculated using information from drilling logs and the March 1999 water level measuments. The saturated thickness varies in response to undulations of the erosional surface that forms the top of the Nacimiento Formation (Plate 9). Plate 15 shows saturated thickness greater than 7 feet near Hammond Ditch and in the southern portion of the Study Area (MW-13, MW-26, MW-4). (See also Plates 7 and 8.)

Plates 16 and 17 plot water levels over time for six monitoring wells: MW-1, MW-3, MW-8, MW-4, MW-9 and RW-15. All wells except MW-1 show that water levels have fluctuated by about two feet during the 10-year period of measurement. MW-1 exhibits more than 6 feet of fluctuation. Other hydrographs, not presented in this report, are similar to MW-3, MW-8, MW-9 and RW-15 showing water level fluctuations of about two feet.

4.11 Separate-Phase Hydrocarbon Distribution

Hearsay evidence suggests that, during the 1980s, separate-phase hydrocarbon (SPH) periodically entered Hammond Ditch and also discharged to the seeps along the Nacimiento Formation cliff. Along the cliff, the sand and gravel of the Jackson Lake Terrace is heavily stained with hydrocarbons. This staining provides evidence of SPH flow near the cliff.

We were surprised to find no data relating to SPH in monitor wells prior to an October 1991 map in a 1993 GTI report (RCRA Facility Investigation, Task 1: Description of Current Conditions). GCL data (1988) suggest that SPH is present on the south border of the Refinery; however, this report is silent regarding SPH distribution throughout the remainder of the Refinery. We know from the 1988 report that GCL installed the first three recovery wells in 1988. According to the 1993 GTI report, Refinery staff completed an expansion and upgrade of the hydrocarbon recovery system in 1991. Well logs document the installation of RW-14 through RW-19 in August 1990. We assume that the 1991 data represent the groundwater regime immediately before operation of the expanded recovery system.

We assume that the 1991 survey presented in the 1993 report is representative of conditions before activation of the recovery system and year-round maintenance of water in Hammond Ditch. Therefore, Plate 18, which plots these 1991 data, shows the SPH zero isopleth truncating against the Nacimiento Formation cliff. Plate 19 presents data from a March 1995 field program; Plate 20 is our interpretation of the data for April 1999. After the Refinery began to maintain water in Hammond Ditch throughout the year, SPH was no longer observed at cliffside seeps. As these two Plates show, the zero SPH isopleth now truncates against Hammond Ditch.

These plates consistently show SPH thickness of one foot or more in the central Refinery area. Within the tank farm area (RW-14 to RW-17), SPH thickness has declined from more than 1 foot in 1991 to zero in 1999.

4.12 Groundwater Chemistry

4.12.1 April 1999 Sampling Event

The April 1999 sampling event provides the most complete characterization to date of the general chemistry of the groundwater zone underlying the Refinery. Forty-four samples were analyzed for over 80 chemical species. We collected samples from three wells screened within the Nacimiento Formation (MW-7, MW-39 and MW-44) and one well that is screened in both the Jackson Lake Terrace and the underlying Nacimiento Formation. All values above detection limits appear in Table 7. Appendix C presents all chemical data obtained directly from the laboratory. Below, we summarize observations of selected analytes obtained in this "snapshot" characterization. Because these samples were not filtered in the field, concentrations for metals (e.g. aluminum, iron, lead) may be artificially elevated with respect to the dissolved phase. Acidification of an unfiltered sample can de-sorb certain metals from suspended clay particles in the sample.

> **1,2 dichoroethane** is above WQCC Standards (10 ppb) in 6 wells and above 100 ppb in 3 wells (RW-23, MW-9 and MW-4). Most wells sampled did not detect this compound.

1,2,4 Trimethylbenzene and **1,3,5 Trimethylbenzene** are present in most wells and at concentrations higher than 40,000 ppb and 11,000 ppb respectively. Because these compounds typically to not degrade in groundwater, at some sites they are used as a conservative tracer to measure the rate of intrinsic biodegradation of BTEX. Concentratons above 1,000 µg/l are associated with SPH and high benzene concentrations. Concentrations below 100 ug/l generally occur in wells down-gradient from Hammond Ditch or adjacent to the unammed arroyo in the southern portion of the Study Area. At the Refinery site, these compounds appear to degrade in a manner similar to BTEX and therefore cannot be employed to determine the rate of intrinsic biodegradation.

Naphthalene and **1-methylnaphthalene** and other polynuclear aromatic hydrocarbons are present above the WQCC standard (30 ug/l for total PAHs) in most of the sampled wells. Two analytical methods can provide results for naphthalene: VOC analysis (SW-846-8260) and SVOC analysis (SW-846-8270). For samples with two results, we reported the highest value. Naphthalene exceeds 30 µg/l in all 31 samples where it was detected. With the exception of an anomalous value of 69 µg/l for MW-34 (where adjacent wells do not detect naphthalene) and a "not detected" for RW-23 (where naphthalene exceeds 100 µg/l in adjacent wells and the lower limit of detection for this sample is greater than 100 µg/l), naphthalene was detected in wells near processing and storage areas. The highest values are associated with wells that show or showed SPH. Plate 21 displays the naphthalene concentrations for the Study Area in April 1999. Our interpretation of the extent of naphthalene considers 1998 data from the seeps (S1 through S5). We did not employ data from wells screened within the Nacimiento Formation.

Aluminum exceeds the WQCC Standard of 5 mg/l in 7 wells, showing a maximum concentration of 198 mg/l.

Boron is detected in most wells and is above the 0.75 mg/l standard in 6 wells.

Barium exceeds the 1.0 mg/l standard in 14 wells. Plate 22 displays the barium isopleth map. Because barium is also a hazardous constituent regulated by RCRA, we examined the spatial distribution. Concentrations below 0.06 mg/l are present on the south and west side of the Refinery. Concentrations above 1.0 mg/l are generally within the processing area and in two wells removed from the Refinery (MW-38 and MW-37). We used the Surfer ™ contouring software to generate this and other isopleth maps for inorganic analytes. For some plates, such as Plate 22, we inserted one or two data points at strategic locations to generate an isopleth that was consistent with both the data and the hydrogeology. If more than three "imaginary" points were required to generate an acceptable isopleth, we contoured the map by hand (e.g. benzene).

Benzene concentrations range from "non-detect" (ND) to 30,000 µg/l (Plate 23). The large range of values and the abrupt concentration gradients caused unusual isopleth lines when attempting to use Surfer ™. Therefore, this map, and others like it, was contoured by hand using professional judgement. For clarity of presentation, the concentration values for each well are not plotted. Appendix D presents the concentration data plotted on the same scale as Plate 23. Twenty-nine wells exceed the WQCC groundwater standard. Ethylbenzene exceeds 750 mg/l in 16 samples; total xylene exceeds the 620 µg/l standard in 19 wells. Toluene exceeds the 750 µg/l standard in 8 samples. These VOCs behave in a relatively similar manner. The highest benzene values are in the northern portion of the Refinery, adjacent to the tank berm associated with Tanks 3, 4 and 5 (see Plate 4 of Volume I). With the exception of an anomalous "non-detect" for RW-17, values greater than 1,000 µg/l are evident in the storage and processing areas. An abrupt concentration gradient is evident between MW-11 and MW-35 in the southwestern portion of the Study Area.

Chloride is above the 250 mg/l standard in more than half the wells tested (23 of 44). The highest concentration is 2,340 mg/l (MW-5); the lowest concentrations of 24.6 mg/l and 34.5 mg/l are in Nacimiento Formation wells (MW-39 and MW-7). Choride comprises about 30% (by weight) of the Total Dissolved Solids in the Jackson Lake Terrace groundwater.

Total Dissolved Solids (TDS) ranges from 5,490 mg/l in MW-5 to 408 mg/l in MW-1. Only 7 of the 43 wells tested fell below 1,000 mg/l. The average TDS concentration in the April 1999 sampling event was 2,379 mg/l, with a standard deviation of 1,464. Plate 24 presents the spatial distribution of TDS. Groundwater meets the WQCC Standard in wells located down-gradient from Hammond Ditch (MW-1, MW-12 and MW-29), in MW-28 near the unlined Raw Water Ponds and in the southwest corner of the Study Area, down-gradient from the unnamed arroyo. TDS exceeds 3,000 mg/l in the southeastern portion of the Study Area and in the processing area of the Refinery. Generally, sodium and chloride follow this same pattern (see Plate 25 for chloride distribution).

Sulfate exceeds the 600 mg/l standard in 12 samples. Values higher than 2,000 mg/l are from Nacimiento Formation wells. The highest observed value in the Jackson Lake Terrace is 1,600 mg/l in MW-31, which is south of the tank farm releases in the product storage area. Like TDS, higher values of sulfate occur in the southeastern portion of the Study Area (Plate 26). With the exception of an anomalous value of 1,570 mg/l in RW-3, sulfate generally exhibits concentrations of less than 100 mg/l in wells which show hydrocarbon concentrations and in wells down-gradient from wells exhibiting hydrocarbons. Sulfate is an electron acceptor; the spatial variation observed is similar to that of dissolved oxygen, nitrate and iron. As discussed earlier, the sulfate values for RW-17 and RW-3 appear anomalous.

Cobalt is above the WQCC Standard (0.05 mg/l) in 7 wells.

Chromium above the WQCC standard of 0.05 mg/l was detected in 10 samples. Wells that exceed standards include MW-12, MW-37, MW-38, which are located in the southwestern corner of the Study Area. MW-43, located between the NOWP and SOWP shows a chromium value of 0.11 mg/l. These disposal units were originally identified as RCRA units, because chromium and benzene typically occurred in many samples of API seperator sludge obtained by the EPA from numerous refineries nationwide. Previous analyses of solid waste from these units did not show chromium levels above RCRA limits. The presence of chromium in the NOWP or SOWP is not documented. Chromium concentrations are higher in Nacimiento wells (MW-39 and MW-44) and in wells within the processing area. Plate 27 presents the spatial distribution of chromium concentrations for the April 1999 sampling event. Chromium was detected in MW-8 at 10 mg/l; however, as this value appears to be anomalous, it will be resampled and field filtered in September 1999.

Iron commonly exceeds WQCC Standards in groundwater with hydrocarbons. In the wells tested, iron exceeds standards in 38 wells. The highest concentration of iron is in MW-41 (326 mg/l). Iron is an electron acceptor. In a saturated unit, iron oxides are ubiquitous as staining, grain coatings, and heavy mineral "placer" deposits in alluvial sediments (e.g. magnetite). In the absence of dissolved oxygen or other dissolved-phase electron acceptors, microbes will employ the oxygen bound to the solid iron oxides for respiration. The result is dissolution of the iron oxides and an increase of dissolved iron in groundwater. Plate 28 shows the spatial distribution of iron. Compare this map with sulfate (another electron acceptor), benzene, naphthalene and the SPH thickness map for April 1999. This map shows high iron concentration in

MW-37 and MW-38, wells located adjacent to a producing gas well. MW-8, located in the fire training area/bone yard, also shows iron concentration above 100 mg/l.

Fluoride exceeds standards in one sample.

MTBE was detected in 12 samples. Four samples, all in the southwestern corner of the Study Area, exceed 100 mg/l. MW-12, a well adjacent to and down-gradient from Hammond Ditch, exhibits 140 mg/l of MTBE.

Manganese exceeds the 0.2 mg/l standard in all but 2 of the 41 samples where this metal was detected. MW-30 shows the highest concentration (22.5 mg/l). MW-1, MW-12 and MW-29, both down-gradient from Hammond Ditch and distant from Refinery release areas, all exceed the manganese standard.

Nickel exceeds WQCC Standards in two wells.

Nitrate exceeds 10 mg/l (as N) in seven wells. Like sulfate and other electron acceptors, the highest concentrations of nitrate occur in the southern portion of the Study Area, distant from hydrocarbons in groundwater. Nitrate is not detected in most recovery wells nor in wells that exhibit SPH.

Lead ranges in concentration from 0.3 mg/l to less than detection limits. Eleven samples exceed the WQCC Standard of 0.05 mg/l. The spatial distribution of lead is similar to that of iron (see Plate 29). Lead concentrations exceed WQCC Standards in wells exhibiting high hydrocarbon concentrations near the processing area of the Refinery and in MW-37 and MW-38.

4.12.2 Groundwater Chemistry Over Time (1984–1999)

Examining the above snapshot in relation to the historical trends at the site gives us a full picture of site conditions and how they are developing.

4.12.2.1 Interpreting Historical Data

Tables 8 and 9 provide the 1984–1998 groundwater chemistry data available to Hicks Consultants. In order to present these historical data in an understandable format, we have selected certain wells as "representative" of portions of the Study Area:

Data from three wells characterize background water quality. MW-1 and MW-8 characterize up-gradient background water quality. MW-3, up-gradient from hydrocarbon releases but down-gradient from the former Spray Irrigation Area, serves as a background well for organic constituents; for inorganic constituents, it characterizes the groundwater quality changes before, during and after use of the Spray Irrigation Area.

Data from four wells characterize the hydrocarbon release areas. MW-9 and RW-18, in the northern portion of the Refinery, provide data from the processing areas, the releases near former Tanks 6 and 7, and the releases from Tanks 3, 4 and 5. RW-15 characterizes the chemistry of groundwater beneath storage tank releases. MW-4 is immediately down-gradient from the documented storage tank releases.

Data from four wells characterize the groundwater down-gradient from the documented releases. MW-11 and RW-1 are 400–600 feet down-gradient from documented releases. MW-34 and MW-35 are located in the distal edge of the hydrocarbons in groundwater (e.g. Plate 23), about 1,200 feet down-gradient from MW-4.

4.12.2.2 Characterization/Results

To identify the changes in groundwater chemistry over time, we selected several analytes to evaluate in these ten wells and to compare to the "snapshot" results of the April 1999 sampling event. Our rationale for selecting these parameters, and the resulting site characterization compiled from past and present data, are presented below.

Separate-Phase Hydrocarbons

SPH is detected in seven wells in the study area (MW-9, MW-20, MW-40, MW-41, MW-42, MW-43 and RW-18). Distribution of SPH ranges from .01 foot in MW-9 to 1.5 feet in MW-42. There are currently two different types of hydrocarbon product found in monitor wells in the Study Area. MW-43 is the only well that exhibits exclusively light (C-10 and less) carbon chains indicative of gasoline. The SPH in the remaining six wells exhibits a "weathered" diesel (GC) pattern. Until the most recent sampling program, two other wells south of the Refinery exhibited SPH. In August 1994, GTI detected SPH in MW-27. In March 1995, GTI measured SPH in MW-26. Although there is no longer any measurable SPH in either of these wells, in 1998 Hicks Consultants measured SPH in MW-26 and MW-27. Laboratory tests of the SPH found in these wells suggests a Jet A source (see Appendix C).

Benzene

The extent, magnitude and fate of benzene in groundwater determines the quantitative risk posed to human health and the environment by hydrocarbons in groundwater. This parameter is present in the Study Area in concentrations thousands of times higher than the health-based standard. Benzene is soluble, mobile and carcinogenic; it is, however, also amenable to metabolic destruction by indigenous microbes. Because benzene behaves in a similar manner to other VOCs and because its health based standard is the lowest, we use it as a surrogate for all the volatile organic constituents (VOCs).

MW-1, MW-3 and MW-8: With the exception of two sampling events (12/13/84, 15 µg/l; 4/20/99, 2.8 µg/l), benzene is not detected in MW-1. MW-3 detected benzene only during the most recent sampling event (4/20/99, 4.70 µg/l). MW-8, located up-gradient from MW-3, also detected benzene only in the most recent sampling event (4/20/99, 1.6 µg/l).

MW-4, MW-9, RW-15 and RW-18: As Plate 30 shows, benzene concentrations in wells MW-9, RW-18, RW-15, and MW-4 exhibit no consistent trend over time. (For ease of visual inspection we have elected to connect the individual data points with a line. We have included a line between sample results in all other graphs showing variations with time.) All of these wells are located in or immediately adjacent to petroleum storage or processing areas. In RW-18, benzene concentration appears more variable, but note the change in scale which may cause this impression. At concentrations this high (around 10,000 ug/l) variability of 100% or more is common.

MW-11, RW-1, MW-34 and MW-35: As Plate 31 shows, RW-1 and MW-34 show a consistent decline in benzene concentration over time. The two years of data from MW-35 suggest a similar trend. The 12-year record of MW-11 shows a relatively constant benzene concentration until early 1997, when concentrations decline. All of these wells are down-gradient from documented hydrocarbon release areas (e.g. MW-4, RW-15).

With few exceptions, benzene has never been detected in the following wells:

MW-2 (destroyed in late 1980s)

MW-5 (10.8, 12/89)

MW-12 (4/20/99, 23 µg/l)

MW-13 (anomalous value of 0.23 µg/l, 9/9/88)

Declining benzene concentrations are also apparent in MW-27, MW-31; stable benzene concentration is evident in MW-26.

Naphthalene

Although naphthalene is not a carcinogen, it presents a risk to human health and the environment. Where crude, diesel or turbine fuel contacts groundwater, naphthalene is common as a dissolved constituent. It is less mobile in groundwater than benzene and more recalcitrant to biodegradation.

We have no chemical data over time that displays the temporal variation of naphthalene, and so must rely entirely on the April 1999 sampling event to interpret its presence in groundwater chemistry.

According to the 1999 event, naphthalene is present at the Study Area in concentrations 1,000 times above the health-based standard (see Section 4.11.1 and Plate 21).

Total Dissolved Solids (TDS)

TDS provides a gross characterization of inoganic parameters and the general quality of groundwater for domestic, agricultural and industrial purposes.

The Refinery's testing program created a historical record of TDS concentration in several wells. MW-1, MW-4 and MW-5 have the most complete record of TDS values over time.

MW-1, MW-3 and MW-8: Plate 32 displays data from the background wells MW-1, MW-3 and MW-8. The record for MW-1 shows relatively constant values, between 2,500 and 5,000 mg/l from 1984 until 1995. Then values decline to below 2,000 mg/l. MW-1 is located less than 100 feet from Hammond Ditch and adjacent to the new Raw Water Ponds. Despite the paucity of data for MW-8 and MW-3, TDS values appear stable. Both of these wells, located 400 and 800 feet respectively from Hammond Ditch, exhibit relatively stable TDS values over time.

- **MW-4, MW-9 and RW-15:** Within and adjacent to the processing and storage areas, MW-4 and MW-9 have a reasonable record of TDS values. These data are displayed in Plate 33. Although MW-9 is adjacent to Hammond Ditch, the variability displayed by MW-1 is not mimicked by MW-9. MW-4 displays a relatively constant TDS of 2,000 mg/l, whereas TDS values in MW-4 are about 1,500 mg/l. These two wells, MW-8 and the last 3 years of data from MW-1 have a mean TDS value of 2,004 mg/l, similar to the mean site-wide value of 2,192 mg/l for the 1999 sampling event. The meager record for RW-15 suggests a relatively constant value for TDS over time.

- **MW-5:** MW-5 is located within the former Spray Irrigation Area. Plate 34 shows that the concentration of TDS in the 1980s remained relatively stable between 3,500 and 5,000 mg/l. In the late 1980s through 1995, TDS increased to a high of 8,878 mg/l. Since 1997, TDS values in MW-5 have remained about 6,000 mg/l.

Chloride

To assist in identifying changes of inorganic content of groundwater in the 1999 sampling event, we used chloride as an indicator parameter. Plate 35 shows chloride over time for the three background wells. The data are similar to TDS variations. For wells within the storage and processing areas, chloride concentration is also similar to the trends observed for TDS, with the exception of an anomalous value of 1,000 mg/l for MW-9 (1986). Plate 36 displays the historic trend in these wells.

Sulfate

Evaluation of sulfate concentration over time at selected wells will help measure the ability of the groundwater zone to attenuate hydrocarbons in the future.

Of the electron acceptors of oxygen, nitrate, sulfate and ferric iron, the Refinery collected more sulfate data over the years. The April 1999 data clearly show depletion of electron acceptors, including sulfate, within the zone of high hydrocarbon concentration.

MW-1 and MW-4 provide a relatively complete history of sulfate concentrations in groundwater at the Refinery. Plate 37 shows the historic concentration of sulfate in MW-1 compared to the other background wells, and to MW-3 and MW-8. The mean value for MW-1 over time is 681 mg/l (standard deviation of 298mg/l). MW-8, which is further from Hammond Ditch than MW-1, exhibits sulfate concentrations around 1,000 mg/l. In the late 1980s, sulfate in MW-3 is about 2,000 mg/l; in 1999, long after closure of the Spray Irrigation Area, sulfate is about 1,000 mg/l.

Plate 38 shows MW-4 and MW-9 sulfate concentration over time near the documented petroleum release sites. The mean for MW-4 is 6.3 mg/l (standard deviation of 3.5 mg/l) andMW-9 varies between 12 mg/l and 117 mg/l. The mean sulfate concentration for the down-gradient wells MW-11, RW-1, MW-34 and MW-35 is 44 mg/l.

In Plate 38, sulfate concentration in MW-5 is shown as decreasing since 1992.

Barium, Chromium and Lead

These three metals are detected in groundwater samples and considered a hazardous constituent under RCRA. As mentioned earlier, the NOWP and SOWP were originally characterized as RCRA waste management units because benzene, chromium and lead were detected in API seperator sludge at other refineries in concentrations that exceeded RCRA limits. In the 1980s, the EPA found API separater sludge in the NOWP and SOWP and thereby classified these units as RCRA units. Evaluating lead and chromium in groundwater will assist in the determination of whether or not the NOWP and SOWP have released hazardous constituents to groundwater. We also selected barium for evaluation because the 1999 analyses exceeded WQCC Standards in 14 wells.

A record of analyses exists only for wells MW-1 and MW-4. Table 8 shows that barium and chromium in MW-1 remain near or below the detection limit, whereas lead appears to decline over time in this background well. Although a lacuna exists in the record for MW-4 between 1989 and 1995, the barium concentration in this well appears consistent over time. During the period of investigation, chromium and lead are near or below the detection limits.

4.13 Exposure Assessment and GTI Risk Assessment

GTI identified constituents of concern (COCs) in their document "Human Health and Ecological Risk Assessment," dated December12, 1995. GTI identified the following chemicals as COPCs:

Soil	Groundwater
Cadmium	2,4 Dimethylphenol
Copper	2-Methylnaphthalene
Nickel	3-Methylphenol
Zinc	Naphthalene
Benzene	Phenol
Toluene	Benzene

Ethylbenzene	Tolune
Xylenes	Ethylbenzene
	Xylenes

The 1995 GTI report identified media of concern (e.g. soil, water, air), potential human and ecological receptors and the potential risk associated with exposure to COPCs associated with the Refinery. GTI included cadmium, copper, nickel and zinc in soil as a COPCs because they were consistently detected above background levels. The organic compounds in groundwater are COPCs because these constituents exceed numerical standards in several monitoring wells. GTI did not identify any inorganic constituents as COPCs in groundwater. GTI did not detect COPCs in San Juan River sediments or in surface water from Hammond Ditch water or the river. Therefore, GTI limited the media of concern to surface soil, the perched groundwater zone, and Hammond Ditch sediments.

During analysis of their data, GTI noted that their calculated baseline (a "no action" scenario) risk associated with the onsite refinery worker was not realistic. The standard default assumption employs residential exposure frequencies, which are significantly longer than exposure frequencies for workers. Additionally, the calculations cannot account for future reductions in concentrations due to natural attenuation or ongoing remediation measures.

GTI identified incidental soil ingestion, dermal contact and inhalation of paticulates as a complete exposure pathway. The calculated cumulative carcinogenic and non-carcinogenic risk of these three pathways were four orders of magnitude below that which the EPA considers acceptable. For instance, the calculated cumulative cancer risk for an onsite worker is 3.0 E-10. The EPA considers 1.0 E-6 to 1.0 E-4 (1.0 E-6 is a 1 in a million risk of cancer) an acceptable risk.

GTI excluded potential risks to offsite receptors due to COPCs in soil because they concluded that offsite concentrations would not present a likelihood of risk to humans.

After analysis of the data, GTI concluded that there is no potential risk posed to the onsite worker and that risks to any potential offsite resident are within EPA acceptable limits. The only identified risk to an offsite resident is exposure to the perched groundwater in the Jackson Lake Terrace. The probability of such an exposure are very small because:

- the natural water quality in the Jackson Lake Terrace is relatively poor, exhibiting over 3,000 mg/l TDS in areas removed from Hammond Ditch recharge, limiting its potential as a long-term (greater than 200 years) water supply

- the saturated thickness of the Jackson Lake Terrace (less than 8 feet) limits its potential as a long-term water supply
- the area is served by the Bloomfield municipal water supply
- the property above the documented hydrocarbons in groundwater is owned by the United States and the BLM identified no future development plans for this property

The results of the GTI risk assessment indicate that there are no unacceptable risks associated with the COPCs in the soil, sediments or dissolved-phase chemicals in the groundwater.

After analysis of GTI's data sets and the methods used for the 1995 Risk Assessment, we concur with their findings.

5 Discussion and Conclusions

5.1 Extent, Transport and Fate of Constituents of Concern

5.1.1 Separate-Phase Hydrocarbons (SPH)

We understand that SPH was present in the Nacimiento Formation seeps prior to the installation of monitoring wells in 1984. The first comprehensive mapping of SPH occurred in 1991. As Plates 18–20 show, the magnitude and extent of SPH has diminished since implementation of the groundwater recovery system in 1991.

Plates 18 and 19 suggest that hydrocarbons from the Refinery area are migrating to the southwest—toward MW-26 and MW-27. Although this pathway is not consistent with the potentiometric surface (see Plate 11), an examination of Plate 15 helps explain the apparent SPH flow direction. The saturated thickness of the Jackson Lake Terrace is less than 1 foot at RW-3. This results in a relatively low transmissivity compared to MW-11, MW-26 and MW-4, where the saturated thickness of the Jackson Lake Terrace exceeds 6.5 feet. The higher transmissivity between MW-11 and MW-4 creates a preferential groundwater flow direction toward the southwest. Migration of SPH follows this same pathway of higher transmissivity. In 1999, as Plate 20 shows, SPH is confined to the Refinery property.

Plates 18–20 also indicate hydrocarbon migration north toward the Nacimiento Formation cliff. As Plate 18 shows, before 1991 SPH had migrated into the Nacimiento Formation cliff; this conforms with hearsay evidence that during the 1980s SPH flowed from seeps on the Nacimiento Formation cliff. In the early 1990s, the Refinery owners began maintaining water in Hammond Ditch throughout the year. This created a hydraulic barrier, preventing continued migration of SPH beyond the ditch; as Plate 19 shows, in 1995 the zero SPH isopleth parallels Hammond Ditch. As Plate 20 shows, in 1999 the zero isopleth parallels Hammond Ditch in a smaller area, north of MW-20.

The reduction of SPH within the Study Area to date has been dramatic. There are several possible causes for this:

- At some sites, SPH thickness diminishes in response to water level changes not related to operational recovery systems. This does not seem to be the case at the Refinery, as groundwater levels throughout the Refinery processing and storage areas generally vary by less than 2 feet (see Plate 17).
- In older monitoring or recovery wells, clogging of the well screen can also cause an apparent reduction in SPH. In sites showing this phenomenon, the upper portion of the well screen is clogged by emulsified SPH or microbial growth. Because the newer wells at the Refinery (MW-42 andMW-43) exhibit the thickest accumulation of SPH, we must question whether apparent SPH reductions measured in other, older, wells might be due to well screen clogging.

We cannot, therefore, conclude that the groundwater recovery system has effectively reduced the SPH mass. We conclude that a well stimulation program or downhole camera survey in RW-17 and RW-19 is necessary to determine if well screen clogging is responsible for the apparent reduction in SPH volume. We conclude that continued pumping of RW-19 and RW-18 and initiation of recovery at MW-43 will reduce the SPH mass at the Refinery.

We conclude that Hammond Ditch leakage continues to create a hydraulic barrier to the northward flow of SPH. As recovery operations continue and the mass of SPH in the northern Refinery area is reduced, the effect of this hydraulic barrier will diminish. We conclude that installation of hydrocarbon recovery equipment in MW-43 will accelerate SPH removal.

5.1.2 Benzene (Plates 23, 30, 31, 38 and 39)

The extent of dissolved-phase benzene has remained constant over time, but the magnitude of the concentrations has declined. Plate 23 shows the benzene concentrations within the Study Area in 1999. Plates 29 and 30 show that benzene concentration within the Refinery crude processing and petroleum storage areas remain consistent, while benzene concentration down-gradient from these release areas is decreasing over time. Comparing Plate 23 with Plate 39 (benzene isopleth map for 1994–1995), however, reveals that the extent of benzene in groundwater has not changed from 1995 to 1999.

Indirect evidence also suggests that the recovery system is reducing the mass of hydrocarbons beneath the Refinery. Assuming that the reduction in SPH thickness is verified by the recovery well testing program (see above), removal of the SPH from groundwater reduces the source of dissolved-phase benzene and other hydrocarbon constituents. Evaluation of MW-11 in Plate 31 shows a steady decline in benzene concentration beginning in 1994, three years after the expansion of the hydrocarbon recovery system and one year after the most recent expansion and upgrade of the system.

Upgrade of petroleum storage tanks, vigilant spill prevention and spill countermeasures will reduce the potential for additional SPH to enter the groundwater system. A reduction in the input of hydrocarbons from surface spills will also result in reduced hydrocarbon concentrations in groundwater.

Plate 40 shows the projected decline in benzene concentration over time in three wells. The projection of MW-11 only uses data since 1994, when a decreasing concentration trend is evident. We used a linear "best fit" trendline to approximate first-order decay of benzene. (First-order decay is employed by the EPA Model Bioplume III.) The projection of benzene concentrations in MW-11 suggest that the area immediately south of the Refinery property line will meet WQCC Standards (10 ug/l) as early as 2009. At the distal edge of hydrocarbons in groundwater (MW-35), natural attenuation (microbial metabolism and dilution from recharge) will restore groundwater to WQCC Standards during or after 2002. On the western edge of the Refinery, benzene concentrations in RW-1 will also meet standards during or after 2002. If the attenuation of benzene follows an exponential decay, complete restoration of groundwater will occur in MW-11 by 2055, in MW-35 by 2010 and in RW-1 by 2030.

At RW-1 and MW-11, leakage from Hammond Ditch and/or the Raw Water ponds does not appear to influence the chemistry of the wells. Therefore, we conclude that microbial metabolism of benzene is the principal abatement mechanism at these locations. At MW-35, recharge from the unnamed arroyo causes some dilution of benzene.

We conclude that, though the extent of benzene in the Study Area remains unchanged from 1985 to 1999, the magnitude of benzene concentrations is being reduced. We conclude that continued reduction of the SPH mass by recovery operations will further reduce the magnitude of benzene concentrations within the Study Area. We conclude that natural attenuation will restore groundwater quality on the southwestern and western portions of the Study Area as early as 2009. Additional benzene data over time from Seeps 1 and 2 will permit prediction of the time required for groundwater restoration on the northern portion of the Study Area.

Benzene migration has also been limited, despite the presence of more than one foot of SPH in the Refinery since the late 1980s, and even though the Refinery owners have not implemented any active groundwater quality restoration system (with the exception of hydrocarbon recovery operations). In the southwestern portion of the Study Area, dissolved-phase benzene has not migrated beyond MW-35 or MW-12. Evaluation of electron acceptor distribution (dissolved oxygen, sulfate, nitrate, iron oxides) shows that the concentration of these constituents is inversely proportional to the concentration of benzene.

Seep 5, a shallow drive-point well west of the Refinery, detected benzene concentrations of 20 µg/l and 56 µg/l in the 1998 and 1999 sampling events. This well point is about 400 feet down-gradient from RW-1 (1,000 µg/l benzene in 1999) and MW-40 (2,300 µg/l benzene in 1999). RW-1 exhibits decreasing benzene over time and relatively low concentrations of sulfate and other electron acceptors.

We concluded that benzene concentration in RW-1 is mitigated by microbial metabolism. We predict that, as early as 2002, benzene concentration in RW-1 will approach the WQCC Standard of 10 ug/l. After three additional years of SPH recovery in the central Refinery area, the benzene source will be significantly diminished. We conclude that all groundwater west of the Refinery boundary will meet WQCC Standards as early as 2002.

In the northern portion of the Refinery, dissolved-phase benzene continues to flow from the Nacimiento Formation cliff face into the San Juan River Alluvium. Surface water data suggest that discharge of groundwater to the river does not result in a measurable degradation in surface water quality. Considering the large volume of water flowing in the San Juan River and the relatively small flux of groundwater from the alluvium into the river, dilution will effectively prevent detection of benzene in the surface water.

We conclude that dissolved-phase benzene migration to the San Juan River Alluvium will continue until the mass of SPH in the northern Refinery area is further reduced. In the absence of a substantial data collection program, an active abatement program is required within the San Juan River Alluvium.

As discussed earlier, leakage from the unlined Hammond Ditch creates a hydraulic barrier that effectively prevents northern migration of SPH. This same leakage reduces the concentration of benzene in groundwater adjacent to and down-gradient from the ditch. In 1999, we observed benzene concentrations of 13,000 µg/l, 30,000 µg/l and 18,000 µg/l in

RW-22, RW-23 and MW-9 respectively, while Seep 1, which is 350 feet down-gradient from these wells and 150 feet down-gradient from the ditch, detected 800 μg/l.

We conclude that dilution and, to a lesser extent, natural attenuation creates the observed 25-fold reduction in benzene concentration at the Nacimiento Formation cliff-side seep. We conclude that microbial metabolism of benzene on the northern portion of the Study Area will be an effective abatement mechanism after all or most SPH is removed from the central Refinery area.

5.1.3 Naphthalene and other SVOCs (Plate 21)

A comparison of Plate 21 with Plates 18–20 shows that naphthalene is detected in wells that have shown SPH either in April 1999 or in past sampling events. The exceptions to this observation—MW-34, MW-31, MW-21, MW-27 and MW-28—are discussed below.

MW-34 is located outside the SPH plume, but shows a high concentration of naphthalene. We conclude that the naphthalene in MW-34 is a relic of a past hydrocarbon release from a nearby oil and gas production well (see Plate 3), and is unrelated to the Refinery. Near the production well, dissolved iron concentration is also two orders of magnitude higher than in adjacent monitoring wells. The well site shows evidence of past crude spills and/or produced water disposal activity. In fact, the owner has posted a warning sign on the well referring to the active bioremediation of such spills.

MW-31 and MW-21 are located adjacent to the SPH plume as mapped in Plates 18 and 19. Detection of naphthalene at these wells is not surprising. Conversely, MW-27 has exhibited SPH in past sampling events but showed no naphthalene in the April 1999 analysis. MW-27 also detected no benzene; we assume this is because the hydrocarbon spill that impacted MW-27 was Jet A, a fuel containing only small amounts of benzene. Unfortunately, the record does not contain past analyses of naphthalene in any wells.

Lower concentrations of sulfate, dissolved oxygen, nitrate and iron as compared to background wells suggest oxidation of hydrocarbons in the southern and western portion of the Refinery. Biologic destruction of naphthalene is a possible explanation for the absence of naphthalene in MW-27. We conclude that naphthalene was once present in MW-27, when SPH was observed in this well, but that biologic destruction of naphthalene has reduced concentrations to below the detection limit.

5.1.4 MTBE

MTBE is not produced at the Refinery, is stored in a single tank near the product loading terminal (east of MW-13) and is added to the refined products at the terminal. The fact that MW-13 exhibits MTBE at 18 ug/l and other wells down-gradient from MW-13 show concentrations one order of magnitude greater (e.g. MW-11, 160 ug/l; MW-34, 510 ug/l) permits us to conclude that the Refinery released MTBE at or near the terminal. We conclude that the release was a single event that caused a "slug" of MTBE to enter groundwater and migrate down-gradient. The center of mass of the MTBE slug is at or near MW-34. The March 26, 1996, spill and fire at the terminal may be the source of the MTBE in groundwater.

5.1.5 Inorganic Parameters

5.1.5.1 Total Dissolved Solids (Plate 24)

Numerous factors influence the TDS of the groundwater zone. Leakage from Hammond Ditch, the old Raw Water Ponds and the new Raw Water Ponds (re-engineered from the former evaporation ponds) recharges the Jackson Lake Terrace with low-TDS water. At and down-gradient from the former Spray Irrigation Area (see Plate 4), TDS ranges from over 5,000 mg/l (MW-5) to 3,000–4,000 mg/l (MW-13 and MW-31). All three wells and several adjacent wells (e.g. MW-30) exhibit high TDS values due to discharges from this former disposal area. In the petroleum storage and crude processing areas of the Refinery, spills and other surface releases contribute to the observed TDS values of 2,000 mg/l or more in these areas. In the southern portion of the Study Area, where the saturated thickness of the Jackson Lake Terrace is less than 2 feet, TDS is greater than 3,000 mg/l (MW-32 and MW-33).

We conclude that the background TDS concentration of the Jackson Lake Terrace in the southern portion of the Study Area, unaffected by the Refinery or Hammond Ditch, is greater than 3,500 mg/l (MW-32, MW-33). Here, the Jackson Lake Terrace is thin and the water quality is more similar to the underlying Nacimiento Formation. We conclude that TDS concentrations at and down-gradient from the former Spray Irrigation Area will continue to decrease over time (see Plate 34 for evidence of this trend). We conclude that leakage from Hammond Ditch and recharge from the unnamed arroyo in the southern portion of the Study Area contributes low-TDS water to the Jackson Lake Terrace resulting in TDS concentrations between 408 mg/l (MW-1) and 646 mg/l (MW-36). Down-gradient from these recharge areas, TDS decrease and approach background concentrations. We conclude that the background concentration of TDS beneath the Refinery is best represented by MW-8

(2,246 mg/l). We conclude that the magnitude and extent of TDS concentrations above 1,000 mg/l will remain static until the recharge regime changes (e.g. lining Hammond Ditch).

5.1.5.2 Chloride (Plate 25)

Chloride concentrations behave in a manner similar to that described above for TDS.

5.1.5.3 Sulfate (Plate 26)

Sulfate concentrations exceed the 600 mg/l WQCC Standard in the southern portion of the Study Area (MW-32 and MW-33) and at other wells where the saturated thickness of the Jackson Lake Terrace is less than 4-feet (MW-31, RW-3). Near the former Spray Irrigation Area (MW-5, MW-3 and MW-30), sulfate concentrations also exceed the WQCC Standard. In most wells where hydrocarbons are present, sulfate concentration is below 50 mg/l.

We conclude that, where the saturated thickness of the Jackson Lake Terrace is less than 4 feet, the background sulfate concentration is about 1,500 mg/l. We conclude that sulfate concentration at and near the former Spray Irrigation Area will continue to decline with time. We conclude that, in the northern portion of the Study Area, the oxidation of hydrocarbons has caused sulfate to reduce to a lower oxidation state.

We conclude that sulfate concentration in the Jackson Lake Terrace should remain relatively constant until oxidation of hydrocarbons is complete. At that time, recharge from Hammond Ditch and the Raw Water Ponds will increase sulfate concentration in the northern Study Area to background concentrations (about 100 mg/l). Over time, wells near the former Spray Irrigation Area will also exhibit background sulfate concentrations.

5.1.5.4 Barium, Chromium and Lead (Plates 22, 27, 29)

Barium concentration in groundwater correlates with high hydrocarbon content and/or low sulfate concentration. We conclude that barite ($BaSO_4$) is dissolving in groundwater in response to metabolic oxidation of hydrocarbons. Barite is common in desert environments and is probably a common mineral in the Jackson Lake Terrace. Barium behaves like iron in and adjacent to petroleum hydrocarbon groundwater plumes.

As of 1999, chromium concentrations are high in three places: the processing area, background well MW-8 and wells MW-37 and MW-38. In the process area, the chromium concentrations of 0.19 mg/l (MW-40 and MW-41) could be due to past releases of chromium-containing process-specific chemicals such as corrosion inhibitors. The concentrations of 0.17 and 0.15 mg/l at MW-37 and MW-38 could not have been caused by a past release not associated with the Refinery. At MW-8, the concentration of 10 mg/l is two orders of magnitude higher than contentations shown in any other analysis, past or present. We conclude that these wells must be resampled and field filtered in September 1999. Furthermore, we hypothesize that heavy minerals (such as magnetite, illmenite and chromite), which dissolve in anaerobic groundwater, contribute dissolved metals to groundwater.

Lead concentrations are similar to those for iron (see Plate 28). The record of analyses demonstrates that lead was detected in about 30% of the analyses. About 20% of the approximately 200 samples exceeded the WQCC Standard (0.05 mg/l). Lead concentrations detected in background well MW-1 have exceeded this standard eight times since sampling began in 1984. We conclude that lead concentrations throughout the Study Area are at or near natural background levels.

5.2 Provenance of Constituents of Concern (COCs)

In this report, we consider petroleum hydrocarbons and other analytes that exceed WQCC Standards (e.g. TDS) to be constituents of concern (COCs). Whereas the provenance of separate-phase hydrocarbons can be clearly associated with releases from the Refinery, the source of other COCs is not readily apparent.

In the southern portion of the Refinery, we conclude that the sources of SPH are releases of jet fuel (e.g. March 8, 1991 – Tank 26) and diesel (e.g. May 19, 1985 – Tank 19). In the central and northern Refinery area, we conclude that SPH originated from releases of intermediate products (e.g. November 7, 1984 – naphtha), diesel (e.g. April 8-9, 1986 – east of crude unit) and gasoline (former Tanks 6 and 7).

We conclude that the principal source of dissolved-phase hydrocarbons, such as benzene, is separate-phase hydrocarbons on groundwater.

The origin of several other constituents is related to the release of hydrocarbons. The Jackson Lake Terrace was originally deposited under aerobic conditions. During the Late Pleistocene, when precipitation was greater than today, groundwater may have existed in the Jackson Lake Terrace. Such groundwater would be oxidized. If groundwater existed in this unit during recent time but prior to the construction of Hammond Ditch, this groundwater would also be oxidized. The releases of petroleum hydrocarbons to groundwater depleted the oxygen in groundwater beneath the Refinery. In such reducing groundwater, mineral oxides (hematite, magnetite, illmenite, chromite, barite, etc.) will dissolve and release metals (iron, magnesium, chromium, barium, etc.). We conclude that the following constituents of concern were released to groundwater from the minerals of the Jackson Lake Terrace: barium, chromium, cobalt, lead, manganese and nickel.

Many constituents of concern are above WQCC Standards in wells removed from the Refinery or at locations up-gradient from active waste management units. Except for wells adjacent to Hammond Ditch and the Raw Water Ponds, chloride and TDS exceed WQCC Standards. We conclude that concentrations of chloride and TDS naturally increase with distance from artificial recharge areas. However, past Refinery activities (the Spray Irrigation Area and the former evaporation ponds) also contributed to increased concentrations of chloride and TDS. We conclude that boron and aluminum are also naturally above WQCC Standards or are a result of the lack of field filtering during the April 1999 sampling event. Field filtering during the September 1999 sampling may show that boron and aluminum are below WQCC Standards.

Except where reducing conditions have essentially removed sulfate from groundwater, sulfate exceeds WQCC Standards throughout the southern portion of the Study Area. We conclude that sulfate is naturally above WQCC Standards and is not a result of Refinery releases.

5.3 Field Testing of Abatement Alternatives

5.3.1 Vapor Extraction/Air Sparge Pilot Testing

GTI conducted vapor extraction/air sparge pilot testing as part of the Phase IV RFI. Previous submittals from GTI provide a complete discussion of the procedures and findings from this pilot test. The significant findings are listed below.

- Venting VEW-1S, a 2-inch well completed in a zone from 5–13 feet below grade, produced measurable induced vacuum in wells up to 57 feet away. At a maximum applied vacuum of 42 inches of water column, induced vacuum response was less than 0.19 inches, reflecting the low permeability clay characteristic of this zone. Maximum soil vapor flow from the test well was 115 scfm.

Calculated effective radii of influence for this shallow zone ranged from 2 feet (for removal of diesel products) to 36 feet (for removal of gasoline products).

- Venting VEW-1D, a 2-inch well completed in a zone from 16–26 feet below grade, produced measurable induced vacuum in wells 19–57 feet from the vent well. At a maximum applied vacuum of 21 inches of water column, the induced vacuum ranged from 1.9–4.0 inches. High permeability sands and gravel in the deep zone may account for the greater response to venting at this depth. Maximum soil vapor flow from the deep test well was 131 scfm. Calculated effective radii of influence for this deeper zone ranged from 3 feet (for removal of diesel products) to 84 feet (for removal of gasoline components).
- GTI evaluated saturated zone sparging effectiveness based on observed induced pressure and VOC concentrations while sparging at applied pressures of 3–5 psi. At 5 psi, maximum airflow into AS-1, a 2-inch diameter well, was 19.5 scfm. Based on observed pressure responses during the sparge test, GTI proposed a conservative value of 50 feet as the effective radius of influence.
- During the combined pilot test, GTI measured a net negative vacuum in all monitor points while venting at 18 inches of water column and sparging at 5 psi, approximately 120% above breakthrough pressure. This indicates that the vacuum system has the capacity to contain all vapors generated through sparging. Due to sparge pressure, vacuum measured in the monitor points during the combined test was generally less than one-half of the vacuum measured while venting only.
- Hydrocarbon mass removal rates reached 0.20 lb/hr total fuel for venting in the shallow zone. Removal rates rose to 5.5 lb/hr total fuel while venting and sparging in the deep zone. Oxygen levels ranged from 4.3%–18% in the vented effluent. Concentrations of methane ranged from 18%–68%.

5.3.2 Bacterial Enumeration Studies

Petroleum hydrocarbons, particularly BTEX compounds and low molecular weight hydrocarbons ($<C_{30}$), are generally biodegradable. Extremely high concentrations of petroleum hydrocarbons, however, can hinder biodegradation. In particular, biodegradation is generally not optimal if petroleum hydrocarbon concentrations are greater than 20,000 mg/l, or if SPH is present.

Effective bioremediation requires a sufficient density of hydrocarbon-degrading bacteria. As part of the original CMS investigation undertaken by GTI, groundwater samples from wells MW-11, MW-26, MW-30, MW-31 and MW-34 were submitted for bacterial enumeration studies to determine the density of total heterotrophic bacteria (THB) and contaminant-utilizing bacteria (CUB). Appendix B of the CMS contains the laboratory analytical results of this sampling event. These tests are qualitative in nature, as the measurement of either the THB or CUB is somewhat imprecise. However, these measurements can indicate the relative health of the subsurface bacterial community. In general, population densities of THB or CUB above 10^5 CFU/ml are considered high; densities below 10^3 CFU/ml are considered low.

Bacteria counts from groundwater at the Refinery range from low to moderate. THB counts for the five wells tested ranged from 1.3×10^3 CFU/ml to 5.9×10^4 CFU/ml. CUB counts ranged from 3.2×10^2 CFU/ml to 4.7×10^4 CFU/ml. Table 10 summarizes bacterial counts for each well.

Volatile hydrocarbons were detected in each of the tested monitoring wells. GTI compared the microbial data with the chemical data to determine whether there was a correlation between hydrocarbon concentrations and bacterial counts. However, they were unable to establish such a correlation. GTI concluded that factors other than hydrocarbons alone are limiting biological activity in the saturated zone.

GTI also submitted groundwater samples from the five wells for analysis of inorganic parameters, dissolved oxygen and pH. The inorganic analytical results show that ammonia and orthophosphate are present in the groundwater but at concentrations lower than optimal to support an extensive bacteria population. Measurements of pH are within the accepted aerobic bioremediation range (6–8). Dissolved oxygen concentrations are lower than optimal and indicate that anaerobic conditions may be present. A review of historical analytical data shows elevated nitrate levels in MW-5, an up-gradient monitoring well, compared to wells located within the hydrocarbon plume. From this, GTI concluded that anaerobic biodegradation of hydrocarbons under denitrifying conditions may be occurring. GTI also stated that high methane levels measured during the vapor extraction/air sparge pilot test suggest the occurrence of denitrifying conditions. Moderate levels of sulfate are present in the plume area. Sulfate can serve as a terminal electron acceptor under highly reducing conditions. GTI concluded that, due to high sulfate concentrations, this mechanism is probably not occurring at the site.

According to GTI, the limited availability of dissolved oxygen and low level of inorganic nutrients appear to be inhibiting factors for effective biodegradation of the hydrocarbons at the site. However, the presence of the heterotrophic bacteria and the high percentage of contaminant-utilizing bacteria in relation to the total heterotrophs indicates that the base bacterial population for effective biodegradation exists.

6 Screening of Abatement Alternatives

Abatement options for the Refinery area include remedial technologies and environmental management alternatives ranging from soil vapor extraction to no action. The March 1993 "RCRA Facility Investigation – Task I: Description of Current Conditions" report included a pre-investigative evaluation of abatement options. As part of the Discharge Plan and CMS process, Hicks Consultants re-evaluated abatement alternatives in light of data collected as part of the RFI, GTI's evaluation in the original CMS and data from this investigation.

Hicks Consultants screened abatement options that address one or more of the three previously outlined abatement objectives at the Refinery. We employed a screening matrix to evaluate which technologies will meet the abatement objectives most efficiently for the following four hydraulic zones:

- surface water (the San Juan River)
- SPH in the unsaturated zone
- sorbed constituents of concern in the unsaturated zone
- dissolved constituents of concern in the saturated zone

Some of the abatement options identified, such as soil vapor extraction, are applicable to more than one zone. Abatement options such as these are perhaps more applicable to the site because one measure can help fulfill more than one objective.

Hicks Consultants screened nine abatement options to address surface water, nine options for SPH, nine options for the unsaturated zone and seven options for the saturated zone.

Hicks Consultants evaluated each technology according to three categories of appropriateness: site characteristics, constituent of concern characteristics and technology limitations. We eliminated those technologies that were unacceptable in any one of the categories. Options that were acceptable in all three areas were retained for further consideration on a more detailed level.

A description of the rating considerations is provided below. Please note that the evaluation of various remediation technologies does not imply that any remediation technology is required to meet the abatement objectives at the Refinery. A "no action" alternative is also a reasonable solution, if it will meet the abatement objectives.

6.1 Description of Technology Evaluation Parameters

6.1.1 Site Characteristics

Hicks Consultants reviewed site data, including current operations, geology and hydrology, to identify any conditions that would limit or promote the use of particular abatement technologies at the Refinery. Technologies whose use was clearly precluded by site conditions were not retained for further consideration.

6.1.2 Constituent of Concern (COC) Characteristics

Hicks Consultants considered abatement options in light of the characteristics of the COCs that may limit the effectiveness or feasibility of particular technologies. Methods that were clearly limited in remediating petroleum hydrocarbons were eliminated.

6.1.3 Technology Limitations

For each of the abatement options, Hicks Consultants evaluated how well-developed the technology is, how the technology has performed at similar sites, and any inherent construction or operation and maintenance problems. Technologies that have performed poorly, or have not been fully demonstrated, at sites similar to the Refinery were not retained for further consideration.

6.2 Retention of Options

A final decision on whether or not to retain a specific listed technology as a candidate for application was made based on the three criteria listed above. Any abatement options that were clearly unsuitable for this site due to site or waste characteristics or inherent technology limitations were not retained for further consideration. Tables 11–14 summarize the results of the screening process. The retained abatement options are described below.

7 Description of Retained Abatement Options

The following sections contain brief descriptions of retained abatement options, each listed under the abatement objective to which it applies. Some abatement options identified, such as soil vapor extraction, are applicable to more that one objective. The final evaluation for each retained option is presented in section 8, below.

7.1 Seepage Control to the San Juan River (Surface Water)

Hydrocarbon-impacted groundwater under the Refinery flows toward the San Juan River through seeps at the base of the bluff on the northwest side of the site. The result is a zone of alluvium containing hydrocarbons and SPH that recently impacted the river during a season of low flow. To prevent future impact on the river, the hydrocarbon-impacted groundwater flow from the alluvium into the river must be mitigated. This can be accomplished either by diverting the flow or by reducing hydrocarbon concentrations. Of these strategies, diverting the flow requires less capital and construction effort, and provides more immediate results; options based on this strategy also require much less field data to evaluate. Due to the immediate threat to surface water and the increased amount of field data required to evaluate options aimed at reducing hydrocarbon concentrations, Hicks Consultants only considered options based on flow control or diversion. Of these, we retained the option of using sheet pilings to control the flow to the river. If, in the future, the sheet pilings prove ineffective, Refinery staff will perform the required investigations to allow evaluation of hydrocarbon reducing technologies.

7.1.1 Sheet Pilings and Slurry Wall

Installation of sheet pilings and a bentonite slurry wall will physically restrict groundwater flow to the San Juan River. Sheet pilings driven into the Nacimiento formation approximately 5–10 feet from the river's edge will minimize construction impact to the river and effectively seal off the perched groundwater zone. A sealant will be applied between the pilings to create an impermeable barrier. Sheet pilings extending around the perimeter of the river bank to the outlet of the water make-up ponds (see Plate 41), south along the west edge of the make-up ponds and east to the east edge of the make-up ponds, will effectively surround the hydrocarbon-impacted groundwater zone. A French Drain between the cliff and the sheet piling will divert all impaired groundwater to the raw water ponds, preventing hydrocarbons from flowing underneath the sheet piling to the river.

7.2 Abatement of Separate-Phase Hydrocarbons (SPH) in the Unsaturated Zone

SPH comprises the largest portion of the total mass of petroleum hydrocarbons under the Refinery. GTI and Hicks Consultants both used well gauging events to estimate the extent of SPH. According to GTI's calculations, SPH in the Study Area ranges from 57,000–68,000 gallons. In calculations for this report, we will use the highest number that GTI calculated for SPH. Regardless of the total mass, however, SPH must be contained to promote water quality and meet the abatement objectives. To meet this objective, Hicks Consultants retained the five abatement options presented below.

7.2.1 Option 1: Soil Vapor Extraction (SVE)

Soil vapor extraction (SVE) is a process in which soil vapors are vacuumed out of the subsurface through vapor extraction wells connected to a vacuum blower. Active venting of soil vapors promotes continuous removal of volatile hydrocarbons sorbed to the soil matrix. The induced flow of air through the vented soil formation also increases the dissolved oxygen concentration available to hydrocarbon-degrading bacteria.

SVE is most effective in course-grained soils impacted with volatile contaminants, similar to the conditions that exist at the Refinery. Pilot testing results from the RFI (see section 5.31, above) indicate that SVE is feasible for use in eliminating hydrocarbons at the Refinery.

Preliminary designs by GTI include one that uses 5 treatment zones, serviced by 3 remediation equipment compounds. Each of the 5 zones will consist of 8 SVE wells. Initial extraction rates will be restricted based on air quality emission limits to prevent the need for air emission abatement technology. As soil vapor concentrations decrease over time, the extraction rates can increase accordingly.

7.2.2 Option 2: SVE and *In Situ* Air Sparging (IAS)

Air sparging is a process in which ambient air is injected into groundwater in the subsurface through multiple wells connected to a pressure blower. SVE, as discussed above, coupled with air sparging, can provide accelerated removal of hydrocarbons from the subsurface.

Together, SVE and air sparging remove SPH by volatilization and by encouraging biodegradation through increased oxygen supply. Sparged air bubbles strip volatile hydrocarbons from impacted groundwater. The volatilized hydrocarbons flow into the unsaturated zone, where they are captured by an SVE system. Additionally, sparging injects air directly into groundwater, thereby supplying a greater amount of oxygen to the subsurface than SVE alone. This additional oxygen promotes hydrocarbon biodegradation.

Given the relatively thin saturated zone at the Refinery (<1 to 10 feet), multiple sparge points would be required to create sufficient coverage of the SPH plumes. Pilot testing results suggest that both SVE and IAS are feasible technologies for the Refinery. Initial designs include 40 extraction wells and 75 sparging wells, organized into 5 treatment zones. Extraction and sparging rates will be limited by the vapor concentrations released to prevent the need for air emission controls.

7.2.3 Option 3:Total Fluids Pumping

Total fluids pumping is used to pump SPH and hydrocarbon-impacted groundwater out of the subsurface for treatment or disposal above grade. This is accomplished by pumping wells installed within the SPH plume.

Total fluids pumping from 7 recovery wells is currently employed at the Refinery (see section 1.5). The recovery wells pump SPH and hydrocarbon-impacted groundwater to the existing Refinery API separator, then on to the RCRA units, the evaporation ponds and finally the injection well. In the past, drawdowns in the pumping wells have been relatively low, limited by the capacity of the facility's water treatment system. Since installation of the injection well in 1995, each pump is able to discharge 1.5–2 gallons per minute.

7.2.4 Option 4: Water Table Depression and SVE

Water table depression coupled with SVE is a process in which the water table is lowered through pumping, thereby creating or exposing a smear zone (an unsaturated zone through which the SPH travels as the water table is lowered). A portion of the SPH is sorbed to the soil matrix in the smear zone, then vacuumed out using SVE. The increased smear zone creates a larger SPH surface area for the SVE flow to remove volatiles and for hydrocarbon-degrading bacteria to feed on. The smear zone in the soils matrix acts like a crude air-stripping matrix combined with a fixed film bioreactor. SVE flow passing through the porous smear zone soil matrix will pull off more volatile contaminants than SVE over the flat plane surface of an SPH plume lying on groundwater. A thin SPH coating on soil grains in the smear zone will be more diluted (less toxic) and more accessible to hydrocarbon degraders. Using SVE coupled with water table depression would provide faster removal of SPH from groundwater than using SVE alone.

As discussed above, SVE is a feasible technology for the Refinery, and could be enhanced locally (in the SPH plume areas) by water table depression. However, the permeability of the Jackson Lake Terrace is so great that in order to depress the water table sufficiently to provide a reasonable benefit to SVE (>2 feet), large volumes of water (5–10 gallons per hour per well) must be discharged. This discharge could overwhelm the existing wastewater disposal system.

7.2.5 Option 5: Monitored Natural Attenuation (MNA)

Monitored natural attenuation (also called intrinsic remediation) is a remedial response that employs naturally occurring processes such as dilution, biodegradation and volatilization. When SPH is present, biodegradation generally progresses rapidly at the edges of the plume, gradually reducing the plume around the release area. Thus, natural attenuation will stabilize hydrocarbon migration and eventually reduce SPH in the source area. Recent data indicate that this option will reduce risk at the edges of the plume, where the risk to human health and the environment is highest, within 10–30 years. It may eventually remove all SPH at the Refinery, though complete restoration will take significantly longer.

According to the USEPA OSWER Directive 9200.4-17P,

> “In determining whether MNA is an appropriate remedy for soil or groundwater at a given site, EPA or other regulatory authorities should consider the following:

- Whether the contaminants present in soil or groundwater can be effectively remediated by monitored natural attenuation processes;
- Whether or not the contaminant plume is stable and the potential for the environmental conditions that influence plume stability to change over time;
- Whether human health, drinking water supplies, other groundwaters, surface waters, ecosystems, sediments, air, or other environmental resources could be adversely impacted as a consequence of selecting MNA as the remediation option;
- Current and projected demand for the affected resources over the time period that the remedy will remain in effect;
- Whether the contamination, either by itself or as an accumulation with other nearby sources (onsite or offsite), will exert a long-term detrimental impact on available water supplies or other environmental resources;
- Whether the estimated timeframe of remediation is reasonable compared to timeframes required for other more active methods;
- The nature and distribution of sources of contamination and whether these sources have been, or can be, adequately controlled;
- Whether the resulting transformation products present a greater risk, due to increased toxicity and/or mobility, than do the parent contaminants;
- The impact of existing and proposed active remediation measures on the MNA component of the remedy, or the impact of remediation measures or other operations/activities (e.g., pumping wells) in close proximity to the site; and
- Whether reliable site-specific mechanisms for implementing institutional controls are available, and if an institution responsible for their monitoring and enforcement can be identified.

Historic groundwater data and bacterial enumeration studies demonstrate that natural attenuation is feasible and is already occurring at the Refinery. It has been well documented that monitored natural attenuation is effective in degrading petroleum hydrocarbons in soil and groundwater. Well gauging events from 1995–1999 demonstrate that the hydrocarbon plume at the Refinery is stable and is in fact shrinking. The only anticipated change in environmental conditions affecting hydrocarbon migration at the site is the proposed lining of Hammond Ditch and the evaporation ponds. These changes should reduce the recharge to the subsurface, slowing hydrocarbon migration and thus allowing monitored natural attenuation processes in any given area more time to degrade the petroleum products in a smaller area around the Refinery.

As the analyses demonstrate, the current distribution of petroleum hydrocarbons creates no adverse impact on human health or the environment. There is no evidence that sediments, air or any other environmental resource will be impacted by allowing the hydrocarbons to remain in their current location until they are naturally degraded. The groundwater at the Refinery is not used for drinking water or any other purpose, nor will it be in the foreseeable future. Thus, there is no projected demand for the "affected resource," nor will the hydrocarbons create any long-term detrimental impact on any nearby water supplies or other resources.

Hicks Consultants estimates that monitored natural attenuation will require approximately 60 years to reduce hydrocarbon concentrations throughout the SPH plume to WQCC numerical standards. Hydrocarbons in groundwater poses no threat to human health or the environment at any place of reasonably foreseeable future use. Therefore, we believe this is a reasonable timeframe for remediation.

Refinery personnel have controlled all known release points; they also conduct regular maintenance and throughput checks to minimize any future release. Past releases at the Refinery contained jet fuel, diesel and gasoline products; the natural degradation of these products forms innocuous chemical species. Thus, there is no additional risk created by the degraded products.

The existing pumping system, and all the proposed active methods for SPH recovery, will increase the potential for natural attenuation by reducing hydrocarbon concentrations and/or introducing oxygen into the subsurface. The existing pumping system may also decrease the hydrocarbon migration rate by removing water and SPH from the up-gradient release area.

The land containing subsurface hydrocarbons is owned either by the Refinery or the BLM. The BLM cannot transfer the land or increase groundwater usage until all hydrocarbons are below detection limits. Therefore, institutional controls are already in place to prevent future uses of groundwater or subsurface that will create a risk to human health or the environment.

Semiannual or annual monitoring of selected groundwater wells provides sufficient data to demonstrate that natural attenuation is progressing and the hydrocarbon plume is not expanding. If groundwater monitoring demonstrates that hydrocarbon concentrations in the saturated zone are remaining stable or decreasing over time, a similar assumption can be made regarding the mass of hydrocarbons sorbed to soil.

7.3 Abatement of Sorbed COCs in the Unsaturated Zone

Hydrocarbons sorbed to soil generally account for a significant portion of any hydrocarbon mass. Soil containing sorbed hydrocarbons is often a continuing contributing source of dissolved hydrocarbons in groundwater. This soil source must be eliminated before groundwater can recover completely. To accomplish this objective at the Refinery, Hicks Consultants retained the following two abatement options for further consideration.

7.3.1 Option 1: Soil Vapor Extraction

The process of Soil Vapor Extraction and its potential effectiveness at the Refinery are discussed as Option 1 for SPH remediation (see section 7.2.1).

7.3.2 Option 2: Monitored Natural Attenuation

Monitored natural attenuation is described in Option 5 under SPH remediation (see section 7.2.5). Chemical data from the Refinery subsurface suggest that natural attenuation has measurably abated the impact to groundwater in the last ten years. If the current distribution of hydrocarbons in the subsurface is below an acceptable EPA risk level, monitored natural attenuation will be sufficient to meet future abatement objectives.

7.4 Abatement of Dissolved-Phase COCs in the Saturated Zone

Some hydrocarbon constituents are soluble in water, becoming dissolved-phase hydrocarbons and typically migrating farther from the release point than SPH. Analytical results from groundwater sampling events at the Refinery indicate that dissolved-phase hydrocarbons have migrated outside the SPH plume boundaries. The mass of dissolved-phase hydrocarbons is generally small relative to the masses in SPH and soil. Hicks Consultants retained four abatement options to address dissolved-phase hydrocarbons at the Refinery.

7.4.1 Option 1: Soil Vapor Extraction (SVE) and *In Situ* Air Sparging

(IAS)

SVE and IAS are described as Option 2 for SPH remediation (see section 7.2.2).

7.4.2 Option 2: Enhanced *In Situ* Bioremediation

Enhanced *in situ* bioremediation is the injection of nutrients, such as nitrogen, and phosphorous into groundwater to promote the biodegradation of hydrocarbons before they reach the river. Bacterial enumeration studies conducted at the Refinery have concluded that site conditions (bacteria populations, contaminant type, temperature, pH, geology) are amenable to bioremediation. However, these studies have also demonstrated that the oxygen, nitrogen and phosphorus levels in groundwater are lower than optimal for bioremediation. If these growth factors are enhanced, bioremediation may have a significant effect on reducing subsurface hydrocarbons.

Water-soluble agricultural fertilizers provide the necessary nutrients for enhanced bioremediation in a cost-effective manner. Doses of the fertilizer mixed with water will be poured down selected monitor wells throughout the Refinery property.

The degree of hydrocarbon biodegradation can be monitored through carbon dioxide levels before and after adding the nutrients. Organic compounds are converted into carbon dioxide and water by the bacteria. The rate of biodegradation can be calculated based on oxygen uptake and carbon dioxide and water production. Carbon dioxide is a direct result of the biodegradation of organic material by microorganisms in soil and groundwater. In general, approximately 30–60% of organic carbon degraded by bacteria is released as carbon dioxide. Because of this direct relationship between biodegradation and carbon dioxide production, monitoring of carbon dioxide provides data reflecting the mass of hydrocarbon degradation. Monitoring carbon dioxide production is also an effective way to check that bioremediation is proceeding efficiently, and to calibrate the appropriate amount of nutrient addition. For example, a significant reduction in carbon dioxide production can indicate an imbalance in the biological system. This imbalance can result from a lack of nutrients or oxygen, from the presence of microbial-inhibiting substances, or from some other condition in the system. An increase in the rate of carbon dioxide production following nutrient addition will indicate that lack of such nutrients was a partial cause of this imbalance. Nutrient addition will be adjusted based on the response in carbon dioxide levels following the initial nutrient input.

Nutrient addition to groundwater is permissible in New Mexico with a Groundwater Discharge Permit issued by the NMED Groundwater Bureau. Typically, the permit conditions require installation of down-gradient sentinel wells to monitor for the presence of nitrogen and phosphorus escaping the treatment area.

7.4.3 Option 3: Source Removal and Monitored Natural Attenuation

This corrective measure option entails the use of remediation technologies such as vapor extraction or total fluids pumping to remove and degrade SPH and soil sources. The water quality improvement will then rely on monitored natural attenuation to diminish the dissolved-phase hydrocarbons remaining. Semiannual or annual monitoring will be necessary to demonstrate that the SPH plume is stable and the dissolved-phase hydrocarbon concentrations are decreasing with time.

7.4.4 Option 4: Monitored Natural Attenuation (MNA)

The principles of monitored natural attenuation are described as Option 5 for SPH remediation (see section 7.2.5).

8 Evaluation of Abatement Alternatives

This section presents a detailed evaluation of retained abatement alternatives based on how well they address the four abatement objectives listed above (see section 6). Hicks Consultants examined each alternative in terms of characteristics and environmental concerns specific to the Refinery. Section 8.1 outlines the methodology applied. Tables 15–18 provide a summary of the evaluation.

Due to the magnitude of the release at the Refinery, we believe "no action" is not an acceptable alternative for the Refinery. For purposes of quantitative comparison, we have referred to monitored natural attenuation (MNA) as the baseline, or zero, option and rated all other alternatives relative to this option.

8.1 Evaluation Methodology

8.1.1 AOC-Specified Criteria

As directed in the Administrative Order on Consent, Hicks Consultants evaluated each corrective action alternative according to the following criteria:

8.1.1.1 Technical

Technical evaluation is based on the three factors discussed below.

Performance: Performance includes the ability of a particular method to meet the objective, any waste or site characteristic that would impede the effectiveness of a given method, and the useful life of the method in question.

Reliability: Reliability considerations include the operation and maintenance requirements for each alternative, including the frequency and complexity of maintenance operations, and the availability of labor and materials. This category also includes the demonstrated reliability of each method at similar sites.

Implementability: Implementability concerns the ease of installation, time required to achieve a given level of response, constructability of the system (including location of utilities, depth to water, heterogeneities and location) and external factors such as required permits, equipment availability and location of treatment and disposal facilities. Implementability also includes consideration of the time needed for the method to begin functioning effectively and the time required to reach a desired level of remediation. Hicks Consultants approximated this length of time using professional judgement.

8.1.1.2 Environmental

Environmental considerations include short- and long-term beneficial and adverse effects, adverse effects on environmentally sensitive areas, and analysis of measures to mitigate adverse effects.

8.1.1.3 Human Health

Human health factors include mitigation of short- and long-term potential exposure and the ability of a particular method to be protective of human health both during and after implementation. The Administrative Order on Consent also includes potential exposure pathways and potentially affected populations in this area of evaluation. GTI performed a complete risk assessment for the site, discussing these and other risk assessment factors associated with all aspects of the site (see section 4.13). The risk assessment demonstrates that risks to human health and the environment under current conditions are below target levels accepted by the EPA. Therefore, only new exposure routes created by the abatement were included in this area of evaluation.

8.1.1.4 Institutional

This area of evaluation considers effects of federal, state and local standards and regulations and community relations on the design, operation and timing of each abatement alternative.

8.1.1.5 Cost

Hicks Consultants developed a two-part cost estimate for each abatement option. The first part of the estimate is for the year in which the method is implemented. This includes all construction, engineering design, legal and regulatory costs associated with installing the system and initiating operation. This part also includes the first year's costs for operation and maintenance, labor and materials, energy, professional and laboratory fees, disposal costs and administrative costs. The second part of the cost estimate is an annual cost for every year following the first. This annual cost includes operation and maintenance, energy, professional and laboratory fees, disposal costs and administrative costs.

The costs developed during this evaluation are merely estimates and may not match the actual costs of the corrective action alternatives implemented at the Refinery. However, they are close enough to the actual costs to use as evaluation tools in determining which corrective action alternatives are most cost-effective for the Bloomfield Refinery.

8.1.2 Rating System

While the Administrative Order on Consent provides the above criteria for evaluating different abatement options, it does not specify what importance each element should carry. Hicks Consultants therefore established a simple rating system, applying appropriate weighting factors to those considerations deemed most important at the Refinery.

The abatement alternatives for each abatement option were evaluated relative to monitored natural attenuation. If a measure provided higher benefits than monitored natural attenuation in a particular category, it was assigned a value of "+1." If the measure proved less beneficial than monitored natural attenuation, it was assigned a value of "–1." If the measure provided similar benefits, or provided additional benefits but also created adverse effects of the same magnitude, the measure was assigned a value of "0." By definition, monitored natural attenuation was assigned a "0" for every category.

In addition to the relative comparisons, Hicks Consultants assigned each of the evaluation criteria a weighting factor based on the relative importance at the Refinery. For example, Hicks Consultants deemed protection of human health more important than cost of implementation. Thus, the human health category was assigned a larger weighting factor than the cost category. Table 19 lists the assigned weighting factors and the justification for each.

Tables 15–18 display the results of the rating and evaluation for each of the abatement alternatives. Hicks Consultants selected the recommended remedial system based on the relative merit of each alternative as displayed in these tables.

8.2 Seepage Control to the San Juan River (Surface Water)

8.2.1 Sheet Pilings and Slurry Wall

Installing impermeable sheet piling and a bentonite slurry wall along the edge of the San Juan River will have an immediate and long-lasting effect in preventing dissolved-phase hydrocarbons and SPH in groundwater from entering the river. This technology has been used for many years and has proven effective at numerous sites. The pilings will require a relatively quick, though labor intensive, installation period. As there are no moving parts, the pilings require no maintenance and will have a long useful life. The manufacturer's warranty ensures that the sheet piling will function for the life of the Refinery, commonly estimated as 20 years for amortization purposes.

The installation of sheet pilings and slurry wall may have the adverse effect of increasing turbidity and noise levels in the river bed area during construction, but there will be no adverse long-term effects. The ability to prevent hydrocarbons from entering the river will be immediate. Adverse effects to the river will be minimized through careful construction and installation procedures.

As demonstrated in the analyses, there is no current threat to human health posed by hydrocarbons in the sediment of the San Juan River. However, the river is used for recreation and fishing. The installation of sheet pilings will remove any potential risk of future hydrocarbon exposure in the river.

Installing sheet pilings is an active and visible abatement alternative that immediately protects against the likelihood of future hydrocarbon exposure. Thus, it should be acceptable to environmental regulators and the surrounding community.

As described in plans previously submitted to the NMOCD, the initial designs for a sheet piling system call for installing sheet piling to a depth of approximately 22 feet, extending from the perimeter of the river bank to the outlet of the water make-up ponds, then south along the west edge of the make-up ponds and east to the east edge of the ponds. A French Drain or similar system will be installed on the Refinery side of the impermeable barrier to pump SPH to a recovery tank as necessary. The initial capital costs are estimated at $173,000, with only negligible costs after the first year.

8.3 Abatement of Separate-Phase Hydrocarbons (SPH) in the Unsaturated Zone

8.3.1 Soil Vapor Extraction (SVE)

Soil vapor extraction has proven successful in reducing SPH at sites similar to the Bloomfield Refinery. An SVE system has its drawbacks: it will require installation of approximately 40 wells, and the equipment will have a limited useful life. However, installation of such equipment will probably reduce hydrocarbon concentrations to nondetectable levels within 5–10 years.

Soil vapor extraction will reduce the risk of having SPH in the subsurface, but will also introduce the potential for exposure through air emissions. The maximum flow rate will be limited by the allowable emission limits for volatile organic compounds. Limiting the flow rate will preclude the need for air emission control equipment; but installing a vapor extraction system will increase the regulatory burden for the site by adding air quality to the list of regulatory considerations.

Based on GTI's preliminary design without the *in situ* air sparging system, the approximate capital and maintenance costs for the first year will be $799,000. GTI estimated annual operation and maintenance costs thereafter at $82,000.

8.3.2 Soil Vapor Extraction (SVE) with *In Situ* Air Sparging (IAS)

SVE coupled with IAS will remove SPH from the subsurface more quickly than SVE alone, probably reducing hydrocarbon concentrations to nondetectable levels within 3–10 years. Pilot tests demonstrate that SVE and IAS are feasible at the Refinery, but due to the thin unsaturated zone, many IAS wells will be required to adequately cover the impacted area.

The SVE/IAS system will require regular, but simple, maintenance for efficient operation. These technologies are in use at numerous other sites and are generally reliable if carefully maintained. This abatement option will require the installation of over 100 extraction and injection wells in addition to the vacuums, blowers and associated equipment. Well drilling near the Refinery has proven to be relatively difficult. Therefore, it may require many months to install all 100 wells and begin system operation.

SVE/IAS systems typically have a limited useful life. Initial reductions in SPH mass may be quite impressive, but it is common knowledge that nearly all extraction systems reach an asymptotic level below which only minor reductions can be made. In addition, all pumps and vacuums will eventually fail to function. Thus, the cost of such a system must be weighed against the productive life of the system and the importance of reduction rates. In this case, the time required for remediation is relatively unimportant because the current conditions pose no threat to human health or the environment.

While this type of system will probably remove contaminants much faster than monitored natural attenuation, it will also introduce a new path for exposure by releasing volatilized hydrocarbons to the atmosphere. While the flow rates will be limited to maintain air emissions below acceptable regulatory levels, releasing hydrocarbons into the air in any concentration creates a new pathway for possible human exposure or environmental impairment.

This option involves active remediation methods, reducing the time required to remove hydrocarbons from the decades required by monitored natural attenuation to less than 10 years. However, since there is no risk to human health or the environment created by the SPH plume, the time required to reduce the hydrocarbon mass is relatively unimportant. Thus, this option and monitored natural attenuation should be equally acceptable to the regulatory agencies. SVE and IAS will create the same response among the community as monitored natural attenuation or a "no action" alternative, because there will be neither visible efforts along the riverbed nor any immediate improvements to the water quality.

As an initial design for this remedial approach, GTI proposed 5 treatment zones, each containing 8 extraction wells and 15 injection wells. GTI estimated the initial capital costs including the first year's operation and maintenance at $1,173,400, with annual operation and maintenance costs of $82,000 thereafter.

8.3.3 Total Fluids Pumping

Total fluids pumping will meet the objective of removing SPH from the source area. Pumping is most effective in saturated zones with high hydraulic conductivities, such as those measured at the Refinery. The equipment required for pumping has a limited useful life and requires 3–4 hours of weekly maintenance to operate effectively. The hardness in the water at the Refinery will require frequent cleaning of pumps to maintain pumping efficiency.

Total fluids pumping is a commonly used and well proven technology. A total fluids pumping system is already in place at the Refinery; therefore, there is no time delay associated with implementing this remedy. Source reduction using total fluids pumping began at the site in 1989. The reduction rate is unknown. GTI presented Refinery personnel with data regarding the amount of SPH removed through pumping, but these figures were later invalidated. Well gauging events, however, continue to show a reduction in the size of the SPH plume.

Total fluids pumping decreases the inherent risk of having SPH in the subsurface, but creates additional exposure pathways by bringing SPH and hydrocarbon-impaired water above the surface. The Refinery has the ability to treat both the SPH and the water onsite, thus reducing risks of accidental release during transport. However, there are risks associated with onsite disposal and possible accidental release in unimpaired portions of the Refinery property.

Pumping should be acceptable to regulatory agencies because the system is already in place and employs active methods to reduce the source area. Community response should be the same for this method as for monitored natural attenuation or a "no action" alternative, as both the system and its effects will be relatively invisible to the public.

The system already in place is sufficient to continue active and efficient recovery of SPH. Therefore, the only costs associated with total fluids pumping are annual operation and maintenance costs and performance monitoring. Based on data from previous years, the approximate annual cost for total fluids pumping is $5,000.

8.3.4 Water Table Depression and SVE

In addition to the merits of stand-alone soil vapor extraction, water table depression increases the smear zone, thereby increasing the surface area of volatile hydrocarbons. The physical limitations associated with the equipment are essentially the same as those discussed for SVE. The system will have a limited useful life and will require weekly maintenance to operate efficiently.

Due to infiltration, the high transmissivity of the Jackson Lake Terrace and the thickness of the saturated zone, depressing the water table will require extremely aggressive pumping. While this method will probably reduce the source area faster than monitored natural attenuation, the system's ability to enhance stand-alone SVE results will depend on its being able to sustain a flow rate greater than the infiltration rate.

This remedy will reduce the inherent risk of having hydrocarbons in the subsurface faster than monitored natural attenuation, but will also introduce two new exposure pathways. In addition to the air emissions associated with the extraction system, depressing the water table will involve bringing large quantities of groundwater containing dissolved-phase hydrocarbons above the surface. The potential risks to human health and the environment associated with disposing of this water are far greater than those posed by leaving the water in place.

The pumping system already in place may be sufficient to depress the water table, but will probably need augmentation. Initial cost estimates for this option include only capital costs for the SVE system. Based on GTI's estimates and pumping costs from previous years, the first year of SVE and water table depression will cost approximately $10,000. Annual maintenance thereafter will be approximately $5,000. Additional capital costs may be involved if the current pumping system is not sufficient to lower the water table effectively.

8.3.5 Monitored Natural Attenuation (MNA)

Monitored natural attenuation will eventually remove the SPH in the source area, but will probably require decades to completely rehabilitate the area. Because monitored natural attenuation is more effective in dealing with low concentrations of hydrocarbons, the edges of the SPH plume will be degraded more rapidly, causing the plume to shrink in toward the source area. Thus, the time required for SPH removal using MNA will be considerably longer than for the active methods listed above.

Historic data show that natural attenuation is viable at the Refinery. This method will have an infinite useful life. There is no maintenance required for monitored natural attenuation; the monitoring burden will be roughly equivalent to that required for SVE/IAS. Monitored natural attenuation is already in progress at the Refinery. Thus, there is no new equipment to install and no implementation time required.

There are no increased risks or new exposure pathways created using this method, but the inherent risk due to SPH in the subsurface will exist much longer than for more active methods. However, the risk assessment demonstrates that the risk posed by the current distribution of hydrocarbons is below target levels accepted by the EPA. Therefore, the length of time required for remediation is relatively unimportant. Historic data show that the plume is stable and the hydrocarbons are no longer migrating. Therefore, aside from the inherent risk posed by hydrocarbons in the subsurface, there is no risk to human health or the environment posed by allowing the hydrocarbons to remain in place until they are naturally degraded. Because all treatment occurs *in situ*, this method poses no risk of increasing exposure through disposal or a possible accidental release of recovered product.

Monitored natural attenuation is generally encouraged by regulatory agencies as an addition to active remediation methods. Given the close proximity of the river and the extended timeframe required for concentration reduction, monitored natural attenuation may not be easily accepted as a stand-alone remedy for protecting the San Juan River.

The only costs associated with this remedy are labor and analytical costs for monitoring. Hicks Consultants recommends a year of semiannual sampling, followed by annual sampling thereafter. We suggest monitoring 15 wells and 3 seeps for BTEX constituents and 5 wells for monitored natural attenuation parameters. Based on this preliminary sampling plan, the first year cost will be $12,500. Annual costs thereafter will be approximately $6,250.

8.4 Abatement of Sorbed COCs in the Unsaturated Zone (Soil Remediation)

8.4.1 Soil Vapor Extraction

The applicability of soil vapor extraction to the Refinery is discussed under SPH recovery (see section 8.3.1). The beneficial and adverse effects of using this method for soil remediation are essentially the same as those detailed above for SPH recovery.

8.4.2 Monitored Natural Attenuation

The applicability of monitored natural attenuation to the Refinery is discussed under SPH recovery (see section 8.3.5). Monitored natural attenuation may be more acceptable to regulatory agencies as a method for treating the vadose zone once the SPH plume has been diminished through more active treatment methods. Thus, the institutional rating for monitored natural attenuation may be higher for soil remediation than for SPH source reduction. Aside from this, the beneficial and adverse effects of this method are the same as those discussed previously.

8.5 Abatement of Dissolved-Phase COCs in the Saturated Zone (Groundwater Remediation)

8.5.1 Soil Vapor Extraction (SVE) and *In Situ* Air Sparging (IAS)

The applicability of soil vapor extraciton and air sparging to the Refinery is discussed under SPH recovery (see section 8.3.2). The basic arguments in favor of and against using this type of remediation system for soil remediation are the same as those for SPH recovery.

8.5.2 Enhanced *In Situ* Bioremediation

Enhanced bioremediation will meet the objective of removing hydrocarbons from the saturated zone, but will likely require more time than the SVE/IAS system. There is no equipment to install with this method, and the method is effective for an infinite time. Enhanced bioremediation requires no operation or maintenance, but increases the sampling burden required for monitored natural attenuation. Optimizing nutrient addition may require more frequent sampling for a larger number of parameters, including carbon dioxide. This method will also require careful monitoring of the nutrient levels in groundwater reaching the river to prevent undesirable eutrophication effects.

The addition of nutrients to the subsurface will require preparation and approval of a discharge plan, which will increase the time associated with implementing this strategy. If nutrient addition is effective, the time required to reduce hydrocarbons to nondetectable levels will be approximately 5–15 years. This is considerably faster than monitored natural attenuation, but the timeframe is relatively unimportant due to the low risk involved at the site. If nutrient addition is not effective due to other limiting factors, such as dissolved oxygen or marginal bacteria populations, this method may require as long as monitored natural attenuation. Therefore, the anticipated benefit to human health or the environment is only marginally higher than that of monitored natural attenuation.

There are no initial capital costs associated with the implementation of this method. Based on a preliminary assumption of semiannual nutrient addition, the estimated annual costs for quarterly nutrient addition and sampling are $34,000. Monitoring will include: BTEX analysis for 15 wells along the edges of the plume; monitored natural attenuation parameters for 5 wells; and BTEX and nutrients analyses for 3 seeps. If nutrient levels can be calibrated appropriately and groundwater analyses are consistent throughout the first year, semiannual sampling may be sufficient thereafter, which will reduce the annual costs to $21,000.

8.5.3 Source Removal and Monitored natural attenuation

This remediation strategy involves using active remediation, such as SVE or total fluids pumping, to remove SPH and reduce the hydrocarbon concentrations in the source area, then allowing monitored natural attenuation to reduce concentrations in the soil and groundwater. The merits of each active method have been discussed in previous sections. Hicks Consultants believes the most appropriate source removal method for the Refinery will be total fluids pumping because the system is already in place and functioning effectively.

There are no capital costs associated with using total fluids pumping and monitored natural attenuation. Based on previous years' pumping operation costs and the estimated sampling burden, annual costs for this corrective action alternative will be approximately $5,000.

8.5.4 Monitored Natural Attenuation

Monitored natural attenuation as it applies to the Refinery is discussed above as an option for SPH recovery (see section 8.3.5). The same arguments discussed in that section also apply to monitored natural attenuation as a groundwater remedy. Many of the active remedies considered will provide faster source degradation, but the rate of removal of dissolved-phase hydrocarbons from groundwater may not be significantly faster than unaided monitored natural attenuation. In addition, the rate of removal is of little importance as the current risk to human health and the environment is below acceptable EPA standards.

9 Recommended Abatement Plan

The recommended abatement plan consists of:

- Installing sheet piling and a bentonite clay slurry wall between the Refinery and the San Juan River
- SPH pumping from wells RW-18, RW-19, MW-42 and MW-43
- Monitored natural attenuation

Based on the arguments presented in section 7 and the evaluation methodology outlined in section 8.1, this alternative appears to provide the highest level of protection to human health and the environment with the fewest adverse effects. The following discussion provides justification for selecting this remedial option based on the criteria listed in the Administrative Order on Consent (section 8.1.1).

9.1 Technical

Performance: Sheet piling is the only abatement method guaranteed to prevent seepage to the river and the only measure that will produce immediate results. An impermeable barrier such as this should continue to protect the river until the hydrocarbon concentrations in the seeps naturally degrade to non-detectable levels. Monitored natural attenuation is already occurring at the Refinery and has proven effective at controlling hydrocarbon migration. Not withstanding significant changes in the saturated zone properties, these natural processes will continue to reduce hydrocarbon concentrations in the subsurface until the source area is gone and dissolved-phase concentrations are non-detectable.

Reliability: While many of the corrective action options require frequent maintenance, neither sheet piling nor monitored natural attenuation require any maintenance to continue operating effectively. Monitored natural attenuation has been well documented at the Refinery and at numerous other sites with similar characteristics.

Implementability: Sheet piling provides the timeliest remedy with regard to protecting the river from hydrocarbons. While an impermeable barrier will provide immediate protection, other corrective action alternatives would require months or years to produce visible results in the seeps. Though monitored natural attenuation will require the longest period of time to reduce hydrocarbon concentrations, the Refinery is already below the required risk-based concentrations.

Safety: Sheet piling and monitored natural attenuation are the only abatement options that address the subsurface hydrocarbons without introducing new exposure pathways or adverse effects on the environment. Because the sheet piling will be driven to the proper depth with a hydraulically driven vibratory hammer, there will be no exposure to the construction workers through excavation. Following the initial installation, neither of these methods require intrusion into the subsurface or extraction of hydrocarbons from the subsurface. Because the Refinery already meets the risk-based standards developed to protect human health and the environment, the safest approach to remediation is to minimize future exposure through new exposure pathways.

9.2 Human Health

The hydrocarbon concentrations measured at the Refinery are below the risk-based standards required to protect human health and the environment. Therefore, the time to completely remove the hydrocarbons from the subsurface is relatively unimportant in terms of risk to human health. However, methods that bring hydrocarbons to the surface create new exposure pathways to the Refinery workers responsible for transportation and disposal of the extracted hydrocarbons, and to the surrounding community if extracted hydrocarbons are accidentally released in a currently unimpaired area. Therefore, monitored natural attenuation, though it will require more time to completely remove the hydrocarbons, is most protective of human health because it minimizes the potential exposure pathways.

9.3 Environmental

The San Juan River is the most environmentally sensitive area near the Refinery. An impermeable barrier along the river bank will provide the greatest protection to the river in the shortest period of time. Such a barrier will also provide protection to the river for an essentially infinite period of time. Monitored natural attenuation, while requiring a longer period of time, will provide the same level of improvement to the environment with none of the adverse impacts created by other abatement alternatives.

10 Contingency Plan

If future monitoring demonstrates that monitored natural attenuation is no longer controlling migration of the hydrocarbons, Hicks Consultants recommends implementing total fluids pumping to remove hydrocarbons in the source area. Total fluids pumping scored highest among the active methods in the evaluation tables. The system is already in place at the Refinery. Therefore, there will be minimal costs involved with startup and maintenance training. The necessary disposal facilities are located onsite, reducing the risk of accidental release during transport and disposal. Although there are added risks created by bringing SPH above the surface, this method should reduce the hydrocarbon source sufficiently to allow monitored natural attenuation to stabilize the outer edges of the dissolved plume and prevent further migration.

11 Monitoring Program

We first must determine if wells RW-2 and RW-14 through RW-19 will permit the flow of SPH through the well screen. Pumping SPH, especially with air-driven pumps, can create a hydrocarbon emulsion that clogs well screen. We propose a video camera survey of RW-2 and RW-19. A mechanical and chemical stimulation program may follow this inspection program if necessary.

During the video camera survey, a submersible pump will evacuate the well. If the well screen shows no evidence of clogging and fluid freely flows through the well at or near the water table, we will conclude that the well is not clogged. If the data suggest well screen clogging, Refinery personnel will implement a mechanical and chemical stimulation program.

This stimulation program will employ a 3-inch diameter, 5-foot long bailer to mechanically surge the well. First, a pump pulling unit or drill rig will rapidly evacuate the water within the well. As the water flows into the well from the Jackson Lake Terrace, the pulling unit will rapidly lower and then raise a bailer full of fresh water with the check valve immobilized. This action will rapidly move water across the well screen while groundwater flows into the well. The pulling unit will repeat this process until the well produces water that is relatively free of sediment and/or petroleum emulsion.

Refinery staff will consult with local oil well stimulation experts to determine the appropriate chemical additives that may dissolve any hydrocarbon or bacterial clogging of the well screen. After NMOCD approval of the addition of chemicals, the well stimulation experts will add the appropriate volume of chemicals for the appropriate duration. Refinery staff will re-install the hydrocarbon recovery pump, commence pumping and monitor the well for accumulation of SPH.

If SPH is detected after 30 days of pumping, Refinery staff will repeat the process on the other recovery wells.

Refinery staff will monitor the efficacy of the hydraulic barrier between the San Juan River and the alluvial sediments with six permanent piezometers. Refinery staff will install these steel drive-point wells with a small backhoe. Plate 41 shows the location of these proposed wells. Each well will be installed with approximately one foot of screen above the water table.

In March, June, September and December, Refinery personnel will measure water levels and SPH thickness in each well. Annually, Refinery personnel will sample each well for BTEX and naphthalene.

Refinery personnel will measure water levels and SPH thickness in all 44 wells on a semiannual basis. This measurement program will monitor the efficacy of the SPH removal program.

Refinery personnel will use 15 wells and 3 seep-monitoring points to monitor natural attenuation of hydrocarbons. In 1999, Refinery personnel will sample the following wells for BTEX and naphthalene on a semiannual basis:

1. MW-1
2. MW-8
3. MW-3
4. RW-15
5. MW-9
6. MW-4
7. RW-1
8. MW-11
9. MW-26
10. MW-34
11. MW-35
12. MW-12
13. MW-27
14. MW-36
15. MW-27
16. Seep #2
17. Seep #3
18. Seep #5

Refinery personnel will also collect field measurements of dissolved oxygen, nitrate and conductance from each well. To compliment the semiannual field measurements of dissolved oxygen and nitrate, Refinery personnel will sample following wells for sulfate, iron and methane:

1. MW-8
2. RW-15
3. MW-11
4. MW-34
5. MW-35

After the first year of sampling (April 1999 and September 1999), the Refinery will sample annually. The consistency of the groundwater chemistry over the past 15 years of sampling demonstrates that annual sampling is sufficient to document the natural attenuation process.

Every five years, prior to Discharge Plan renewal, Refinery personnel will sample all of the wells identified above for all WQCC parameters except radioactive constituents.

APPENDIX A

View Record Detail

Faxback 11434

9441.1989(30)

United States Environmental Protection Agency
Washington, D.C. 20460
Office of Solid Waste and Emergency Response

June 19, 1989

Mr. Thomas C. Jorling
Commissioner
Department of Environmental
Conservation
State of New York
Albany, New York 12233-1010

Dear Mr. Jorling:

I am writing in response to your letter of May 5, 1989, in which you ask numerous questions concerning the regulatory status, under the Resource Conservation and Recovery Act (RCRA), of environmental media (ground water, soil, and sediment) contaminated with RCRA-listed hazardous waste.

As you point out in your letter, it is correct that the Agency's "contained-in" interpretation is that contaminated environmental media must be managed as if they were hazardous wastes until they no longer contain the listed waste, or are delisted. This leads to the critical question of when an environmental medium contaminated by listed hazardous waste ceases to be a listed hazardous waste. In your letter, you discuss three possible answers (based on previous EPA positions and documents) which you believe address this question, and request the Agency to clarify its interpretation. Each of these is discussed below.

The first possible answer you cite would be that the contaminated media would be a hazardous waste unless and until it is delisted, based on the "mixture" and "derived-from" rules. As you correctly state in your letter, a waste that meets a listing description due to the application of either of these rules remains a listed hazardous waste until it is delisted. However, these two rules do not pertain to contaminated environmental media. Under our regulations, contaminated media are not considered solid wastes in the sense of being abandoned, recycled, or inherently waste-like as those terms are defined in the regulations. Therefore, contaminated environmental media cannot be considered a hazardous waste via the "mixture" rule (i.e., to have a hazardous waste mixture, a hazardous waste must be mixed with a solid waste per 40 CFR 261.3(a)(2)(iv)). Similarly, the "derived-from rule does not apply to contaminated media. Our basis for stating that contaminated environmental media must be managed as hazardous wastes is that they "contain" listed hazardous waste. These environmental media must be managed as hazardous waste because, and only as long as, they "contain" a listed hazardous waste, (i.e., until decontaminated).

The second possibility you mention is that environmental media contaminated with a RCRA listed waste no longer have to be managed as a hazardous waste if the hazardous constituents are completely removed by treatment. This is consistent with the Agency's "contained-in" interpretation and represents the Agency's current policy.

The third possibility you discuss comes from Sylvia Lowrance's January 24, 1989, memorandum that you cited in your letter. This memorandum indicates that OSW has not issued any definitive guidance as to when, or at what levels, environmental media contaminated with listed hazardous waste are no longer considered to contain that hazardous waste. It also states that until such definitive guidance is issued, the Regions may determine these levels on a case-specific basis. Where this determination involves an authorized State, such as New York, our policy is that the State may also make such a determination.

Related to such a determination, you ask whether a risk assessment approach that addressed the public health and environmental impacts of hazardous constituents remaining in treatment residuals would be acceptable. This approach would be acceptable for contaminated media, but would not be acceptable for "derived-from" wastes under our current rules. Additionally, consistent with the statute, you could substitute more stringent standards or criteria for contaminated environmental media than those recommended by the Federal EPA if you determined it to be appropriate.

The Agency is currently involved in a rulemaking effort directed at setting de minimis levels for hazardous constituents below which eligible listed wastes, treatment residuals from those wastes, and environmental media contaminated with those listed wastes would no longer have to be managed as hazardous wastes. The approach being contemplated in the De Minimis program would be similar to that used in the proposed RCRA Clean Closure Guidance in terms of the exposure scenario (direct ingestion), the management scenario (not in a waste management unit), and the levels (primarily health-based).

Your final question related to whether the "remove and decontaminate" procedure set forth in the March 19, 1987 Federal Register preamble to the conforming regulations on closing surface impoundments applies when making complete removal determinations for soil. These procedures do apply when one chooses to clean close a hazardous waste surface impoundment by removing the waste. The preamble language states that the Agency interprets the term "remove" and "decontaminate" to mean removal of all wastes, liners, and/or leachate (including ground water) that pose a substantial present or potential threat to human health or the environment (52 FR 8796). Further discussion of these requirements is provided in a clarification notice published on March 28, 1988, (53 FR 1144) and in OSWER Policy Directive # 9476.00-18 on demonstrating equivalence of Part 265 clean closure with Part 264 requirements (copy enclosed).

I hope that this response will be helpful to you in establishing and implementing New York's hazardous waste policies on related issues. Should you have additional questions, please contact Bob Dellinger, Chief of the Waste Characterization Branch at (202) 475-8551.

Sincerely yours,
Jonathan Z. Cannon
Acting Assistant Administrator
☐

View Record Detail

Faxback 11140

9441.1986(23)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

MAR 21 1986

Mr. Thomas J. Jackson
Thorp, Reed, and Armstrong
One Riverfront Center
Pittsburgh, Pennsylvania 15222

Dear Mr. Jackson:

This is in response to your letter dated, February 28, 1986. In your letter, you requested an interpretation of the Federal hazardous waste rules concerning a mixture of methanol and a non-hazardous waste which does not exhibit the ignitability characteristic. Under the Federal hazardous waste rules, this mixture would not be defined as a hazardous waste, provided the waste does not exhibit any of the other hazardous waste characteristics (i.e., corrosivity, reactivity, and extraction procedure (EP) toxicity). In particular, a mixture of a characteristic hazardous waste, including wastes that are listed solely because they exhibit one or more of the hazardous waste characteristics and a solid waste is not hazardous if the mixture does not exhibit any of the hazardous waste characteristics. In the example described in your 1/ letter, methanol (a hazardous waste due to its ignitability) is mixed with a non-hazardous wastestream; the resulting mixture is no longer ignitable. Therefore, this mixture would not be considered hazardous (as long as the waste does not exhibit any of the other hazardous waste characteristics) under the Federal hazardous waste rules (i.e., a delisting petition is not necessary). States, however, may have rules that are more stringent or broader in scope than the Federal rules. Therefore, this waste remains hazardous under Pennsylvania law, unless it is exempted in accordance with State law.

1/ If the methanol is being used as a solvent, the spent methanol would be defined as EPA Hazardous Waste No. F003.

Please feel free to give me a call at (202) 475-8551 if you have any further questions.

Sincerely,

Matthew A. Straus
Chief
Waste Identification Branch

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Hotline Questions and Answers

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1. Solid Waste Determination for Spilled Commercial Chemical Products

According to 40 CFR □261.2, Table 1, hazardous commercial chemical products, when recycled, are exempt from RCRA because they are not solid wastes. If a manufacturer spills a commercial chemical product into the soil and intends to reclaim the spill residue, is the spill residue exempt from RCRA standards?

The intent to recycle a commercial chemical product spill residue does not exempt the material from RCRA jurisdiction. In fact, EPA has stated that contaminated soils and other cleanup residues generally are solid wastes because of the difficulty associated with recycling wastes contained within environmental media (54 FR 48494; November 22, 1989). Sometimes, however, a spill residue can be returned to a process or otherwise put to use, and thus remain exempt from RCRA standards.

In order to demonstrate that a spill residue is not a solid waste, the generator has the burden of proving that legitimate recycling will take place. The Agency has adopted objective considerations to evaluate a generator's claim that a spilled product will be legitimately recycled. The length of time the spill residue has existed is one such consideration. In order to prove that legitimate recycling will occur, a generator may also show that recycling has already begun, the material is valuable, the material can feasibly be recycled and/or the company has recycled such material in the past (55 FR 22671; June 1, 1990).

In the absence of strong, objective indicators of recycling or intent to recycle a spill residue, "the materials are solid wastes immediately upon being spilled because they have been abandoned" (54 FR 48494; November 22, 1989), and must be managed in accordance with all applicable RCRA standards.

TABLES

Table 1
Previous Site Investigations

Date	Title	Author	Summary
8/5/85	RCRA 3013 Final Workplan	Bloomfield Refining Company	A Comprehensive Groundwater Study Proposal to determine the extent of the hydrocarbon plume. Monitor wells MW-1 through MW-6 installed in February 1984 in preparation for the workplan submittal.
6/2/86	Report on Subsurface Hydrocarbon Data	Bloomfield Refining Company	This study first identified hydrocarbons outside of the refinery boundaries. Bloomfield Refining Company installed monitoring wells MW-7 through MW-10.
8/20/86	Final Closure Plan for the API Wastewater Ponds, Landfill, and Landfill Pond at the Bloomfield Refinery	Engineering Science	This study provides data on waste material and underlying soils associated with these solid waste management units. All analytical results were consistent with clean closure for all of the subject areas.
2/6/87	A Final Report on Section 3013 Administrative Order Work Elements	Engineering Science	Identification of hydrocarbons in the unsaturated zone.
4/4/88	Site Investigation and Remedial Action Conceptual Design for the Bloomfield Refining Company	Geoscience Consultants, Ltd. (GCL)	Computer modeling determined that a three well recovery system would be optimal to minimize further hydrocarbon migration.
8/3/89	Final Report on Soil Vapor Survey, Well Installation and Hydrocarbon Recovery System	Geoscience Consultants Ltd. (GCL)	Hydrocarbons are evident south of the site on BLM land. The study proposed a recovery well system to minimize hydrocarbon migration from the refinery.
2/11/92	Interim Measures Work Plan	Groundwater Technology (GTI)	The proposed Interim Measures were: two additional recovery wells, implement a pumping system, survey wells, gauge liquid levels in the wells, startup tests for the two new recovery wells and monitoring of all new equipment.
3/29/93	RCRA Facility Investigation (RFI)-Task 1 and Task II	GTI	The report describes surface and subsurface conditions and provides a draft work plan to conduct the RFI.
2/2/94	RFI-Phase I-Soil Gas Survey	GTI (subcontracted to Burlington Environmental)	The highest level of hydrocarbon is the area around the flare, the roadway south of Tanks 11 and 12, and the area surrounding Tanks 24 and 28.
4/22/94	RFI- Phase II-Soil Boring Investigation	GTI (Drilling contracted to Western Technologies)	The area around the product loading area was not found to be significantly impacted by a product release or to be a hydrocarbon source area.
6/23/94	RFI-Phase III-Well Installation/1st Groundwater Sampling Event	GTI	All wells not containing SPH were sampled (16). See analytical table for specific results.
9/30/94	RFI-Phase III- 2nd Groundwater Sampling Event	GTI	All wells not containing SPH were sampled (16). See analytical table for specific results.

Date	Title	Author	Summary
7/30/94	RFI- Phase IV- Uppermost Aquifer Hydraulic Testing and Modeling	GTI	Values calculated for transmissivity and hydraulic conductivity were indicative of a high-permeability saturated zone. Fast accumulation of SPH in the cone-of-depression during pumping indicated that dual liquid removal is an alternative for the collection of the SPH.
8/16/94	RFI-Phase IV-Soil Vapor Extraction/Air Sparging Pilot Studies	GTI (Subcontracted drilling to Layne Environmental Services)	Calculated effective radii of influence for the shallow zone ranged from 2 feet to 36 feet. Any vapors generated as a result of sparging can be captured and contained by the vacuum system. Hydrocarbon mass removal rates ranged from .20 lb./hr to 5.5 lb./hr.
8/14/94	RFI-Phase V-Stream and Sediment Sampling	GTI	Stream and sediment sample analysis show no significant impact to the Hammond Ditch or the San Juan River.
12/21/95	Human Health and Ecological Risk Assessment	GTI	There are no unacceptable risks to human health and environment unless the shallow unsaturated zone is used for potable water.
12/21/95	Corrective Measures Study	GTI	A summary using the previous investigations to determine the best course of action at the GRC site. The study recommended air sparging, SPH recovery and vapor extraction.

Table 2: Surface Water and Sediment Chemical Analyses

Stream Sample Analytical Results - 7/14/82 & 7/28/82 (Refinery)

Parameter	Units	HD Downstream	HD Upstream at siphon	HD 150 yds S of Sullivan Rd	HD 150 yds S of Sullivan Rd (NMOCD)
Sulfate	mg/l	56.7	57.3	30	51
Cl	mg/l	6.5	3.9	40	5
B	mg/l	0.07	0.03		0.03
F	mg/l			0.2	0.22
Oil & Grease	mg/l			0.8	1.2
TDS	mg/l	186	184	5494	4180
TOC	mg/l	5.4	4.6	18	3.6
Mn	mg/l	0.05	0.05		
Co	mg/l	0.05	0.05		<0.05
Pb	mg/l	<0.005	<0.005		<0.005
U	mg/l	NA	NA		
Phenols	mg/l	0.013	0.191	<0.1	0.0295
Cn	mg/l	0.002	NA	4	ND
Benzene	ug/l	<1	<1	0.2	<1
Toluene	ug/l	<1	<1	1.3	<1
M-Xylene	ug/l	<1	<1	0.8	<1
Ethylbenzene	ug/l	<1	<1	0.09	NA
Aliphatic hydrocarbons		ND	ND	ND	ND

Surface Water Analytical Results - 4/22/86 (Refinery)

Parameter	Units	HD near Sullivan Rd	HD near API Ponds	HD near API Waste Ponds	HD near Sullivan Rd
Benzene	mg/l	0.006	ND	ND	ND
Toluene	mg/l	0.003	ND	ND	ND
Anthracene	mg/l	0.006	ND	ND	ND
Benzo(a)anthracene	mg/l	0.003	ND	ND	ND
Chrysene	mg/l	0.005	ND	ND	ND
Fluoranthene	mg/l	ND	0.001	ND	ND
Naphthalene	mg/l	0.013	ND	ND	ND
Phenanthrene	mg/l	0.007	ND	ND	ND
Pyrene	mg/l	0.008	ND	ND	ND
Phenols	mg/l	0.002	0.002	0.003	0.002
Pb	mg/l	ND	ND	NA	NA
CN	mg/l	ND	ND	NA	NA

Table 2: Surface Water and Sediment Chemical Analyses

Surface Water Analytical Results - 7/24/87 (Refinery)

Parameter	Units	SJ Hwy 44 Bridge near side	SJ Hwy 44 Bridge near middle	SJ Hwy 44 Bridge far side	SJ Upstream
Benzene	mg/l	ND	ND	ND	ND
Toluene	mg/l	ND	ND	ND	ND
Anthracene	mg/l	ND	ND	ND	ND
Benzo(a)anthracene	mg/l	ND	ND	ND	ND
Chrysene	mg/l	ND	ND	ND	ND
Fluoranthene	mg/l	ND	ND	ND	ND
Naphthalene	mg/l	ND	ND	ND	ND
Phenanthrene	mg/l	ND	ND	ND	ND
Pyrene	mg/l	ND	ND	ND	ND
Phenols	mg/l	0.018	ND	0.013	0.018
Pb	mg/l	0.061	0.054	ND	ND
CN	mg/l	0.066	0.038	0.053	0.044
TDS	mg/l	238	228	248	232
Cl	mg/l	4.96	4.96	4.96	4.46
Sulfate	mg/l	64.5	75	64.9	62.4
TOC	mg/l	5	5	6	5

Stream Sample Analytical Results - 8/11/94 (GTI)

Parameter	Meth chlorid	SVOCs	Lead	Zinc	TPH	Ammonia as N	Tot Ammonia	BOD	TOC	NO3+NO4	TKN	COD	Phosphorus	TDS	TSS
UNITS	ug/l	ug/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SJ-1W	13	ND	ND	ND	ND	<0.05	NA	9.8	3.3	<0.05	<0.1	4.5	0.58	220	130
SJ-2W	ND	ND	ND	ND	ND										
SJ-2WD	ND	ND	ND	ND	ND										
SJ-3W	ND	ND	ND	ND	ND										
HD-1W	ND	ND	ND	ND	ND										
HD-2W	9	ND	ND	ND	ND										
HD-3W	32	ND	ND	ND	ND										
HD-4W	ND	ND	ND	ND	ND										
HD-5W	47	ND	ND	ND	ND										
HD-6W	15	ND	ND	ND	ND										
HD-7W	29	ND	ND	0.03	ND										
HD-8W	37	ND	ND	ND	ND										
HD-9W	ND	ND	0.004	0.02	ND										
HD-9WD	ND	ND	ND	ND											
HD-10W	ND	ND	0.003	0.03	ND										
HD-11W	ND	ND	ND	ND	ND										
HD-12W	ND	ND	ND	ND	ND										
HD-13W	ND	ND	ND	ND	ND										
HD-14W	ND	ND	ND	ND	ND	NA	<0.05	NA	NA	<0.01	<0.1	2.7	0.23	170	6

Table 2: Surface Water and Sediment Chemical Analyses

Sediment Sample Analytical Results - 7/14/82 (Refinery)

Parameter	Units	HD near API wastewater pond
Sulfate	mg/l	125
Cl	mg/l	109
B	mg/l	
F	mg/l	0.6
Oil & Grease	mg/l	NA
TDS	mg/l	NA
TOC	mg/l	NA
Mn	mg/l	NA
Co	mg/l	NA
Pb	mg/l	NA
U	mg/l	NA
Phenols	mg/l	NA
Cn	mg/l	NA
Benzene	ug/l	NA
Toluene	ug/l	NA
M-Xylene	ug/l	NA
Ethylbenzene	ug/l	NA
Aliphatic hydrocarbons		NA

Table 2: Surface Water and Sediment Chemical Analyses

Sediment Sample Analytical Results - 8/10/94 (GTI)
S = Sides, B = Bottom

Parameter UNITS	Meth chlorid mg/kg	Toluene mg/kg	Phenanthrene mg/kg	As mg/kg	Be mg/kg	Cr mg/kg	Cu mg/kg	Pb mg/k	Ni mg/kg	Se mg/kg	Zn mg/k	TOC %	TPH mg/kg
SJ-1S	0.011	ND	ND	16	ND	8.6	5.8	ND	4.9	ND	16	0.1	ND
SJ-2S	0.011	ND	ND	11	ND	ND	5.6	ND	4.5	ND	19	0.2	ND
SJ-3S	0.012	ND	ND	ND	ND	ND	ND	ND	1.8	ND	10	0.1	ND
HD-1S	ND	ND	ND	16	ND	6.1	6.8	ND	5.3	ND	26	0.4	ND
HD-1B	0.007	ND	ND	ND	0.9	9.6	16	ND	10	11	45	0.7	ND
HD-2S	ND	ND	ND	ND	ND	6	6.6	ND	5.6	ND	26	1	ND
HD-2B	ND	ND	ND	ND	0.9	9.4	17	12	9.8	ND	43	0.6	ND
HD-3S	0.057	ND	ND	16	1.2	13	21	14	13	ND	55	1.4	ND
HD-3B	0.009	ND	ND	ND	1.1	11	26	ND	12	ND	60	0.9	ND
HD-4S	0.01	ND	ND	ND	ND	8.2	14	ND	5.2		69	0.9	ND
HD-4B	0.006	ND	1.3	ND	0.7	8.8	180	ND	8.7		64	0.7	540
HD-5S	0.007	ND	ND	10	ND	7.1	13	11	7.4		43	1.1	ND
HD-5B	0.006	0.006	ND	13	0.9	13	18	12	11		56	0.4	ND
HD-6S	ND	ND	ND	ND	0.6	18	14	ND	9.3		43	0.6	ND
HD-6B	0.005	ND	ND	10	1	12	18	ND	12		44	0.6	ND
HD-7S	ND	ND	ND	ND	0.6	7.9	12	11	7.8		37	0.9	ND
HD-7B	ND	0.012	ND	ND	1	12	19	16	12		53	0.6	ND
HD-8S	ND	ND	ND	15	0.8	15	35	18	9.1		180	0.8	ND
HD-8B	ND	ND	ND	12	1	20	17	ND	11		58	0.4	ND
HD-9S	ND	ND	ND	ND	ND	16	12	ND	6.7		44	0.7	ND
HD-9B	ND	0.005	1.2	ND	1	17	18	12	11		56	0.7	240
HD-10S	0.009	ND	ND	ND	ND	9.4	17	11	5.6		59	0.4	ND
HD-10B	0.006	ND	ND	13	0.9	12	16	ND	9.8		38	0.6	ND
HD-11S	ND	ND	ND	10	ND	8.1	11	ND	6.2		38	0.7	ND
HD-11B	ND	ND	ND	15	1	14	17	11	11		51	0.6	ND
HD-12S	ND	ND	ND	12	0.6	12	11	ND	8.8		47	1.1	ND
HD-12B	ND	ND	ND	15	1.3	17	19	15	13		58	0.7	ND
HD-13S	ND	ND	ND	ND	ND	9.2	15	ND	7.8		36	0.6	ND
HD-13B	ND	ND	ND	10	0.9	9.5	17	11	10		39	0.8	ND
HD-14S	ND	ND	ND	ND	ND	6.7	11	ND	6		29	0.3	ND
HD-14B	ND	ND	ND	ND	1.1	11	18	11	12		50	0.8	ND

Table 2: Surface Water and Sediment Chemical Analyses

San Juan River Sediment Samples - 10/28/98 (Hicks)

Parameter	Units	SJ-1	SJ-2
Acetone	mg/kg	0.05	
Benzene	mg/kg	0.028	
Ethylbenzene	mg/kg	0.35	
m,p-Xylene	mg/kg		0.18
Barium	mg/kg	121	130
Beryllium	mg/kg		
Cadmium	mg/kg		0.25
Chromium	mg/kg	3.5	5
Lead	mg/kg	11.1	3.4

Table 3 Soil Sampling Results

Soil Samples - February 1994 (GTI)

Parameter	Units	B-1/2.5-4.5	B-2/10-12	B-3/6-8	B-4/8-10	B-4/10-12
Acetone	mg/kg	ND	ND	ND	ND	0.13
Benzene	mg/kg	ND	ND	ND	0.012	ND
Ethylbenzene	mg/kg	ND	ND	ND	0.004	ND
m,p-Xylene	mg/kg	ND	ND	ND	0.031	ND
o-Xylene	mg/kg	ND	ND	ND	0.022	ND
Toluene	mg/kg	ND	ND	ND	0.023	0.0065
Methylene Cl	mg/kg	ND	ND	0.11	ND	ND
SVOCs	mg/kg	ND	ND	ND	ND	ND
TPH	mg/kg	ND	ND	ND	ND	ND
Beryllium	mg/kg	0.66	0.53	0.54	0.53	0.76
Cadmium	mg/kg	4.5	3	3.2	3.1	4
Chromium	mg/kg	9.7	8.5	8	9.9	11
Copper	mg/kg	12	8.9	8.8	8.2	11
Lead	mg/kg	ND	ND	ND	ND	11
Nickel	mg/kg	9.8	7	7.4	7.2	10
Thallium	mg/kg	25	15	15	19	23
Zinc	mg/kg	46	34	35	32	44

Parameter	Units	B-5/2-4	B-6/2-4	B-7/6-8	B-8/8-10	B-9/2-4	B-10/10-12
Acetone	mg/kg	ND	ND	ND	ND	ND	ND
Benzene	mg/kg	ND	ND	ND	ND	ND	ND
Ethylbenzene	mg/kg	ND	ND	ND	ND	ND	ND
m,p-Xylene	mg/kg	ND	ND	ND	ND	ND	ND
o-Xylene	mg/kg	ND	ND	ND	ND	ND	ND
Toluene	mg/kg	ND	ND	ND	ND	ND	ND
Methylene Cl	mg/kg	ND	ND	ND	ND	ND	ND
SVOCs	mg/kg	ND	ND	ND	ND	ND	ND
TPH	mg/kg	ND	ND	ND	ND	ND	ND
Beryllium	mg/kg	ND	0.54	ND	0.57	ND	1.2
Cadmium	mg/kg	2.3	3.2	1.8	3.2	0.77	2.3
Chromium	mg/kg	7.2	8.1	5.7	9.3	ND	6
Copper	mg/kg	6.5	9.1	5.3	7.1	ND	ND
Lead	mg/kg	ND	ND	ND	ND	ND	ND
Nickel	mg/kg	5.9	6.8	4.8	7	1.6	4.7
Thallium	mg/kg	16	20	14	21	ND	13
Zinc	mg/kg					8	22

Table 3 Soil Sampling Results

Soil Sample Analytical Results - 3/11/97 (Precision Engineering)

Parameter	Units	MW-41	SB1-397-10.5	SB2-397-6.0	SB2-397-10.0	SB2-397-25
Benzene	ppb	875	ND	ND	270	777
Toluene	ppb	13000	72	392	2050	3610
Ethylbenzene	ppb	11100	83.7	3090	17900	ND
m,p-Xylenes	ppb	40600	139	10400	103500	97200
o-Xylene	ppb	20200	324	948	2140	5900
TPH	mg/kg	1900	317	1400	2520	1390

Soil Samples - 8/20/98 (Hicks-Hand Auger)

Parameter	Units	HA1 4FT (SHB 1)	HA2 7FT (SHB 4)	HA2 4FT (SHB-4)
Benzene	mg/kg	0.074	0.052	
Ethylbenzene	mg/kg	0.089	0.2	59
m,p-Xylene	mg/kg	0.26	0.68	410
o-Xylene	mg/kg	0.15	0.24	150
Toluene	mg/kg	0.16	0.17	18

Soil Samples - 9/98 (Hicks-Soil Borings)

Parameter	Units	SHB2 5' (MW-43)	SHB2 13' (MW-43)	SHB1 12.8	SHB1 5	SHB1 9
Benzene	mg/kg	0.71		0.5		
Ethylbenzene	mg/kg	1.9		3.3	38	3.4
m,p-Xylene	mg/kg	9.2	0.011	14	200	16
o-Xylene	mg/kg	3		3.8	42	3.9
Toluene	mg/kg	1.8		2.4	21	2.1

Parameter	Units	SHB4 18'	SHB3 7.5	SHB3 11	SHB3 20
Benzene	mg/kg	27	0.5	0.22	0.09
Ethylbenzene	mg/kg	27			0.051
m,p-Xylene	mg/kg				
o-Xylene	mg/kg				
Toluene	mg/kg	29	0.28	0.18	0.1

Table 4 Soil Samping Results

Soil Sample Analytical Results - 10/16/85 (Engineering Science)

Parameter Units	Phenols mg/kg	Cr mg/kg	Pb mg/kg	Benzene mg/kg	Ethylbenzene mg/kg	Toluene mg/kg	Xylenes mg/kg	MEK mg/kg
L1&L2, 0-6" Quadrant #1-Landfill	ND	11	10	ND	ND	ND	ND	NA
L3&L4, 6-12" Quadrant #1-Landfill	ND	8.9	9.8	ND	ND	ND	ND	NA
L5&L6, 0-6" Quadrant #2-Landfill	ND	9.9	9	ND	ND	ND	ND	NA
L7&L8, 6-12" Quadrant #2-Landfill	ND	7.6	6.7	ND	ND	ND	ND	NA
L9&L10, 0-6" Quadrant #3-Landfill	ND	7.8	7.6	ND	ND	ND	ND	NA
L11&L12, 6-12" Quadrant #3 Landfill	ND	7.4	7	ND	ND	ND	ND	NA
L13&L14, 6-12" Quadrant #4 Landfill	ND	9.1	8.2	ND	ND	ND	ND	NA
L15&L16, 6-12" Quadrant #4 Landfill	ND	7	7.7	ND	ND	ND	ND	NA
LP1&LP2,0-6" Points 1&2 @ Landfill Pond	ND	6.2	9	ND	ND	ND	ND	NA
LP3&LP4,6-12" Points 1&2 @ Landfill Pond	ND	8.1	8.5	ND	ND	ND	ND	NA
LP5&LP6,0-6" Points 3&4 @ Landfill Pond	ND	7.8	8.9	ND	ND	ND	ND	NA
LP7&LP8,6-12" Points 3&4 @ Landfill Pond	ND	10	12	ND	ND	ND	ND	NA
LP9&LP10, 0-6" Points 5&6 @ Landfill Pond	ND	8	12	0.0013	ND	ND	ND	NA
LP11&LP12, 6-12" Points 5&6 @ Landfill Pond	ND	7.8	13	ND	ND	ND	ND	NA

Table 4 Soil Samping Results

Soil Sample Analytical Results - 10/16/85 (Engineering Science)

Parameter Units	Phenols mg/kg	Cr mg/kg	Pb mg/kg	Benzene mg/kg	Ethylbenzene mg/kg	Toluene mg/kg	Xylenes mg/kg	MEK mg/kg
LP13&LP14, 0-6" S. Evap Pond Landfill Pond	ND	2.3	4	ND	ND	ND	ND	ND
MS1&MS2, Mystery Sample	ND	2.4	4	ND	ND	ND	ND	0.053
APS1&APS2, 0 6" NE&SE of SOWP	ND	4.4	5	ND	ND	ND	0.0074	NA
APS3&APS4, 6 12" NE&SE of SOWP	ND	5.3	5	ND	ND	ND	ND	NA
APS5&APS6, 0 6" N&S of SOWP	ND	5.5	5	ND	ND	ND	ND	NA
APS7&APS8, 6 12" N&S of SOWP	ND	14	4	ND	ND	ND	ND	NA
APS9 & APS10, 0-6" NW & SW of SOWP	ND	6.8	5..1	ND	ND	ND	ND	NA
APS11&APS12, 6-12" NW & SW of SOWP	ND	27	5.9	ND	ND	ND	ND	NA
APS13, 0-6" SE near influent SOWP	ND	4.9	6	ND	ND	ND	ND	ND
APN1&APN2, 0-6" NE & SE of NOWP	ND	7.8	4	ND	ND	ND	ND	NT
APN3&APN4, 6-12" NE&SE of NOWP	ND	3.2	3	ND	ND	ND	ND	NA
APN5&APN6, 0-6" NE&SE of NOWP	ND	3.6	5	ND	ND	ND	ND	NA
APN7&APN8, 6-12" N&S of NOWP	ND	2.3	3	ND	ND	ND	ND	NA
APN9&APN10, 0-6" NW&SW of NOWP	ND	2.9	3	ND	ND	ND	ND	NA

Table 4 Soil Samping Results

Soil Sample Analytical Results - 10/16/85 (Engineering Science)

Parameter Units	Phenols mg/kg	Cr mg/kg	Pb mg/kg	Benzene mg/kg	Ethylbenzene mg/kg	Toluene mg/kg	Xylenes mg/kg	MEK mg/kg
APN11&APN12, 6-12" NW&SW of NOWP	ND	12	4	ND	ND	ND	ND	NA

Table 5
Measured Hydraulic Conductivity

Measured K Values		Location	Source	Method
ft/sec	m/s			
1.65 E-4	5.03 E-5	MW-1	Engineering-Science (1987)	Slug Tests
3.30 E-4	1.00 E-4	MW-2 (near MW-29)		
1.29 E-4	3.84 E-5	MW-4		
2.23 E-4	6.80 E-5	MW-10 (RW-3)	Geoscience Consultants (3/88)	Pumping Test 1
1.95 E-4	5.94 E-5	MW-10 (RW-3)		Pumping Test 2
4.49 E-5	1.36 E-5	MW-10 (RW-3)		Recovery Test 1
6.25 E-5	1.91 E-5	MW-10 (RW-3)		Recovery Test 2
2.34 E-5	7.13 E-6	MW-11		Recovery
2.04 E-3	6.22 E-4	MP-3 (near RW-19)	Groundwater Technology (7/94)	Pumping Test RW-19
1.83 E-3	5.58 E-4	MP-4 (near RW-19)		Pumping Test RW-19
5.09 E-4	1.55 E-4	RW-22		Pumping Test RW-22

Table 6
Groundwater Depth and SPH Over Time

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-1			MW-3			MW-4			MW-5		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5515.85			5535.74			5523.24			5545.51		
Date													
2/23/85	ES 1986	16.7		5499.15	33.7		5502.04	25		5498.24	42.35		5503.16
3/18/85	ES 1986	16.63		5499.22	33.3		5502.44	24.98		5498.26	41.6		5503.91
4/11/85	ES 1986	16.78		5499.07	33.12		5502.62	25		5498.24	41.43		5504.08
5/31/85	ES 1986	16.1		5499.75	33.11		5502.63	24.5		5498.74	41.46		5504.05
6/14/85	ES 1986	15.97		5499.88	33.22		5502.52	24.5		5498.74	41.7		5503.81
6/26/85	ES 1986	15.83		5500.02	33.36		5502.38	24.57		5498.67	41.86		5503.65
7/10/85	ES 1986	15.57		5500.28	33.37		5502.37	24.5		5498.74	41.8		5503.71
8/2/85	ES 1986	15.57		5500.28	33.37		5502.37	24.52		5498.72	41.73		5503.78
9/17/85	ES 1986	15.43		5500.42	33.6		5502.14	24.5		5498.74	42.1		5503.41
10/9/85	ES 1986	15.74		5500.11	33.43		5502.31	24.6		5498.64	41.8		5503.71
10/24/85	ES 1986	16.54		5499.31	33.57		5502.17	24.76		5498.48	42		5503.51
11/8/85	ES 1986	17.05		5498.8	33.65		5502.09	24.7		5498.54	42.01		5503.5
12/17/85	ES 1986	17.42		5498.43	34		5501.74	24.9		5498.34	42.2		5503.31
1/8/86	ES 1986	16.18		5499.67	34		5501.74	24.95		5498.29	42.33		5503.18
1/24/86	ES 1986	17.02		5498.83	33.81		5501.93	24.94		5498.3	42.34		5503.17
2/20/86	ES 1986	16.84		5499.01	33.42		5502.32	24.95		5498.29	41.8		5503.71
3/21/86	ES 1986	16.67		5499.18	32.96		5502.78	25		5498.24	40.87		5504.64
3/26/86	ES 1986	16.7		5499.15	32.94		5502.8	24.99		5498.25	40.86		5504.65
4/4/86	ES 1986	16.7		5499.15	32.87		5502.87	25.09		5498.15	40.53		5504.98
4/18/86	ES 1986	16.92		5498.93	32.87		5502.87	24.88		5498.36	40.68		5504.83
5/5/86	ES 1986	16.34		5499.51	32.93		5502.81	24.98		5498.26	40.83		5504.68
5/21/86	ES 1986	15.72		5500.13	33		5502.74	24.9		5498.34	40.75		5504.76
6/4/86	ES 1986	15.36		5500.49	32.9		5502.84	24.9		5498.34	40.93		5504.58
6/23/86	ES 1986	14.56		5501.29	32.8		5502.94	24.85		5498.39	40.97		5504.54
7/8/86	ES 1986	14.43		5501.42	32.89		5502.85	24.86		5498.38	41.23		5504.28
8/4/86	ES 1986	15.52		5500.33	32.93		5502.81	24.63		5498.61	41.33		5504.18
9/2/86	ES 1986	15.54		5500.31	32.91		5502.83	24.52		5498.72	41.52		5503.99
9/18/86	ES 1986	15.74		5500.11	33.08		5502.66	24.32		5498.92	41.58		5503.93
10/8/86	ES 1986	15.94		5499.91	33.72		5502.02	24.17		5499.07	41.64		5503.87
11/7/86	ES 1986	16.32		5499.53	33.13		5502.61	24.11		5499.13	41.62		5503.89
12/8/86	ES 1986	16.32		5499.53	33.07		5502.67	24.02		5499.22	42.67		5502.84
12/16/86	ES 1986	16.32		5499.53	33.05		5502.69	24.02		5499.22	41.69		5503.82
2/15/89	GCL 1989												
10/21/91	DP Files	16.69		5499.16	34.84		5500.9	25.65	0.58	5498.054	43.48		5502.03
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files	17.21		5498.64	34.13		5501.61	25	0.54	5498.672	42.75		5502.76
5/24/94	GTI 1994	15.64		5500.21	34.32		5501.42	25.72	0.58	5497.984	43.36		5502.15

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-1			MW-3			MW-4			MW-5		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5515.85			5535.74			5523.24			5545.51		
Date													
8/2/94	GTI 1994	14.57		5501.28	33.9		5501.84	24.89	0.001	5498.351	42.8		5502.71
3/1/95	DP Files	16.89		5498.96	34.46		5501.28	25.27	0.88	5498.674	43.73		5501.78
5/22/95	DP Files	15.64		5500.21							43.98		5501.53
12/7/95	DP Files	17.65		5498.2							44.45		5501.06
5/23/96	DP Files	16.7		5499.15							46.42		5499.09
5/31/96	DP Files	10.7		5505.15									
11/21/96	TLS 1/97	17.74		5498.11				26.16	0.58	5497.544	45.56		5499.95
11/17/97	DP Files	17.5		5498.35							44.17		5501.34
8/27/98	DP Files												
10/27/98	DP Files	15.54		5500.31	33.42		5502.32	24.72		5498.52			
2/2/99	DP Files	14.29		5501.56	33.9		5501.84	24.96		5498.28	43.55		5501.96
4/26/99	DP Files	14.3		5501.55	33.8		5501.94	24.95		5498.29	43.5		5502.01

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-6			MW-7			MW-8			MW-9		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5549.84			5523.12			5531.33			5519.63		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986				26.07		5497.05	29.17		5502.16	21.55		5498.08
3/26/86	ES 1986				26.07		5497.05	29.15		5502.18	21.5		5498.13
4/4/86	ES 1986				25.32		5497.8	29.26		5502.07	21.48		5498.15
4/18/86	ES 1986				26.17		5496.95	29.3		5502.03	20.8		5498.83
5/5/86	ES 1986				26.81		5496.31	29.39		5501.94	21.08		5498.55
5/21/86	ES 1986				25.23		5497.89	29.29		5502.04			
6/4/86	ES 1986				25.24		5497.88	29.23		5502.1	20.53		5499.1
6/23/86	ES 1986												
7/8/86	ES 1986				26.22		5496.9	28.9		5502.43	20.2		5499.43
8/4/86	ES 1986				25.32		5497.8	29		5502.33	20.3		5499.33
9/2/86	ES 1986				25.14		5497.98	28.91		5502.42	20.15		5499.48
9/18/86	ES 1986												
10/8/86	ES 1986				24.13		5498.99	29.15		5502.18	20.28		5499.35
11/7/86	ES 1986				24.61		5498.51	29.22		5502.11	20.14		5499.49
12/8/86	ES 1986				24.69		5498.43	29.02		5502.31	20.56		5499.07
12/16/86	ES 1986				21.99		5501.13	31.97		5499.36	20.4		5499.23
2/15/89	GCL 1989												
10/21/91	DP Files				24.15		5498.97	30.5		5500.83	21.65	0.05	5498.02
11/1/91	DP Files										22		5497.63
2/7/92	DP Files										22.4	0.1	5497.31
6/10/92	DP Files										20.8	0.03	5498.854
10/16/92	DP Files										21.04	0.03	5498.614
5/4/94	DP Files	49.63		5500.21	25		5498.12	29.86		5501.47	22.2	0.12	5497.526
5/24/94	GTI 1994	dry			25.21		5497.91	29.8		5501.53	20.88	0.01	5498.758

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-6			MW-7			MW-8			MW-9		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5549.84			5523.12			5531.33			5519.63		
Date													
8/2/94	GTI 1994	dry			25.37		5497.75	29.35		5501.98	19.9	0.001	5499.731
3/1/95	DP Files	49.63		5500.21	25.37		5497.75	29.74		5501.59	22.19	0.15	5497.56
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files										21.1		5498.53
11/21/96	TLS 1/97										21.84	0.02	5497.806
11/17/97	DP Files										21.67		5497.96
8/27/98	DP Files										19.62		5500.01
10/27/98	DP Files				25.89		5497.23	27		5504.33	21.22		5498.41
2/2/99	DP Files				26		5497.12	28.93		5502.4	21.77		5497.86
4/26/99	DP Files				25.34		5497.78	28.93		5502.4	21.34		5498.29

Table 6 Groundwater Depth and SPH Over Time

	Source	RW-1			P-1			RW-2			P-2		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5524.94			5523.88			5523.44			5523.28		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989	29.15	0.17	5495.926	28.49	0.04	5495.422	26.62	0.042	5496.854	26.52		5496.76
10/21/91	DP Files	27.65		5497.29	26.43		5497.45	24.73	0.31	5498.958	25	0.38	5498.584
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files	28.02		5496.92	26.75		5497.13	24.41	0.92	5499.766	24.65	0.01	5498.638
5/24/94	GTI 1994	27.33		5497.61	26		5497.88	25.21	0.8	5498.87	25.02	0.32	5498.516

Table 6 Groundwater Depth and SPH Over Time

	Source	RW-1			P-1			RW-2			P-2		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5524.94			5523.88			5523.44			5523.28		
Date													
8/2/94	GTI 1994	26.76		5498.18	25.44		5498.44	24.14	0.001	5499.301	24.45	0.001	5498.831
3/1/95	DP Files	27.99		5496.95	26.71		5497.17	25.4	0.45	5498.4	24.79	0.93	5499.234
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	27.64		5497.3	26.3		5497.58	25.96	0.05	5497.52	25.71	0.66	5498.098
11/17/97	DP Files												
8/27/98	DP Files												
10/27/98	DP Files	27.25		5497.69				23.89		5499.55			
2/2/99	DP Files	27.42		5497.52				24.2		5499.24			
4/26/99	DP Files	27.3		5497.64				24.3		5499.14			

Table 6 Groundwater Depth and SPH Over Time

	Source	RW-3			P-3			MW-11			MW-12		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5514.91			5507.05			5506.6			5497.98		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986	19.21		5495.7									
3/26/86	ES 1986	19.2		5495.71									
4/4/86	ES 1986	19.26		5495.65									
4/18/86	ES 1986	19.17		5495.74									
5/5/86	ES 1986	19.03		5495.88									
5/21/86	ES 1986	18.81		5496.1									
6/4/86	ES 1986	18.71		5496.2									
6/23/86	ES 1986												
7/8/86	ES 1986	18.69		5496.22									
8/4/86	ES 1986	18.49		5496.42									
9/2/86	ES 1986	18.33		5496.58									
9/18/86	ES 1986												
10/8/86	ES 1986	18.17		5496.74									
11/7/86	ES 1986	17.82		5497.09									
12/8/86	ES 1986	18.58		5496.33									
12/16/86	ES 1986												
2/15/89	GCL 1989	20.95		5493.96	11.78		5495.27						
10/21/91	DP Files	19.37		5495.54	9.33		5497.72	10.46			9.91		5488.07
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files	19.14		5495.77	9.32		5497.73	10.32		5496.28	9.72		5488.26
5/24/94	GTI 1994	18.68		5496.23	9.21		5497.84	9.82		5496.78	8.92		5489.06

Table 6 Groundwater Depth and SPH Over Time

	Source	RW-3			P-3			MW-11			MW-12		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5514.91			5507.05			5506.6			5497.98		
Date													
8/2/94	GTI 1994	18.27		5496.64	9		5498.05	9.87		5496.73	9.65		5488.33
3/1/95	DP Files	19.15		5495.76	9.4		5497.65	10.34			9.4		5488.58
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	18.86		5496.05	9.35		5497.7	10.3		5496.3	10.7		5487.28
11/17/97	DP Files												
8/27/98	DP Files												
10/27/98	DP Files	17.88		5497.03	7.27		5499.78	8.75		5497.85	8.54		5489.44
2/2/99	DP Files	18.6		5496.31	9.4		5497.65	9.89		5496.71	8.4		5489.58
4/26/99	DP Files	18.6		5496.31	9.4		5497.65	9.89		5496.71	8.4		5489.58

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-13			RW-14			RW-15			RW-16		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5538.54			5533.97			5533.26			5531.92		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989	38.05		5500.49									
10/21/91	DP Files	38.95		5499.59	33.93	0.38	5500.344	33.66	0.52	5500.016	32.99	1.13	5499.834
11/1/91	DP Files							33.8	0.4	5499.78			
2/7/92	DP Files							34.7	0.87	5499.256			
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files	38.36		5500.18	33.49	0.01	5500.488	33.11	0.15	5500.27	32.24	0.03	5499.704
5/24/94	GTI 1994	38.64		5499.9	33.23	0.001	5500.741	32.91	0.001	5500.351	32	0.001	5499.921

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-13			RW-14			RW-15			RW-16		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5538.54			5533.97			5533.26			5531.92		
Date													
8/2/94	GTI 1994	38.69		5499.85	32.71	0.001	5501.261	32.38	0.001	5500.881	31.56	0.001	5500.361
3/1/95	DP Files	38.87		5499.67	34.12	0.01	5499.858	33.72	0.01	5499.548	33.35	0.01	5498.578
5/22/95	DP Files			5538.54									
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	33.36		5505.18	35.03	0.41	5499.268	34.19		5499.07	35.57	0.76	5496.958
11/17/97	DP Files							33.5		5499.76			
8/27/98	DP Files	39.45		5499.09						5533.26			
10/27/98	DP Files	37.7		5500.84	32.18		5501.79	32.42		5500.84	31.49		5500.43
2/2/99	DP Files	38.8		5499.74	32.56		5501.41	32.35		5500.91	31.55		5500.37
4/26/99	DP Files	38.8		5499.74	32.37		5501.6	32.17		5501.09	31.48		5500.44

Table 6 Groundwater Depth and SPH Over Time

	Source	RW-17			RW-18			RW-19			MW-20		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5530.33			5526			5526.94			5516.34		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files	31.65	1.13	5499.584	28.61	0.94	5498.142	28.2	0.68	5499.284	17.93		5498.41
11/1/91	DP Files				29.21	1.13	5497.694				18.33		5498.01
2/7/92	DP Files				29.95	1.34	5497.122				18.69		5497.65
6/10/92	DP Files										17.51		5498.83
10/16/92	DP Files										17.43		5498.91
5/4/94	DP Files	31.4	1.94	5500.482	27.75	5.65	5502.77	27.95	0.01	5498.998	18.55		5497.79
5/24/94	GTI 1994	31.27	0.01	5499.068	27.05	0.02	5498.966	27.8		5499.14	17.48		5498.86

Table 6 Groundwater Depth and SPH Over Time

	Source	RW-17			RW-18			RW-19			MW-20		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5530.33			5526			5526.94			5516.34		
Date													
8/2/94	GTI 1994	30.37	0.01	5499.968	26.01	0.001	5499.991	27.38	0.001	5499.561	16.5		5499.84
3/1/95	DP Files	31.8	0.01	5498.538	26.01	0.01	5499.998	28.14	1.99	5500.392	18.57		5497.77
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files										17.8		5498.54
11/21/96	TLS 1/97	32.12	0.75	5498.81	27.44	0.12	5498.656	28.68	0.59	5498.732	18.47		5497.87
11/17/97	DP Files				27		5499				18.25		5498.09
8/27/98	DP Files										15.94		5500.4
10/27/98	DP Files	30.43		5499.9	27.18	0.63	5499.324	27.41		5499.53	17.94	0.4	5498.72
2/2/99	DP Files	30.65		5499.68	27.33	0.08	5498.734	27.92		5499.02	18.75	0.82	5498.246
4/26/99	DP Files	30.7		5499.63	27.2	0.25	5499	27.64		5499.3	17.85	0.18	5498.634

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-21			RW-22			RW-23			MW-24		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5519.87			5520.94			5517.65			5505.05		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files	19.39		5500.48									
11/1/91	DP Files	19.85		5500.02									
2/7/92	DP Files	20.34		5499.53									
6/10/92	DP Files	19.5		5500.37									
10/16/92	DP Files	19.12		5500.75									
5/4/94	DP Files	19.98		5499.89	23.15	0.01	5497.798	20.6	0.39	5497.362	14.85		5490.2
5/24/94	GTI 1994	19.3		5500.57	22.31	0.001	5498.631	19.28	0.001	5498.371	dry		

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-21			RW-22			RW-23			MW-24		
		Depth	SPH	*Corr.* Elevaton	Depth	SPH	*Corr.* Elevaton	Depth	SPH	*Corr.* Elevaton	Depth	SPH	*Corr.* Elevaton
T.O.C. Elevation	KA 1998	5519.87			5520.94			5517.65			5505.05		
Date													
8/2/94	GTI 1994	18.35		5501.52	21.22	0.001	5499.721	18.23	0.001	5499.421	dry		
3/1/95	DP Files	20.09		5499.78		0.01	5520.95				14.85		5490.2
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files	20		5499.87									
11/21/96	TLS 1/97	20.35		5499.52	22.82	0.41		20.03	0.01	5497.628			
11/17/97	DP Files	20		5499.87									
8/27/98	DP Files	17.76		5502.11	20.94		5500	17.7					
10/27/98	DP Files	19.08		5500.79	21.81		5499.13	19.15			dry		
2/2/99	DP Files	19.58		5500.29	22.6		5498.34	20.14					
4/26/99	DP Files	19.35		5500.52	22.43		5498.51	19.9					

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-25			MW-26			MW-27			MW-28		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5530.45			5514.3			5514.92			5524.34		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994	31.03		5499.42	15.95		5498.35	17.69	0.17	5497.366	25.81	0.08	5498.594

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-25			MW-26			MW-27			MW-28		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5530.45			5514.3			5514.92			5524.34		
Date													
8/2/94	GTI 1994	30.95		5499.5	15.94		5498.36	17.52	0.01	5497.408	24.87	0.02	5499.486
3/1/95	DP Files	31.17		5499.28	25.25	0.01	5489.058	24.49	0.01	5490.438	26.29	0.61	5498.538
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	32.04	0.38	5498.714	16.42	0.03	5497.904	17.91	0.01	5497.018			
11/17/97	DP Files												
8/27/98	DP Files	31.52		5498.93	16.22		5498.08						
10/27/98	DP Files	31.17		5499.28	16.13	0.12	5498.266	17.25		5497.67	25.35		5498.99
2/2/99	DP Files	30.96		5499.49	15.9	0.2	5498.56	17.25		5497.67	25.9		5498.44
4/26/99	DP Files	30.96		5499.49	15.76		5498.54	17.32		5497.6	25.69		5498.65

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-29			MW-30			MW-31			MW-32		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5520.14			5533.33			5532.71			5521.99		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994	21.01		5499.13	31.97	0.001	5501.361	32.37		5500.34			

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-29			MW-30			MW-31			MW-32		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5520.14			5533.33			5532.71			5521.99		
Date													
8/2/94	GTI 1994	20.32		5499.82	31.6		5501.73	32.34		5500.37			
3/1/95	DP Files	21.55		5498.59	32.17		5501.16	32.65		5500.06	24.01		5497.98
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97							33.36		5499.35	24.48		5497.51
11/17/97	DP Files												
8/27/98	DP Files	19.6		5500.54				32.74		5499.97	24.44		5497.55
10/27/98	DP Files	20.75		5499.39	31.6		5501.73	32.5		5500.21	24.25		5497.74
2/2/99	DP Files	20.58		5499.56	31.41		5501.92	32.25		5500.46	23.81		5498.18
4/26/99	DP Files	20.58		5499.56	31.38		5501.95	32.23		5500.48	23.81		5498.18

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-33			MW-34			MW-35			MW-36		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5518.16			5505.59			5515.28			5513.17		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994												

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-33			MW-34			MW-35			MW-36		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5518.16			5505.59			5515.28			5513.17		
Date													
8/2/94	GTI 1994												
3/1/95	DP Files	22.6		5495.56	13.71		5491.88						
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	21.47		5496.69	13.5	0.18	5492.234						
11/17/97	DP Files												
8/27/98	DP Files	26.69		5491.47				21.42		5493.86			
10/27/98	DP Files	21.38		5496.78	12.88		5492.71	21.17		5494.11	19.04		5494.13
2/2/99	DP Files	21.14		5497.02	13.35		5492.24	21.55		5493.73	19.91		5493.26
4/26/99	DP Files	21.24		5496.92	16.35		5489.24	21.55		5493.73	19.91		5493.26

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-37			MW-38			MW-39			MW-40		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5515.87			5515.57			5517.65			5523.54		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994												

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-37			MW-38			MW-39			MW-40		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5515.87			5515.57			5517.65			5523.54		
Date													
8/2/94	GTI 1994												
3/1/95	DP Files												
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97												
11/17/97	DP Files												
8/27/98	DP Files												
10/27/98	DP Files	22.29		5493.58	21.67		5493.9	22.8		5494.85	24.71		5498.83
2/2/99	DP Files	23		5492.87	22.94		5492.63	22.6		5495.05	25.33	0.5	5498.61
4/26/99	DP Files	23		5492.87	22		5493.57	21.52		5496.13	25.3	0.13	5498.344

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-41			MW42			MW-43			MW-44		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5523.34			5523.88						5531.29		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994												

Table 6 Groundwater Depth and SPH Over Time

	Source	MW-41			MW42			MW-43			MW-44		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5523.34			5523.88						5531.29		
Date													
8/2/94	GTI 1994												
3/1/95	DP Files												
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97												
11/17/97	DP Files												
8/27/98	DP Files												
10/27/98	DP Files	25.18	2.06	5499.808	25.18	0.03	5498.724				34.15		5497.14
2/2/99	DP Files	25.54	2.16	5499.528	25.17	1.09	5499.582	21.56	1.42		33.9		5497.39
4/26/99	DP Files	23.15	0.03	5500.214	25.29	0.98	5499.374	20	1.06		32.17		5499.12

Table 6 Groundwater Depth and SPH Over Time

	Source	MP-1			MP-2			MP-3			MP-4		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5523.25			5523.95			5525.52			5525.52		
Date													
2/23/85	ES 1986												
3/18/85	ES 1986												
4/11/85	ES 1986												
5/31/85	ES 1986												
6/14/85	ES 1986												
6/26/85	ES 1986												
7/10/85	ES 1986												
8/2/85	ES 1986												
9/17/85	ES 1986												
10/9/85	ES 1986												
10/24/85	ES 1986												
11/8/85	ES 1986												
12/17/85	ES 1986												
1/8/86	ES 1986												
1/24/86	ES 1986												
2/20/86	ES 1986												
3/21/86	ES 1986												
3/26/86	ES 1986												
4/4/86	ES 1986												
4/18/86	ES 1986												
5/5/86	ES 1986												
5/21/86	ES 1986												
6/4/86	ES 1986												
6/23/86	ES 1986												
7/8/86	ES 1986												
8/4/86	ES 1986												
9/2/86	ES 1986												
9/18/86	ES 1986												
10/8/86	ES 1986												
11/7/86	ES 1986												
12/8/86	ES 1986												
12/16/86	ES 1986												
2/15/89	GCL 1989												
10/21/91	DP Files												
11/1/91	DP Files												
2/7/92	DP Files												
6/10/92	DP Files												
10/16/92	DP Files												
5/4/94	DP Files												
5/24/94	GTI 1994												

Table 6 Groundwater Depth and SPH Over Time

	Source	MP-1			MP-2			MP-3			MP-4		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5523.25			5523.95			5525.52			5525.52		
Date													
8/2/94	GTI 1994												
3/1/95	DP Files												
5/22/95	DP Files												
12/7/95	DP Files												
5/23/96	DP Files												
5/31/96	DP Files												
11/21/96	TLS 1/97	25.27	1.04	5498.812	26.12	1.13	5498.734	27.08	1.12	5499.336	27.23	1.28	5499.314
11/17/97	DP Files												
8/27/98	DP Files												
10/27/98	DP Files	23.48	0.001	5499.771				25.16		5500.36	26.12	0.94	5500.152
2/2/99	DP Files	23.7		5499.55				25.75	0.65	5500.29	25.67	0.59	5500.322
4/26/99	DP Files	23.7		5499.55				25.75	0.83	5500.434	25.67	0.59	5500.322

Table 6 Groundwater Depth and SPH Over Time

	Source	MP-5			AS-1		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5525.2			5523.45		
Date							
2/23/85	ES 1986						
3/18/85	ES 1986						
4/11/85	ES 1986						
5/31/85	ES 1986						
6/14/85	ES 1986						
6/26/85	ES 1986						
7/10/85	ES 1986						
8/2/85	ES 1986						
9/17/85	ES 1986						
10/9/85	ES 1986						
10/24/85	ES 1986						
11/8/85	ES 1986						
12/17/85	ES 1986						
1/8/86	ES 1986						
1/24/86	ES 1986						
2/20/86	ES 1986						
3/21/86	ES 1986						
3/26/86	ES 1986						
4/4/86	ES 1986						
4/18/86	ES 1986						
5/5/86	ES 1986						
5/21/86	ES 1986						
6/4/86	ES 1986						
6/23/86	ES 1986						
7/8/86	ES 1986						
8/4/86	ES 1986						
9/2/86	ES 1986						
9/18/86	ES 1986						
10/8/86	ES 1986						
11/7/86	ES 1986						
12/8/86	ES 1986						
12/16/86	ES 1986						
2/15/89	GCL 1989						
10/21/91	DP Files						
11/1/91	DP Files						
2/7/92	DP Files						
6/10/92	DP Files						
10/16/92	DP Files						
5/4/94	DP Files						
5/24/94	GTI 1994						

Table 6 Groundwater Depth and SPH Over Time

	Source	MP-5			AS-1		
		Depth	SPH	Corr. Elevaton	Depth	SPH	Corr. Elevaton
T.O.C. Elevation	KA 1998	5525.2			5523.45		
Date							
8/2/94	GTI 1994						
3/1/95	DP Files						
5/22/95	DP Files						
12/7/95	DP Files						
5/23/96	DP Files						
5/31/96	DP Files						
11/21/96	TLS 1/97						
11/17/97	DP Files						
8/27/98	DP Files						
10/27/98	DP Files				23.32		5500.13
2/2/99	DP Files				23.52		5499.93
4/26/99	DP Files				23.52		5499.93

Table 7
April 1999 Groundwater Analytical Results

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

Well	Analyte	Result	
RW-23	1,2 Dichloroethane	530.00	
MW-9	1,2 Dichloroethane	330.00	
MW 4	1,2 Dichloroethane	160.00	
MW-#26	1,2 Dichloroethane	77.00	
RW-1	1,2 Dichloroethane	21.00	
MW 21	1,2 Dichloroethane	12.00	
MW 13	1,2 Dichloroethane	1.80	
MW 44	1,2 Dichloroethane	1.70	
MW-#32	1,2 Dichloroethane	1.40	
RW 17	1,2,4-Trimethylbenzene	44000.00	
RW-3	1,2,4-Trimethylbenzene	42000.00	
MW-41	1,2,4-Trimethylbenzene	17000.00	
RW 2	1,2,4-Trimethylbenzene	14000.00	
RW 15	1,2,4-Trimethylbenzene	13000.00	
MW-40	1,2,4-Trimethylbenzene	12000.00	
MW-42	1,2,4-Trimethylbenzene	5000.00	
MW-28	1,2,4-Trimethylbenzene	4300.00	
RW-23	1,2,4-Trimethylbenzene	2800.00	
RW 16	1,2,4-Trimethylbenzene	2400.00	
MW 30	1,2,4-Trimethylbenzene	2300.00	
SEEP #1	1,2,4-Trimethylbenzene	2200.00	
RW 14	1,2,4-Trimethylbenzene	2100.00	
MW-39	1,2,4-Trimethylbenzene	1400.00	
RW-18	1,2,4-Trimethylbenzene	1200.00	
MW-#26	1,2,4-Trimethylbenzene	1000.00	
MW-9	1,2,4-Trimethylbenzene	930.00	
MW-#11	1,2,4-Trimethylbenzene	710.00	
SEEP #5	1,2,4-Trimethylbenzene	640.00	
RW-19	1,2,4-Trimethylbenzene	570.00	
RW-22	1,2,4-Trimethylbenzene	530.00	
MW-#34	1,2,4-Trimethylbenzene	510.00	
MW 4	1,2,4-Trimethylbenzene	400.00	
MW 21	1,2,4-Trimethylbenzene	310.00	
MW 31	1,2,4-Trimethylbenzene	260.00	
MW-#36	1,2,4-Trimethylbenzene	200.00	
MW-#27	1,2,4-Trimethylbenzene	170.00	
MW-#37	1,2,4-Trimethylbenzene	110.00	
MW-#35	1,2,4-Trimethylbenzene	88.00	
RW-1	1,2,4-Trimethylbenzene	66.00	
MW 25	1,2,4-Trimethylbenzene	46.00	
MW-#38	1,2,4-Trimethylbenzene	19.00	
MW 7	1,2,4-Trimethylbenzene	14.00	
MW-#12	1,2,4-Trimethylbenzene	7.00	
MW 3	1,2,4-Trimethylbenzene	5.40	
MW-#32	1,2,4-Trimethylbenzene	4.20	
MW 1	1,2,4-Trimethylbenzene	4.10	
MW-#33	1,2,4-Trimethylbenzene	3.90	
MW 29	1,2,4-Trimethylbenzene	3.40	
MW 8	1,2,4-Trimethylbenzene	3.20	
SEEP #4	1,2,4-Trimethylbenzene	3.00	
MW 44	1,2,4-Trimethylbenzene	2.70	
TRIP BLA	1,2,4-Trimethylbenzene	2.10	
MW 13	1,2,4-Trimethylbenzene	2.00	
RW-3	1,3,5-Trimethylbenzene	11000.00	
RW 2	1,3,5-Trimethylbenzene	6200.00	
MW-41	1,3,5-Trimethylbenzene	4500.00	
RW 15	1,3,5-Trimethylbenzene	4200.00	
RW 17	1,3,5-Trimethylbenzene	2700.00	
MW-40	1,3,5-Trimethylbenzene	2100.00	
MW-28	1,3,5-Trimethylbenzene	1600.00	
MW-42	1,3,5-Trimethylbenzene	1600.00	
MW 30	1,3,5-Trimethylbenzene	1100.00	
RW-23	1,3,5-Trimethylbenzene	890.00	
RW 14	1,3,5-Trimethylbenzene	810.00	
MW-39	1,3,5-Trimethylbenzene	540.00	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

SEEP #1	1,3,5-Trimethylbenzene	480.00	
MW-#26	1,3,5-Trimethylbenzene	460.00	
MW-#11	1,3,5-Trimethylbenzene	380.00	
MW-9	1,3,5-Trimethylbenzene	380.00	
RW 16	1,3,5-Trimethylbenzene	180.00	
SEEP #5	1,3,5-Trimethylbenzene	94.00	
MW 31	1,3,5-Trimethylbenzene	58.00	
MW 4	1,3,5-Trimethylbenzene	54.00	
MW 21	1,3,5-Trimethylbenzene	39.00	
RW-1	1,3,5-Trimethylbenzene	13.00	
MW-#34	1,3,5-Trimethylbenzene	12.00	
MW-#36	1,3,5-Trimethylbenzene	5.80	
MW-#35	1,3,5-Trimethylbenzene	5.50	
MW 7	1,3,5-Trimethylbenzene	5.30	
MW-#12	1,3,5-Trimethylbenzene	3.80	
MW-#32	1,3,5-Trimethylbenzene	2.10	
MW-#33	1,3,5-Trimethylbenzene	1.80	
MW 3	1,3,5-Trimethylbenzene	1.70	
MW 1	1,3,5-Trimethylbenzene	1.60	
MW 8	1,3,5-Trimethylbenzene	1.40	
MW 29	1,3,5-Trimethylbenzene	1.30	
TRIP BLA	1,3,5-Trimethylbenzene	1.00	
MW 44	1,3,5-Trimethylbenzene	1.00	
RW-18	1-METHYLNAPHTHALEN	12000.00	
MW-42	1-METHYLNAPHTHALEN	9700.00	
MW-40	1-METHYLNAPHTHALEN	7700.00	
MW-41	1-METHYLNAPHTHALEN	2600.00	
RW 16	1-METHYLNAPHTHALEN	430.00	
RW 2	1-METHYLNAPHTHALEN	410.00	
RW 15	1-METHYLNAPHTHALEN	240.00	
RW 14	1-METHYLNAPHTHALEN	180.00	
RW 17	1-METHYLNAPHTHALEN	140.00	
MW-43	1-METHYLNAPHTHALEN	100.00	
MW-#27	1-METHYLNAPHTHALEN	97.00	
MW-#26	1-METHYLNAPHTHALEN	81.00	
MW-20	1-METHYLNAPHTHALEN	70.00	
MW-9	1-METHYLNAPHTHALEN	62.00	
MW 4	1-METHYLNAPHTHALEN	32.00	
MW-40	2,4-DIMETHYLPHENOL	310.00	
RW 17	2,4-DIMETHYLPHENOL	24.00	
MW-9	2,4-DIMETHYLPHENOL	19.00	
RW 15	2,4-DIMETHYLPHENOL	15.00	
RW-18	2-METHYLNAPHTHALEN	16000.00	
MW-42	2-METHYLNAPHTHALEN	14000.00	
MW-40	2-METHYLNAPHTHALEN	12000.00	
MW-41	2-METHYLNAPHTHALEN	3600.00	
RW 2	2-METHYLNAPHTHALEN	710.00	
RW 15	2-METHYLNAPHTHALEN	420.00	
RW 16	2-METHYLNAPHTHALEN	360.00	
RW 14	2-METHYLNAPHTHALEN	280.00	
RW 17	2-METHYLNAPHTHALEN	160.00	
MW-43	2-METHYLNAPHTHALEN	130.00	
MW-#26	2-METHYLNAPHTHALEN	120.00	
MW-9	2-METHYLNAPHTHALEN	100.00	
MW-20	2-METHYLNAPHTHALEN	66.00	
MW 4	2-METHYLNAPHTHALEN	52.00	
MW-#27	2-METHYLNAPHTHALEN	24.00	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW-43	2-METHYLPHENOL	10.00	
MW-43	3+4 METHYLPHENOL	11.00	
RW 15	3+4 METHYLPHENOL	9.60	
RW 2	4-CHLOROANILINE	58.00	
RW 14	ACENAPHTHENE CCC	6.60	
MW-43	ACENAPHTHENE CCC	4.60	
MW-20	ACENAPHTHENE CCC	3.80	
MW-#34	Acetone	30.00	
MW-#38	Acetone	9.50	
MW-#12	Ag	0.01	
MW 25	Ag	0.01	
MW-#38	Al	200.00	
MW-41	Al	198.00	
MW-42	Al	163.00	
MW-#37	Al	156.00	
MW-40	Al	154.00	
MW-39	Al	93.50	
MW-43	Al	39.50	
MW 44	Al	38.60	
MW-28	Al	13.40	
MW-#32	Al	4.50	
MW-#36	Al	4.40	
RW 15	Al	3.20	
RW-23	Al	2.90	
RW 16	Al	2.60	
MW-#35	Al	2.50	1
MW 3	Al	2.30	
MW-#12	Al	1.60	
MW-#26	Al	1.30	
MW 25	Al	1.10	
MW 5	Al	1.00	
RW-18	Al	0.70	
MW-#11	Al	0.60	
MW 30	Al	0.60	
MW 8	Al	0.50	
RW-22	Al	0.40	
MW 1	Al	0.20	
RW 2	Al	0.20	
MW-9	Al	0.10	
MW 29	Al	0.10	
RW 14	Al	0.10	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

RW 17	B	2.53	
MW 31	B	0.90	
MW 13	B	0.88	
MW 30	B	0.81	
RW-3	B	0.78	
RW-19	B	0.78	
RW 16	B	0.73	
RW 15	B	0.67	
RW-22	B	0.60	
MW-42	B	0.60	
MW-9	B	0.59	
MW-20	B	0.59	
RW-23	B	0.58	
RW-1	B	0.58	
MW 21	B	0.58	
MW-43	B	0.57	
MW-#32	B	0.52	
MW 4	B	0.51	
MW 5	B	0.49	
RW 2	B	0.49	
RW 14	B	0.46	
MW-#26	B	0.43	
MW 25	B	0.43	
MW 3	B	0.42	
MW-#11	B	0.40	
MW 44	B	0.38	
MW-#33	B	0.37	
MW-40	B	0.33	
MW-41	B	0.31	
MW 7	B	0.29	
MW-#27	B	0.27	
MW-#34	B	0.26	
MW-28	B	0.26	
MW-#35	B	0.22	
RW-18	B	0.22	
MW-#37	B	0.21	
MW 8	B	0.18	
MW-#28 E	B	0.12	
MW-#36	B	0.11	
MW-#38	B	0.11	
MW 29	B	0.11	
MW 1	B	0.06	
MW-39	B	0.05	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW-42	Ba	11.80	
MW-43	Ba	11.00	
RW 17	Ba	11.00	
MW-41	Ba	10.80	
MW-40	Ba	6.95	
RW-19	Ba	3.70	
RW-18	Ba	3.14	
MW-#37	Ba	2.68	
MW-#38	Ba	2.52	
MW-39	Ba	2.25	
RW-1	Ba	1.97	
RW 2	Ba	1.90	
MW 4	Ba	1.87	
MW-9	Ba	1.75	
MW-28	Ba	1.45	
MW-#26	Ba	1.42	
RW-22	Ba	1.39	
RW-23	Ba	0.98	
RW 15	Ba	0.96	
MW 21	Ba	0.84	
MW-20	Ba	0.78	
MW-#36	Ba	0.65	
RW 14	Ba	0.62	
MW-#11	Ba	0.58	
MW-#34	Ba	0.51	
MW-#35	Ba	0.48	
MW 44	Ba	0.44	
RW 16	Ba	0.44	
MW 25	Ba	0.37	
RW-3	Ba	0.19	
MW-#12	Ba	0.18	
MW-#27	Ba	0.15	
MW-#32	Ba	0.10	
MW-#28 E	Ba	0.08	
MW 30	Ba	0.06	
MW 31	Ba	0.03	
MW 8	Ba	0.03	
MW 3	Ba	0.03	
MW-#33	Ba	0.02	
MW 13	Ba	0.02	
MW 5	Ba	0.01	
MW 1	Ba	0.01	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

RW-23	Benzene	30000.00	
MW-9	Benzene	18000.00	
RW 15	Benzene	14000.00	
RW-22	Benzene	13000.00	
MW-28	Benzene	12000.00	
MW-43	Benzene	9300.00	
RW 2	Benzene	9200.00	
MW 4	Benzene	8900.00	
MW-39	Benzene	4700.00	
RW-3	Benzene	4700.00	
MW-#26	Benzene	4200.00	
RW 14	Benzene	4000.00	
MW-42	Benzene	3900.00	
MW 30	Benzene	3400.00	
RW-19	Benzene	3200.00	
MW-#11	Benzene	2700.00	
MW-40	Benzene	2300.00	
RW 16	Benzene	1600.00	
MW-41	Benzene	1400.00	
RW-1	Benzene	1000.00	
SEEP #1	Benzene	800.00	
MW 21	Benzene	660.00	
MW-#28 E	Benzene	160.00	
MW-#34	Benzene	110.00	
MW 31	Benzene	62.00	
SEEP #5	Benzene	56.00	
MW-20	Benzene	36.00	
MW 25	Benzene	33.00	
MW-#12	Benzene	23.00	
MW-#32	Benzene	6.10	
MW-#35	Benzene	5.50	
MW 3	Benzene	4.70	
MW-#33	Benzene	4.50	
MW 1	Benzene	2.80	
MW 7	Benzene	2.30	
MW 29	Benzene	1.70	
MW 8	Benzene	1.60	
MW 44	Benzene	1.40	
RW 15	BENZOIC ACID	140.00	
RW-18	BIS(2-ETHYLHEXYL)PHT	4200.00	
MW-9	BIS(2-ETHYLHEXYL)PHT	110.00	
RW 17	BIS(2-ETHYLHEXYL)PHT	94.00	
MW-#27	BIS(2-ETHYLHEXYL)PHT	92.00	
RW 16	BIS(2-ETHYLHEXYL)PHT	36.00	
RW 15	BIS(2-ETHYLHEXYL)PHT	35.00	
MW-#28 E	BIS(2-ETHYLHEXYL)PHT	30.00	
MW-20	BIS(2-ETHYLHEXYL)PHT	25.00	
MW 4	BIS(2-ETHYLHEXYL)PHT	24.00	
MW-43	BIS(2-ETHYLHEXYL)PHT	23.00	
RW 2	BIS(2-ETHYLHEXYL)PHT	22.00	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

RW 17	Ca	1360.00	
MW-39	CA	667.00	
MW 5	CA	492.00	
MW 3	CA	472.00	
MW-#32	CA	452.00	
MW 7	CA	424.00	
MW 4	CA	423.00	
MW-#33	Ca	420.00	
MW 44	CA	391.00	
MW 31	CA	367.00	
MW 8	CA	317.00	
MW 21	CA	310.00	
MW-40	CA	286.00	
MW-41	CA	274.00	
MW 13	CA	252.00	
MW 30	CA	250.00	
MW-43	CA	237.00	
MW-#38	CA	234.00	
MW 25	CA	234.00	
RW-18	CA	210.00	
MW-#37	Ca	202.00	
RW-3	CA	193.00	
MW-20	CA	184.00	
RW-1	CA	180.00	
RW-19	CA	178.00	
MW-9	CA	176.00	
RW 16	CA	168.00	
RW 2	CA	160.00	
MW-#12	Ca	154.00	
RW 15	CA	152.00	
MW-42	CA	150.00	
RW-23	CA	136.00	
MW-#27	CA	123.00	
MW-#11	Ca	121.00	
RW-22	CA	93.30	
MW-#34	Ca	89.80	
MW-#36	Ca	81.80	
MW-#35	Ca	75.30	
RW 14	CA	66.40	
MW-#26	CA	64.80	
MW-28	CA	57.30	
MW-#28 E	CA	33.00	
MW 1	CA	16.80	
MW 29	CA	16.30	
RW-18	Cd	0.01	
MW-42	Cd	0.01	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW 5	CHLORIDE	2340.00	
MW-40	CHLORIDE	2290.00	
MW-#32	CHLORIDE	1520.00	
MW-41	CHLORIDE	1290.00	
MW 21	CHLORIDE	1290.00	
MW 3	CHLORIDE	1290.00	
MW-#33	CHLORIDE	1220.00	
RW-19	CHLORIDE	1030.00	
RW-1	CHLORIDE	932.00	
RW 15	CHLORIDE	755.00	
MW-20	CHLORIDE	705.00	
MW 44	CHLORIDE	608.00	
MW-43	CHLORIDE	606.00	
MW 30	CHLORIDE	582.00	
MW 13	CHLORIDE	568.00	
RW 16	CHLORIDE	504.00	
MW 4	CHLORIDE	446.00	
RW 14	CHLORIDE	404.00	
RW-3	CHLORIDE	402.00	
MW 31	CHLORIDE	391.00	
RW 2	CHLORIDE	387.00	
RW 17	CHLORIDE	308.00	
MW-#11	CHLORIDE	266.00	
MW 8	CHLORIDE	243.00	
MW-#37	CHLORIDE	208.00	
MW-#27	CHLORIDE	205.00	
MW 25	CHLORIDE	184.00	
MW-9	CHLORIDE	183.00	
MW-42	CHLORIDE	181.00	
RW-22	CHLORIDE	165.00	
MW-#34	CHLORIDE	164.00	
MW-#35	CHLORIDE	135.00	
RW-23	CHLORIDE	134.00	
RW-18	CHLORIDE	106.00	
MW-#26	CHLORIDE	96.70	
MW-#38	CHLORIDE	77.80	
MW-#36	CHLORIDE	63.50	
MW 29	CHLORIDE	48.80	
MW-28	CHLORIDE	48.00	
MW-#12	CHLORIDE	47.70	
MW 1	CHLORIDE	36.80	
MW-#28 E	CHLORIDE	30.50	
MW 7	CHLORIDE	30.50	
MW-39	CHLORIDE	24.60	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW-40	Co	0.20	
MW-42	Co	0.15	
MW-41	Co	0.14	
MW-#38	Co	0.09	
MW-#37	Co	0.07	
MW-39	Co	0.06	
MW 8	Co	0.06	
MW-43	Co	0.04	
RW-19	Co	0.04	
MW 44	Co	0.04	
MW-28	Co	0.02	
MW 3	Co	0.02	
MW-#32	Co	0.01	
RW-22	Co	0.01	
RW-23	Co	0.01	
MW 7	Co	0.01	
RW 16	Co	0.01	
MW 5	Conductivity	8600.00	
MW-40	Conductivity	7810.00	
MW 7	Conductivity	7250.00	
RW-3	Conductivity	7010.00	
MW-#32	Conductivity	6480.00	
MW 44	Conductivity	6160.00	
MW 3	Conductivity	5960.00	
MW-#33	Conductivity	5390.00	
MW-41	Conductivity	5170.00	
MW 21	Conductivity	5070.00	
MW 31	Conductivity	4920.00	
MW 30	Conductivity	4520.00	
RW-19	Conductivity	4440.00	
RW-1	Conductivity	4410.00	
MW 13	Conductivity	4220.00	
MW-39	Conductivity	4100.00	
RW 15	Conductivity	3940.00	
RW 17	Conductivity	3910.00	
RW 16	Conductivity	3810.00	
MW-20	Conductivity	3720.00	
MW-43	Conductivity	3240.00	
MW 4	Conductivity	3160.00	
RW 2	Conductivity	3010.00	
MW 25	Conductivity	2750.00	
RW 14	Conductivity	2660.00	
MW-9	Conductivity	2560.00	
MW 8	Conductivity	2550.00	
MW-#11	Conductivity	2410.00	
RW-23	Conductivity	2380.00	
RW-18	Conductivity	2180.00	
MW-42	Conductivity	2140.00	
MW-#26	Conductivity	2090.00	
RW-22	Conductivity	2090.00	
MW-#27	Conductivity	2040.00	
MW-#34	Conductivity	1980.00	
MW-#37	Conductivity	1900.00	
MW-#35	Conductivity	1600.00	
MW-#38	Conductivity	1280.00	
MW-28	Conductivity	1150.00	
MW-#36	Conductivity	1050.00	
MW-#12	Conductivity	865.00	
MW 29	Conductivity	861.00	
MW 1	Conductivity	666.00	
MW-#28 E	Conductivity	356.00	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW 8	Cr	10.00	
MW-39	Cr	1.13	
MW 44	Cr	0.30	
MW-40	Cr	0.19	
MW-41	Cr	0.19	
MW-#37	Cr	0.17	
MW-#38	Cr	0.15	
MW-42	Cr	0.14	
MW-43	Cr	0.11	
MW-#12	Cr	0.06	
MW-#32	Cr	0.04	
MW-28	Cr	0.04	
RW-18	Cr	0.04	
RW-23	Cr	0.03	
MW 25	Cr	0.02	
MW 13	Cr	0.02	
RW 16	Cr	0.02	
RW 2	Cr	0.01	
RW-18	Cu	0.43	
MW-#38	Cu	0.32	
MW-41	Cu	0.26	
MW-#37	Cu	0.25	
MW-42	Cu	0.24	
MW-40	Cu	0.20	
MW 8	Cu	0.20	
MW-39	Cu	0.18	
MW-43	Cu	0.07	
MW 44	Cu	0.05	
MW-28	Cu	0.04	
MW-20	Cu	0.04	
MW 30	Cu	0.04	
MW-#36	Cu	0.01	
MW-#35	Cu	0.01	
MW-#12	Cu	0.01	
MW-#28 E	Cu	0.01	
MW 4	Cu	0.01	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW-41	DIBENZOFURAN	120.00	
MW-20	DIBENZOFURAN	2.00	
MW-#27	DIETHYLPHTHALATE	17.00	
MW-#28 E	DI-N-OCTYLPTHALATE C	1.50	
MW-#28 E	Dissolved Oxygen	7.70	
MW-28	Dissolved Oxygen	7.30	
MW-20	Dissolved Oxygen	7.00	
RW-1	Dissolved Oxygen	6.10	
MW 4	Dissolved Oxygen	5.00	
RW 15	Dissolved Oxygen	5.00	
MW-9	Dissolved Oxygen	4.90	
MW-41	Dissolved Oxygen	4.90	
MW-42	Dissolved Oxygen	4.90	
RW-19	Dissolved Oxygen	4.10	
RW-23	Dissolved Oxygen	3.70	
MW-43	Dissolved Oxygen	3.40	
MW-40	Dissolved Oxygen	3.20	
RW-22	Dissolved Oxygen	3.10	
MW-39	Dissolved Oxygen	1.40	
RW 14	Dissolved Oxygen	1.40	
RW-18	Dissolved Oxygen	0.60	
RW 2	Dissolved Oxygen	0.50	
RW 17	Dissolved Oxygen	0.40	
RW 16	Dissolved Oxygen	0.40	
RW-3	Dissolved Oxygen	0.30	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

RW 15	Ethylbenzene (CCC)	6900.00	
RW 2	Ethylbenzene (CCC)	5100.00	
RW-23	Ethylbenzene (CCC)	4500.00	
RW 17	Ethylbenzene (CCC)	4200.00	
MW-28	Ethylbenzene (CCC)	4100.00	
RW 14	Ethylbenzene (CCC)	3100.00	
RW-3	Ethylbenzene (CCC)	2900.00	
MW-39	Ethylbenzene (CCC)	1800.00	
MW-42	Ethylbenzene (CCC)	1800.00	
MW 30	Ethylbenzene (CCC)	1700.00	
RW-22	Ethylbenzene (CCC)	1400.00	
SEEP #1	Ethylbenzene (CCC)	1400.00	
RW 16	Ethylbenzene (CCC)	1400.00	
MW-9	Ethylbenzene (CCC)	1000.00	
RW-19	Ethylbenzene (CCC)	820.00	
MW-#26	Ethylbenzene (CCC)	800.00	
MW 4	Ethylbenzene (CCC)	600.00	
MW-41	Ethylbenzene (CCC)	590.00	
MW-43	Ethylbenzene (CCC)	540.00	
MW-#11	Ethylbenzene (CCC)	330.00	
MW 21	Ethylbenzene (CCC)	250.00	
RW-1	Ethylbenzene (CCC)	130.00	
MW-#28 E	Ethylbenzene (CCC)	130.00	
MW 25	Ethylbenzene (CCC)	28.00	
SEEP #5	Ethylbenzene (CCC)	10.00	
MW 31	Ethylbenzene (CCC)	10.00	
MW-20	Ethylbenzene (CCC)	7.60	
MW 7	Ethylbenzene (CCC)	7.30	
MW-#34	Ethylbenzene (CCC)	6.20	
MW-#12	Ethylbenzene (CCC)	5.00	
MW 3	Ethylbenzene (CCC)	4.70	
MW 1	Ethylbenzene (CCC)	2.50	
MW-#32	Ethylbenzene (CCC)	2.30	
MW-#33	Ethylbenzene (CCC)	2.00	
MW 8	Ethylbenzene (CCC)	2.00	
MW 29	Ethylbenzene (CCC)	1.80	
MW 44	Ethylbenzene (CCC)	1.60	
SEEP #4	Ethylbenzene (CCC)	1.50	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW-41	Fe	326.00	
MW-42	Fe	250.00	
MW-#38	Fe	215.00	
MW-40	Fe	208.00	
RW-18	Fe	197.00	
MW-#37	Fe	191.00	
MW-39	Fe	163.00	
RW 17	Fe	115.00	
MW 8	Fe	107.00	
MW-43	Fe	76.10	
RW 2	Fe	55.80	
MW 44	Fe	51.60	
MW-28	Fe	37.00	
MW 3	Fe	19.80	
RW-19	Fe	14.20	
MW 21	Fe	13.40	
MW-#11	Fe	12.60	
RW 15	Fe	12.20	
MW 4	Fe	12.10	
RW 16	Fe	10.40	
RW-23	Fe	9.95	
MW-9	Fe	8.85	
MW 5	Fe	8.62	
MW-#26	Fe	8.54	
RW-22	Fe	8.15	
MW-#34	Fe	7.80	
MW-#36	Fe	7.49	
MW 30	Fe	6.99	
MW 25	Fe	6.96	
MW-#35	Fe	6.42	
MW-20	Fe	6.07	
RW 14	Fe	5.53	
RW-1	Fe	5.34	
MW 1	Fe	5.30	
MW-#32	Fe	5.24	
RW-3	Fe	3.58	
MW-#27	Fe	2.36	
MW-#12	Fe	1.91	
MW 31	Fe	0.86	
MW-#33	Fe	0.39	
MW 13	Fe	0.38	
MW 29	Fe	0.36	
MW-#28 E	Fe	0.06	

Table 7 April 1999 Groundwater Analytical Results Values below detection are not presented			
MW-42	FLUORENE	1500.00	
RW-18	FLUORENE	1400.00	
MW-40	FLUORENE	810.00	
MW-41	FLUORENE	480.00	
RW 16	FLUORENE	33.00	
RW 2	FLUORENE	23.00	
RW 17	FLUORENE	12.00	
MW-43	FLUORENE	7.50	
RW 15	FLUORENE	7.50	
RW 14	FLUORENE	6.60	
MW-20	FLUORENE	6.20	
MW 29	FLUORIDE	1.70	
RW 15	FLUORIDE	1.30	
MW-39	FLUORIDE	1.10	
MW 1	FLUORIDE	1.10	
MW-#38	FLUORIDE	1.00	
MW-#28 E	FLUORIDE	1.00	
MW-#36	FLUORIDE	0.80	
MW-#34	FLUORIDE	0.60	
MW-#37	FLUORIDE	0.60	
MW-#12	FLUORIDE	0.60	
MW 8	FLUORIDE	0.60	
MW-#35	FLUORIDE	0.50	
RW-18	HG-L	0.00	
MW-41	HG-L	0.00	
MW-#36	HG-L	0.00	
MW-#37	HG-L	0.00	
MW 44	HG-L	0.00	
MW-39	HG-L	0.00	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW 44	K	27.90	
MW-#38	K	25.40	
MW-39	K	25.00	
RW 17	K	25.00	
MW-40	K	23.70	
MW-41	K	23.30	
MW-#37	K	21.30	
MW-42	K	19.60	
MW-43	K	14.50	
MW-20	K	11.00	
MW 7	K	9.70	
MW 5	K	7.50	
MW 3	K	6.40	
RW-3	K	6.30	
MW 31	K	6.10	
RW-19	K	5.10	
RW 2	K	5.10	
MW-#33	K	5.00	
RW-1	K	5.00	
MW 30	K	5.00	
MW-28	K	4.90	
MW 21	K	4.80	
MW-#32	K	4.60	
RW-23	K	4.30	
MW 13	K	4.20	
MW-#28 E	K	4.10	
RW 15	K	4.10	
RW-18	K	3.80	
RW 16	K	3.80	
MW 8	K	3.70	
RW-22	K	3.50	
MW 25	K	3.40	
MW 4	K	3.30	
MW-#36	K	2.90	
MW-9	K	2.90	
RW 14	K	2.80	
MW-#26	K	2.60	
MW-#27	K	2.00	
MW-#35	K	1.90	
MW 1	K	1.90	
MW 29	K	1.60	
MW-#11	K	1.20	
MW-#12	K	1.20	
MW-#34	K	1.10	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW-#34	Methyl t-Butyl Ether (MtBE)	510.00	
MW-#36	Methyl t-Butyl Ether (MtBE)	240.00	
MW-#11	Methyl t-Butyl Ether (MtBE)	160.00	
MW-#12	Methyl t-Butyl Ether (MtBE)	140.00	
MW-#38	Methyl t-Butyl Ether (MtBE)	61.00	
MW 13	Methyl t-Butyl Ether (MtBE)	18.00	
MW 21	Methyl t-Butyl Ether (MtBE)	17.00	
MW 3	Methyl t-Butyl Ether (MtBE)	13.00	
MW 44	Methyl t-Butyl Ether (MtBE)	12.00	
MW 5	Methyl t-Butyl Ether (MtBE)	4.50	
MW 29	Methyl t-Butyl Ether (MtBE)	2.30	
MW 8	Methyl t-Butyl Ether (MtBE)	2.10	
RW 17	Mg	629.00	
MW-41	MG	150.00	
MW-40	MG	148.00	
MW 31	MG	142.00	
MW 5	MG	141.00	
RW-3	MG	97.40	
MW 21	MG	84.80	
MW-42	MG	79.60	
RW 16	MG	79.50	
MW 30	MG	78.60	
MW-#32	Mg	77.50	
MW 25	MG	75.20	
RW-19	MG	74.80	
MW 44	MG	72.20	
MW 3	MG	71.80	
MW-43	MG	66.60	
MW-#33	Mg	65.10	
MW 13	MG	64.20	
MW-20	MG	61.90	
MW-#37	Mg	59.90	
MW-#38	MG	56.80	
RW-1	MG	56.40	
RW-23	MG	56.10	
MW 4	MG	46.00	
RW-22	MG	45.30	
RW 15	MG	44.70	
MW-39	MG	44.20	
RW 2	MG	39.00	
MW-28	MG	36.00	
RW-18	MG	34.60	
MW 8	MG	33.20	
RW 14	MG	29.20	
MW-#11	Mg	27.20	
MW-9	MG	26.70	
MW-#26	MG	21.40	
MW-#12	Mg	20.60	
MW-#34	Mg	17.00	
MW-#27	MG	16.30	
MW-#35	Mg	14.90	
MW-#36	Mg	13.20	
MW 7	MG	7.90	
MW-#28 E	MG	5.30	
MW 1	MG	4.60	
MW 29	MG	3.90	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW 30	Mn	22.50	
MW-41	Mn	14.40	
MW-40	Mn	11.00	
RW 17	Mn	9.55	
MW-#37	Mn	7.63	
MW 21	Mn	6.44	
MW-43	Mn	5.96	
MW-42	Mn	5.91	
MW-20	Mn	5.57	
RW-23	Mn	5.47	
MW-#38	Mn	5.40	
RW-19	Mn	5.33	
RW 15	Mn	5.11	
MW-39	Mn	4.73	
RW-22	Mn	4.53	
MW 4	Mn	4.43	
MW 25	Mn	4.30	
RW 2	Mn	4.28	
MW-#34	Mn	4.11	
MW-#12	Mn	3.77	
MW 8	Mn	3.70	
RW-18	Mn	3.68	
MW-9	Mn	3.42	
RW-1	Mn	3.42	
MW-28	Mn	3.36	
RW 16	Mn	3.27	
MW-#26	Mn	2.75	
MW-#11	Mn	2.47	
MW 44	Mn	2.41	
MW-#36	Mn	2.37	
RW 14	Mn	2.23	
RW-3	Mn	1.92	
MW-#35	Mn	1.86	
MW-#27	Mn	1.79	
MW 31	Mn	1.09	
MW 13	Mn	1.01	
MW 1	Mn	0.42	
MW 3	Mn	0.26	
MW-#32	Mn	0.24	
MW 29	Mn	0.18	
MW 5	Mn	0.11	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

RW 17	Na	3950.00	
RW-3	NA	1680.00	
MW 7	NA	1620.00	
MW-40	NA	1600.00	
MW 5	NA	1290.00	
MW-41	NA	1270.00	
MW-#32	NA	1010.00	
MW 3	NA	993.00	
MW 44	NA	993.00	
MW 13	NA	811.00	
RW-1	NA	792.00	
RW-19	NA	775.00	
RW 15	NA	725.00	
MW 21	NA	713.00	
MW-#33	NA	706.00	
MW 31	NA	696.00	
MW 30	NA	669.00	
RW 16	NA	654.00	
MW-39	NA	590.00	
RW 2	NA	563.00	
MW 4	NA	541.00	
RW 14	NA	539.00	
MW 8	NA	532.00	
MW-20	NA	509.00	
MW-42	NA	437.00	
MW-9	Na	434.00	
MW-43	Na	430.00	
MW-#11	Na	410.00	
MW-#26	Na	409.00	
MW-#34	Na	359.00	
MW 25	Na	358.00	
RW-23	Na	340.00	
MW-#27	Na	326.00	
MW-#37	Na	318.00	
RW-22	Na	318.00	
RW-18	NA	304.00	
MW-#35	Na	258.00	
MW 29	Na	160.00	
MW-#36	Na	144.00	
MW-28	Na	137.00	
MW-#38	Na	128.00	
MW 1	Na	112.00	
MW-#12	Na	59.70	
MW-#28 E	NA	37.60	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW-40	Naphthalene	35000.00	
RW 17	Naphthalene	26000.00	
MW-41	Naphthalene	12000.00	
RW 15	Naphthalene	11000.00	
MW-42	Naphthalene	7000.00	
RW-3	Naphthalene	4700.00	
RW-18	NAPHTHALENE	4500.00	
MW-42	NAPHTHALENE	4400.00	
RW-19	Naphthalene	4300.00	
MW-40	NAPHTHALENE	4100.00	
MW-41	NAPHTHALENE	1200.00	
RW 16	Naphthalene	1000.00	
RW 15	NAPHTHALENE	750.00	
RW-23	Naphthalene	630.00	
RW 14	NAPHTHALENE	560.00	
RW 2	NAPHTHALENE	420.00	
MW-#26	Naphthalene	300.00	
MW-9	Naphthalene	290.00	
SEEP #1	Naphthalene	260.00	
MW-#26	NAPHTHALENE	210.00	
MW-9	NAPHTHALENE	190.00	
RW 16	NAPHTHALENE	190.00	
MW-43	NAPHTHALENE	180.00	
MW 21	Naphthalene	160.00	
RW 17	NAPHTHALENE	140.00	
RW-1	Naphthalene	110.00	
MW 4	NAPHTHALENE	100.00	
MW-20	Naphthalene	85.00	
MW-#34	Naphthalene	69.00	
MW-20	NAPHTHALENE	54.00	
MW 31	Naphthalene	34.00	
MW 8	Ni	1.02	
MW-39	Ni	0.37	
MW 3	Ni	0.19	
MW 44	Ni	0.19	
MW-42	Ni	0.15	
MW-41	Ni	0.11	
MW-#38	Ni	0.10	
MW-#37	Ni	0.09	
MW-40	Ni	0.09	
MW 30	Ni	0.05	
MW-#12	Ni	0.04	
MW 13	Ni	0.04	
MW 29	Ni	0.04	
MW-43	Ni	0.03	
MW-#28 E	Ni	0.03	
MW 5	Ni	0.03	
MW-#32	Ni	0.02	
MW-9	Ni	0.02	
RW-18	Ni	0.02	
MW 1	Ni	0.02	
RW 14	Ni	0.02	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW 3	NITRATE NITROGEN	34.10	
MW 5	NITRATE NITROGEN	27.70	
MW 31	NITRATE NITROGEN	27.10	
MW-#32	NITRATE NITROGEN	22.40	
MW 13	NITRATE NITROGEN	21.50	
MW-#33	NITRATE NITROGEN	19.60	
MW 8	NITRATE NITROGEN	11.30	
MW 1	NITRATE NITROGEN	2.30	
RW-18	NITRATE NITROGEN	1.00	
MW 7	NITRATE NITROGEN	0.60	
MW-#28 E	NITRATE NITROGEN	0.40	
MW-#36	NITRATE NITROGEN	0.20	
MW 29	NITRATE NITROGEN	0.20	
MW 31	NITRITE NITROGEN	2.20	
RW-18	NITRITE NITROGEN	1.20	
RW 14	N-NITROSODIPHENYLAM	4.50	
RW 15	O-Xylene	9400.00	
MW-28	O-Xylene	7000.00	
RW 14	O-Xylene	4800.00	
RW-23	O-Xylene	4600.00	
RW 2	O-Xylene	3100.00	
MW-39	O-Xylene	3000.00	
MW 30	O-Xylene	1900.00	
RW-22	O-Xylene	1300.00	
MW-42	O-Xylene	1200.00	
MW-43	O-Xylene	940.00	
MW-9	O-Xylene	510.00	
RW 16	O-Xylene	220.00	
MW-#28 E	O-Xylene	150.00	
RW-1	O-Xylene	87.00	
MW 31	O-Xylene	61.00	
MW 21	O-Xylene	11.00	
MW 7	O-Xylene	7.60	
SEEP #4	O-Xylene	2.20	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

RW 2	P/M Xylenes	43000.00	
RW 15	P/M Xylenes	36000.00	
RW-23	P/M Xylenes	34000.00	
MW-28	P/M Xylenes	26000.00	
RW 14	P/M Xylenes	15000.00	
MW-39	P/M Xylenes	11000.00	
RW-3	P/M Xylenes	9800.00	
MW-#11	P/M Xylenes	8900.00	
MW-#26	P/M Xylenes	7900.00	
RW-22	P/M Xylenes	7800.00	
MW-42	P/M Xylenes	7600.00	
MW 30	P/M Xylenes	7200.00	
MW-9	P/M Xylenes	6300.00	
RW 17	P/M Xylenes	6200.00	
MW-43	P/M Xylenes	4000.00	
MW-41	P/M Xylenes	3900.00	
RW 16	P/M Xylenes	2400.00	
SEEP #1	P/M Xylenes	1100.00	
MW-#28 E	P/M Xylenes	560.00	
MW 21	P/M Xylenes	440.00	
RW-1	P/M Xylenes	430.00	
SEEP #5	P/M Xylenes	330.00	
MW 4	P/M Xylenes	330.00	
MW 31	P/M Xylenes	260.00	
MW-#12	P/M Xylenes	130.00	
MW-#34	P/M Xylenes	80.00	
MW-#32	P/M Xylenes	62.00	
MW-#35	P/M Xylenes	59.00	
MW 25	P/M Xylenes	55.00	
MW-#36	P/M Xylenes	54.00	
MW-#33	P/M Xylenes	52.00	
MW 7	P/M Xylenes	38.00	
MW 1	P/M Xylenes	30.00	
MW 3	P/M Xylenes	29.00	
MW-#27	P/M Xylenes	28.00	
MW 8	P/M Xylenes	23.00	
MW 29	P/M Xylenes	22.00	
TRIP BLA	P/M Xylenes	14.00	
SEEP #4	P/M Xylenes	8.90	
MW 44	P/M Xylenes	5.70	
MW 13	P/M Xylenes	3.30	
MW-9	PB	0.30	
MW-42	PB	0.30	
MW-#38	PB	0.20	
MW-40	PB	0.20	
MW-41	PB	0.20	
MW-#37	PB	0.13	
MW-43	PB	0.10	
MW-28	PB	0.10	
RW-23	PB	0.10	
MW-39	PB	0.10	
RW-18	PB	0.06	
RW 2	PB	0.05	
RW-22	PB	0.02	
MW 44	PB	0.02	
MW-#11	PB	0.02	
MW 30	PB	0.02	
MW-#34	PB	0.01	
MW-#12	PB	0.01	
MW-#36	PB	0.01	
MW-#35	PB	0.01	
RW 15	PB	0.00	
MW-#26	PB	0.00	
MW 4	PB	0.00	
RW-3	PB	0.00	
RW-19	PB	0.00	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW-39	pH	8.80	
MW 7	pH	8.30	
RW-18	pH	8.20	
MW 1	pH	8.00	
MW-#28 E	pH	7.90	
MW 29	pH	7.90	
MW-#33	pH	7.60	
MW 8	pH	7.60	
MW-#37	pH	7.50	
MW-#12	pH	7.50	
MW-#38	pH	7.50	
MW-#36	pH	7.40	
MW-#27	pH	7.30	
MW 5	pH	7.30	
MW 3	pH	7.30	
MW-#32	pH	7.20	
RW-3	pH	7.20	
RW 17	pH	7.20	
MW 31	pH	7.20	
MW 44	pH	7.20	
RW 14	pH	7.20	
RW 16	pH	7.20	
MW-#35	pH	7.10	
MW-41	pH	7.10	
RW-23	pH	7.00	
MW-20	pH	7.00	
RW-1	pH	7.00	
MW-42	pH	7.00	
MW 25	pH	7.00	
MW 13	pH	7.00	
RW 15	pH	7.00	
MW-#34	pH	6.90	
MW-#11	pH	6.90	
MW-#26	pH	6.90	
RW-22	pH	6.90	
MW-9	pH	6.90	
MW-40	pH	6.90	
MW 21	pH	6.90	
RW 2	pH	6.90	
MW-28	pH	6.80	
RW-19	pH	6.80	
MW 30	pH	6.80	
MW 4	pH	6.80	
MW-43	pH	6.70	
RW-18	PHENANTHRENE	3200.00	
MW-42	PHENANTHRENE	2500.00	
MW-40	PHENANTHRENE	960.00	
MW-41	PHENANTHRENE	870.00	
RW 16	PHENANTHRENE	56.00	
RW 2	PHENANTHRENE	25.00	
RW 15	PHENANTHRENE	17.00	
MW-43	PHENANTHRENE	13.00	
RW 14	PHENANTHRENE	11.00	
RW 17	PHENANTHRENE	6.60	
MW-20	PHENANTHRENE	6.30	
MW-9	PHENANTHRENE	5.00	
RW-18	PYRENE	210.00	
MW-42	PYRENE	160.00	
RW-18	Se	0.10	
MW-40	Se	0.08	
MW-42	Se	0.08	
MW 8	Se	0.07	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW-#37	Si	85.40	
MW-43	Si	83.00	
MW-42	Si	80.90	
RW 17	Si	72.90	
MW-#38	Si	72.50	
MW-39	Si	69.80	
MW-40	Si	61.30	
MW-41	Si	49.60	
MW-28	Si	41.00	
MW 44	Si	39.20	
MW-20	Si	31.90	
RW 16	Si	30.20	
RW 15	Si	28.40	
RW-23	Si	28.30	
MW 30	Si	27.10	
MW-#26	Si	25.40	
RW-22	Si	24.60	
MW-#32	Si	24.00	
RW-19	Si	24.00	
RW 2	Si	23.90	
MW-9	Si	23.40	
MW-#28 E	Si	22.80	
MW-#36	Si	21.90	
MW 4	Si	21.90	
RW-18	Si	21.50	
MW 25	Si	21.40	
MW-#11	Si	21.30	
MW-#35	Si	20.60	
RW 14	Si	20.60	
RW-1	Si	20.40	
MW-#34	Si	19.90	
MW 8	Si	19.90	
MW 21	Si	19.90	
RW-3	Si	19.30	
MW 3	Si	18.70	
MW-#27	Si	17.00	
MW 5	Si	16.10	
MW 13	Si	16.00	
MW-#12	Si	14.00	
MW-#33	Si	13.60	
MW 1	Si	10.80	
MW 29	Si	10.60	
MW 7	Si	8.80	
MW 31	Si	8.70	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW 7	SULFATE	4320.00	
MW 44	SULFATE	2610.00	
MW-39	SULFATE	2530.00	
MW 31	SULFATE	1600.00	
RW-3	SULFATE	1570.00	
MW-#32	SULFATE	1230.00	
MW-#33	SULFATE	1060.00	
MW 5	SULFATE	1030.00	
MW 3	SULFATE	943.00	
MW 8	SULFATE	794.00	
RW 17	SULFATE	718.00	
MW 30	SULFATE	669.00	
MW 13	SULFATE	539.00	
MW 25	SULFATE	450.00	
MW-#12	SULFATE	178.00	
MW 29	SULFATE	150.00	
RW-18	SULFATE	141.00	
MW 1	SULFATE	124.00	
RW-23	SULFATE	96.40	
RW 16	SULFATE	74.90	
RW 2	SULFATE	50.30	
MW-#28 E	SULFATE	48.50	
MW 21	SULFATE	41.90	
MW-#38	SULFATE	32.00	
MW-#36	SULFATE	26.10	
MW-#37	SULFATE	19.30	
MW 4	SULFATE	18.30	
MW-#35	SULFATE	16.20	
RW-22	SULFATE	15.70	
MW-#27	SULFATE	14.60	
MW-9	SULFATE	14.60	
MW-#34	SULFATE	13.60	
RW-1	SULFATE	7.60	
RW-19	SULFATE	1.90	
MW-20	SULFATE	0.80	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW 7	TDS	6050.00	
MW 5	TDS	5490.00	
RW-3	TDS	5250.00	
MW 44	TDS	4920.00	
MW-40	TDS	4420.00	
MW-#32	TDS	4410.00	
MW 31	TDS	4000.00	
MW 3	TDS	3900.00	
MW-39	TDS	3660.00	
MW-#33	TDS	3630.00	
MW 30	TDS	3490.00	
MW-41	TDS	2960.00	
MW 21	TDS	2930.00	
RW 17	TDS	2800.00	
MW 13	TDS	2780.00	
RW-19	TDS	2660.00	
RW-1	TDS	2610.00	
RW 16	TDS	2450.00	
RW 15	TDS	2390.00	
MW-20	TDS	2090.00	
MW 4	TDS	2040.00	
RW 2	TDS	1920.00	
MW-43	TDS	1910.00	
MW 25	TDS	1900.00	
MW 8	TDS	1780.00	
MW-9	TDS	1690.00	
RW 14	TDS	1630.00	
RW-23	TDS	1580.00	
MW-#11	TDS	1510.00	
MW-#26	TDS	1400.00	
MW-42	TDS	1330.00	
RW-22	TDS	1320.00	
MW-#34	TDS	1300.00	
MW-#27	TDS	1300.00	
RW-18	TDS	1180.00	
MW-#37	TDS	1140.00	
MW-#35	TDS	975.00	
MW-28	TDS	720.00	
MW-#36	TDS	646.00	
MW-#38	TDS	642.00	
MW-#12	TDS	576.00	
MW 29	TDS	531.00	
MW 1	TDS	408.00	
MW-#28 E	TDS	289.00	

Table 7 April 1999 Groundwater Analytical Results

Values below detection are not presented

MW-28	Toluene (CCC)	46000.00	
RW 15	Toluene (CCC)	25000.00	
RW 14	Toluene (CCC)	22000.00	
RW-23	Toluene (CCC)	17000.00	
MW-39	Toluene (CCC)	11000.00	
MW-43	Toluene (CCC)	7900.00	
RW-22	Toluene (CCC)	5500.00	
MW 30	Toluene (CCC)	1200.00	
MW-9	Toluene (CCC)	690.00	
RW 16	Toluene (CCC)	610.00	
MW-#28 E	Toluene (CCC)	580.00	
RW-1	Toluene (CCC)	260.00	
MW-20	Toluene (CCC)	5.20	
SEEP #4	Toluene (CCC)	4.00	
MW 7	Toluene (CCC)	2.70	
RW-18	Zn	1.16	
MW-41	Zn	0.86	
MW-40	Zn	0.77	
MW-42	Zn	0.73	
MW-#38	Zn	0.62	
MW-#37	Zn	0.52	
MW-39	Zn	0.35	
MW-43	Zn	0.16	
MW 44	Zn	0.15	
RW-19	Zn	0.07	
MW-#12	Zn	0.06	
MW-28	Zn	0.04	
MW-#35	Zn	0.03	
MW-#32	Zn	0.03	
MW-20	Zn	0.03	
MW 25	Zn	0.03	
MW-#34	Zn	0.02	
MW-#36	Zn	0.02	
MW-#11	Zn	0.02	

Table 8
Groundwater Analytical Results – Inorganic Parameters

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
1	3/19/84													ND
1	9/1/84		7.2	3582	1059		7.2						825	0.125
1	12/13/84		7.2	3512	1135		ND						700	0.18
1	1984-85		7.41	3516	1070.5		5.725						815.5	0.086
1	3/21/85		7.35	3726	1135		0.3						855	0.04
1	7/10/85		7.5	3246	953		15.4						882	ND
1	11/8/85		7.9	3120	973		2						920	ND
1	3/26/86		7.3	2936	750								7.5	0.085
1	6/23/86		7.25	2960	994.7		0.1						630	0.065
1	9/18/86		7.27	2866	814								673	0.15
1	12/16/86		7.19	2498	774		2.9						579	ND
1	5/28/87			3272	794								827.6	0.2
1	11/17/87			3050	910								655	ND
1	6/3/88			3500	1040								851	ND
1	11/18/88			3430	1140		4.03						665	ND
1	5/25/89			3308									653.46	0.05
1	12/1/89			3120	1142.85								515.61	ND
1	6/19/90			2952	1269.1								491.3	0.007
1	11/14/90			3440	1170								539	ND
1	6/5/91			3200	1060		2.54				0.05	1.27	1070	ND
1	11/7/91			3540	1190		20.6						684	ND
1	6/9/92			3730	1220								882	ND
1	12/11/92			4920	1760		20.2						747	ND
1	5/14/93		6.8	4440	1740		6.91				2.04		563	ND
1	12/13/93		7	4380	1840		6.44				ND	3.17	420	ND
1	5/25/94			NT	NT		NT				NT	NT	NT	NT
1	8/3/94			3856	1510		1.5				2.6	2.8	559	ND
1	12/21/94			4024	1630		4.6				1.5	0.6	1740	ND
1	5/22/95		7	4850	1730		3				4.8	10	899	ND
1	12/7/95		7.16	4400	1300		15				3.9	10	960	ND
1	5/31/96		7.3	2390	728		7.6				0.6	7.6	531	ND
1	11/20/96		7.6	882	152		?				1	1.8	246	ND
1	5/23/97		7.62	1590	260		17.3				0.6	1.8	511	ND
1	11/17/97		7.4	1230	110		8.7				1.1	1.6	502	ND
1	5/28/98			778	105		12.6				0.2	0.4	226	0.06
1	11/23/98	954	7.2	600	52			3.6	1/0/00		0.5		202	

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se	Si	Ag
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02					
	MCL			2		0.005	0.1							0.05		
	RCRA		0.05	1		0.01	0.05							0.01		0.05
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05		0.05
1	3/19/84		ND	0.2		0.003	0.01			20.9	1.38					
1	9/1/84		ND	1	ND	0.014	ND			57	1.7					
1	12/13/84		0.054	ND	0.25	ND	0.07			128	1.05					
1	1984-85		0.016	0.25	0.266	0.01	0.018			46.268	0.943					
1	3/21/85		0.01	ND	0.69	0.027	ND			0.07	0.5					
1	7/10/85		ND	ND	0.13	ND	ND			ND	0.52					
1	11/8/85		ND	ND	0.1	ND	ND			0.08	0.33					
1	3/26/86		ND			0.05	ND									
1	6/23/86		0.077	ND		ND	ND			ND	0.25					
1	9/18/86		0.05			ND	ND									
1	12/16/86		ND	0.55		ND	ND			ND	1.11					
1	5/28/87		ND	ND	0.7	0.023	ND			0.14	1.51					
1	11/17/87		ND	ND	0.32	ND	ND			ND	1.45					
1	6/3/88		ND	ND	0.25	ND	ND			ND	0.85					
1	11/18/88		ND	ND	0.32	ND	ND			ND	2.11					
1	5/25/89		ND	ND	0.03	ND	ND			ND	ND					
1	12/1/89		0.0005	ND	0.28	0.0073	ND			0.68	1.17					
1	6/19/90		0.0092	ND	0.31	ND	ND			ND	0.59					
1	11/14/90		0.0008	ND	ND	ND	ND			14.38	2.3					
1	6/5/91		ND	ND	0.32	ND	ND			ND	1.04					
1	11/7/91		ND	ND	0.35	ND	0.02			ND	2.79					
1	6/9/92		ND	ND	0.39	ND	ND			ND	0.27					
1	12/11/92		ND	ND	0.55	ND	ND			0.14	3.29					
1	5/14/93		ND	ND	0.35	ND	ND			ND	3.71					
1	12/13/93		ND	ND	0.47	ND	ND			ND	3.7					
1	5/25/94		NT	NT	NT	NT	NT			NT	NT					
1	8/3/94		0.006	ND	0.48	ND	ND			0.05	2.43					
1	12/21/94		0.006	ND	0.19	ND	ND			0.096	4.94					
1	5/22/95		ND	ND	0.4	0.002	ND			1	7.2					
1	12/7/95		ND	ND	0.71	0.003	ND			0.19	9.22					
1	5/31/96		ND	0.01	0.34	0.007	ND			0.2	0.17					
1	11/20/96		ND	ND	ND	ND	ND			2.1	0.505					
1	5/23/97		ND	0.02	0.2	ND	ND			ND	0.665					
1	11/17/97		ND	0.01	0.2	ND	ND			ND	0.781					
1	5/28/98		ND	0.01	ND	ND	ND			ND	0.04					
1	11/23/98				0.3						0.3					

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl	V
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01						
	MCL								0.2			0.006	0.004	0.002	
	RCRA														
	NMWQ							0.005	0.2						
1	3/19/84								ND						
1	9/1/84							0.024	ND						
1	12/13/84							0.065	ND						
1	1984-85							0.055	ND						
1	3/21/85							0.13	ND						
1	7/10/85							ND	ND						
1	11/8/85							0.096	0.04						
1	3/26/86							0.009	ND						
1	6/23/86							0.017	0.1						
1	9/18/86							0.19	0.07						
1	12/16/86							0.012	ND						
1	5/28/87							0.123	0.0056						
1	11/17/87							0.02	ND						
1	6/3/88							0.021	0.022						
1	11/18/88							0.05	ND						
1	5/25/89							0.214	ND						
1	12/1/89							0.151	ND						
1	6/19/90							0.231	ND						
1	11/14/90							0.5	ND						
1	6/5/91							0.022	ND						
1	11/7/91							0.022	ND						
1	6/9/92							0.04	ND						
1	12/11/92							0.01	ND						
1	5/14/93							ND	ND						
1	12/13/93							ND	ND						
1	5/25/94							ND	NT						
1	8/3/94							ND	ND						
1	12/21/94							ND	ND						
1	5/22/95							ND	ND						
1	12/7/95							ND	ND						
1	5/31/96							ND	ND						
1	11/20/96							ND	ND						
1	5/23/97							ND	ND						
1	11/17/97							ND	ND						
1	5/28/98							ND	ND						
1	11/23/98														

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
2	3/26/86			2796	200								11	0.12
2	6/23/86			3650	1204.6								1750	ND
2	9/18/86			3598	993								1104	0.08
2	12/16/86			3664	1012		NT				NT	NT	1372	ND
3	3/26/86			4836	1500								29.5	0.14
3	6/23/86			5362	1584								1950	0.07
3	9/18/86			5514	1290								2056	0.18
3	12/16/86			4860	1290								2204	ND
4	3/19/84													0.042
4	9/1/84		7.1	1860	410		0.02						10	0.088
4	12/13/84		6.9	2408	481		ND						4	0.22
4	3/21/85		7.01	1860	466		ND						9	0.015
4	7/10/85		7.4	2004	556		ND						3	ND
4	6/23/86		6.85	2266	989.7		ND				NT	NT	12.5	0.066
4	5/28/87			2038	635		0.035				NT	NT	4.8	0.14
4	11/17/87			2050	588								ND	ND
4	6/3/88			1820	401		0.14						3	ND
4	11/18/88			1830	490		0.09				NT	NT	ND	ND
4	5/25/89			1454	NT		ND				NT	NT	7.41	0.03
4	11/8/95		7.7	2060	675		ND						3	ND
4	9/2/98	3600			369	ND	ND			ND			ND	ND
4	12/16/86		6.73	2128	675		ND						ND	ND
4	3/26/86		6.84	1868	500								0	0.074
4	9/18/86		6.7	2308	754								ND	ND
4	9/2/98													

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se	Si	Ag
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02					
	MCL			2		0.005	0.1							0.05		
	RCRA		0.05	1		0.01	0.05							0.01		0.05
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05		0.05
2	3/26/86		ND			0.06	ND									
2	6/23/86		0.094			ND	ND									
2	9/18/86		0.08			0.03	ND									
2	12/16/86		ND	NT	NT	ND	ND			ND	NT					
3	3/26/86		ND			0.12	ND									
3	6/23/86		0.15			0.015	ND									
3	9/18/86		0.21			ND	ND									
3	12/16/86		ND			0.11	ND									
4	3/19/84		0.018	1.8		ND	ND			57.7	7.62					
4	9/1/84		ND	4	ND	ND	0.1			43.7	7.8					
4	12/13/84		0.118	7	0.32	ND	0.28			132	25.4					
4	3/21/85		0.005	2.5	0.89	ND	ND			6.8	5.2					
4	7/10/85		ND	ND	0.05	ND	ND			12	5					
4	6/23/86		0.07	3.54	ND	ND	ND			12	3.5					
4	5/28/87		ND	9.88	0.97	0.018	ND			0.17	5.29					
4	11/17/87		ND	1.8	0.59	ND	ND			4.59	4.77					
4	6/3/88		ND	1.4	0.47	ND	ND			6.44	3.51					
4	11/18/88		ND	1.8	0.57	ND	ND			5.95	3.73					
4	5/25/89		ND	1.4	0.5	ND	ND			0.92	3.59					
4	11/8/95		ND	1.5	ND	ND	ND			0.34	2.8					
4	9/2/98	ND	ND	2.05	0.52	ND	ND	ND	ND	7.39	4.16	ND	3.4	0.08	21.9	ND
4	12/16/86		ND	2.3	0.7	ND	ND			18.6	5.7					
4	3/26/86		ND			0.06	ND									
4	9/18/86		0.08			ND	ND									
4	9/2/98			2.05	0.52					7.39	4.16		3.4	0.08	21.9	

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl	V
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01						
	MCL								0.2			0.006	0.004	0.002	
	RCRA														
	NMWQ							0.005	0.2						
2	3/26/86							0.063	ND						
2	6/23/86							0.023	0.1						
2	9/18/86								0.18						
2	12/16/86							0.012	ND						
3	3/26/86								ND						
3	6/23/86								0.25						
3	9/18/86								0.17						
3	12/16/86								0.07						
4	3/19/84								ND						
4	9/1/84							0.55	ND						
4	12/13/84							0.12	ND						
4	3/21/85							0.005	ND						
4	7/10/85							0.08	ND						
4	6/23/86							0.43	0.5						
4	5/28/87							0.278	ND		7.5				
4	11/17/87							0.73	0.005						
4	6/3/88							0.069	ND						
4	11/18/88							0.101	ND						
4	5/25/89							0.25	ND						
4	11/8/95							0.037	0.03						
4	9/2/98	536	ND	159	56.3					ND		ND	ND	ND	ND
4	12/16/86							0.096	ND						
4	3/26/86							0.633	ND						
4	9/18/86							0.085	ND						
4	9/2/98	536		159	56.3										

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
5	5/28/87			3902	1112								772.4	0.2
5	11/17/87			4300	1310								1060	ND
5	6/3/88			4200	1300								1000	ND
5	11/18/88			4080	1480		27.8				NT	NT	777	0.07
5	5/25/89			4196									781.03	0.06
5	12/1/89			4594	1715.62								946.45	0.044
5	6/19/90			4918	1751.4								1131.6	0.005
5	11/14/90			4930	1640								1110	ND
5	11/7/91			5390	1770		24.1				NT	NT	1370	ND
5	6/9/92			7634	3070								1190	0.11
5	12/11/92			6960	2820		6.57				NT	NT	754	ND
5	5/14/93		6.7	7600	3100		21.12				4.06		1120	ND
5	12/13/93		6.8	7390	3190		7.47				0.08	3.52	1050	ND
5	5/25/94													NT
5	8/3/94			8878	2490		18.7				ND	2.8	966	0.16
5	12/21/94			7390	3170		24				0.17	5.6	1020	ND
5	5/22/95		7	7720	3180		19.3				0.2	1.2	943	ND
5	12/7/95		7.16	7500	2600		16				ND	5	780	ND
5	5/31/96		7	6350	2260		14.5				0.6	3.5	918	0.72
5	11/20/96		7.1	5660	2810		?				ND	1	912	ND
5	5/23/97		7.07	6250	2690		13.5				0.4	3.4	879	ND
5	11/17/97		6.64	6240	2530		12.2				0.3	2.2	902	ND
5	5/28/98			2060	848		3.9				0.5	2.9	259	0.05
5	11/8/85		7.7		1588		8						1540	ND
5	12/16/86		7.28	3788	1118		36						1132	ND
5	1984-85		7.41	4746	1402		24				NT	NT	1299	0.015
5	3/19/84													0.02
5	3/21/85		7.22	4758	1257		29							0.046
5	3/26/86		7.23	3840	1100								14	0.16
5	6/10/85		7.6	4746	1360		35						1200	ND
5	6/23/86		7.18	3778	1339.6		12.5						1800	0.055
5	9/18/86		7.19	3184	1151								1237	ND
5	11/23/98	12000	7.4	6600	3090			1/22/00			0.3		1070	
7	3/26/86			6076	60								5.5	ND
7	6/23/86			6406	80								2400	0.24
7	9/18/86			6348	20								5802	0.05
7	12/16/86			6940	29		NT				NT	NT	3630	0.26
7	9/2/98	8400			28.9	ND	0.6			ND			4140	ND

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se	Si	Ag
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02					
	MCL			2		0.005	0.1							0.05		
	RCRA		0.05	1		0.01	0.05							0.01		0.05
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05		0.05
5	5/28/87		ND	ND	0.24	0.026	ND			0.14	0.09					
5	11/17/87		ND	ND	0.54	ND	ND			ND	ND					
5	6/3/88		ND	ND	0.48	ND	ND			ND	1.45					
5	11/18/88		ND	ND	0.45	ND	ND			ND	ND					
5	5/25/89		ND	ND	0.41	ND	ND			ND	ND					
5	12/1/89		0.0006	ND	0.58	0.0039	ND			ND	ND					
5	6/19/90		0.0126	ND	0.06	ND	ND			ND	ND					
5	11/14/90		ND	ND	ND	ND	ND			ND	ND					
5	11/7/91		ND	ND	0.48	ND	0.03			ND	0.12					
5	6/9/92		ND	ND	0.63	ND	ND			ND	9.11					
5	12/11/92		0.01	ND	0.76	ND	0.02			3.72	0.6					
5	5/14/93		0.008	ND	0.48	ND	ND			0	0.32					
5	12/13/93		ND	ND	0.58	ND	0.02			0.5	0.46					
5	5/25/94		NT	NT	NT	NT	NT									
5	8/3/94		0.007	ND	0.55	0.004	ND			0.06	0.24					
5	12/21/94		0.027	ND	0.41	0.002	ND			0.071	0.142					
5	5/22/95		ND	ND	0.5	ND	ND			ND	0.1					
5	12/7/95		ND	ND	0.81	ND	ND			0.08	0.24					
5	5/31/96		ND	0.03	0.54	ND	ND			0.72	0.58					
5	11/20/96		ND	0.03	0.6	ND	0.04			6.2	0.187					
5	5/23/97		ND	ND	0.5	ND	ND			0.2	0.155					
5	11/17/97		ND	0.02	0.5	ND	ND			ND	0.302					
5	5/28/98		ND	0.02	0.3	ND	ND			ND	0.105					
5	11/8/85		ND	ND	ND	ND	ND			0.089	0.045					
5	12/16/86		ND	0.01		0.01	ND			ND	ND					
5	1984-85		0.004	ND	0.48	0.015	ND			0.061	0.128					
5	3/19/84		ND	0.3		ND	0.04			70.6	0.915					
5	3/21/85		0.011	ND	1.29	0.046	ND			0.095	0.098					
5	3/26/86		ND			0.1	ND									
5	6/10/85		ND	ND	0.15	ND	ND			ND	0.24					
5	6/23/86		0.087	ND		ND	ND			0.05	0.025					
5	9/18/86		0.07			ND	ND									
5	11/23/98				0.62					0.18	0.05					
7	3/26/86		ND			0.05	ND									
7	6/23/86		0.36			0.03	0.052									
7	9/18/86		0.22			ND	ND									
7	12/16/86		ND	NT	NT	0.02	0.08			NT	NT					
7	9/2/98	ND	0.25	ND	0.32	ND	ND	ND	ND	ND	ND	ND	10	0.07	8.7	ND

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl	V
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01						
	MCL								0.2			0.006	0.004	0.002	
	RCRA														
	NMWQ							0.005	0.2						
5	5/28/87							0.334	ND						
5	11/17/87							ND	0.016						
5	6/3/88							0.064	0.03						
5	11/18/88							0.16	ND						
5	5/25/89							0.362	ND						
5	12/1/89							0.006	ND						
5	6/19/90							0.102	ND						
5	11/14/90							0.03	0.01						
5	11/7/91							0.002	ND						
5	6/9/92							0.02	ND						
5	12/11/92							0.04	ND						
5	5/14/93							ND	ND						
5	12/13/93							ND	ND						
5	5/25/94							ND							
5	8/3/94							ND	ND						
5	12/21/94							ND	5						
5	5/22/95							ND	ND						
5	12/7/95							0.37	ND						
5	5/31/96							ND	ND						
5	11/20/96							ND	ND						
5	5/23/97							ND	ND						
5	11/17/97							ND	ND						
5	5/28/98							ND	ND						
5	11/8/85							0.02	0.04						
5	12/16/86							0.021	ND		1.3				
5	1984-85							0.008	0.013						
5	3/19/84								ND						
5	3/21/85							0.004	ND						
5	3/26/86							0.006	ND						
5	6/10/85							ND	ND						
5	6/23/86							0.007	0.2						
5	9/18/86							0.034	0.24						
5	11/23/98														
7	3/26/86							ND	ND						
7	6/23/86							0.006	0.25						
7	9/18/86							0.036	0.1						
7	12/16/86							0.025	ND						
7	9/2/98	1670	ND	396	8.8					ND		ND	ND	ND	ND

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
8	12/16/86			3450	913		NT				NT	NT	1270	ND
8	5/24/94													
8	8/3/94													
8	5/26/95													
8	3/26/86			806	160								4	ND
8	6/23/86			2910	840								1500	0.055
8	9/18/86			2284	576								586	ND
9	3/26/86			2360	149								13	ND
9	6/23/86			1718	1009.7								114	0.059
9	9/18/86			1428	89								ND	ND
9	12/16/86			1684	109		NT				NT	NT	20	ND
9	11/1/91		7	NT	123		ND				NT	NT	12	ND
9	2/7/92		7.3		114		ND						117	ND
9	6/10/92		7		117		ND						53	0.03
9	10/16/92		7	NT	38		ND				NT	NT	12	0.02
9	6/15/95													
9	12/8/95		7.2											
9	5/31/96		6.9											
9	5/22/97		6.89				0.2				1	1.6		
9	11/18/97		7.03											
9	5/28/98						ND				ND	5.1		
9	8/27/98						ND							0.011
9	11/24/98	2800	6.7								0.6			
10	3/26/86			1546	245								5.3	ND
10	6/23/86			2820	569.8								165	0.059
10	9/18/86			2408	587								ND	0.05
10	12/16/86			3272	457		NT				NT	NT	10	ND
11	9/30/87		7.04	1910	337.5		0.389						181	0.32
11	9/9/88			1900	NT		0.06				NT	NT	30	NT
11	5/24/94													
11	8/3/94													
11	6/1/95						0.13				0.39		16	
12	9/30/87			658	7.9		0.181						248	0.12
12	9/2/98	571												

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se	Si	Ag
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02					
	MCL			2		0.005	0.1							0.05		
	RCRA		0.05	1		0.01	0.05							0.01		0.05
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05		0.05
8	12/16/86		ND	NT	NT	ND	ND			NT	NT					
8	5/24/94															
8	8/3/94															
8	5/26/95															
8	3/26/86		ND			0.01	ND									
8	6/23/86		0.072			ND	ND									
8	9/18/86		0.03			ND	ND									
9	3/26/86		ND			0.01	ND									
9	6/23/86		ND			ND	ND									
9	9/18/86		0.02			ND	ND									
9	12/16/86		ND	NT	NT	ND	ND			NT	NT					
9	11/1/91		0.013	1.6	NT	ND	ND			5.38	3.22					
9	2/7/92		0.01	1.1		0	0.03			0.15	1.97					
9	6/10/92		0.009	1.77		ND	ND			6.63	3.05					
9	10/16/92		0.008	1.1	NT	ND	ND			3.23	2.19					
9	6/15/95															
9	12/8/95															
9	5/31/96															
9	5/22/97															
9	11/18/97															
9	5/28/98															
9	8/27/98						ND									
9	11/24/98															
10	3/26/86		ND			0.02	ND									
10	6/23/86		0.053			ND	ND									
10	9/18/86		0.05			ND	ND									
10	12/16/86		ND	NT	NT	ND	ND			NT	NT					
11	9/30/87		ND	6.72	ND	0.018	0.2			32	4.71					
11	9/9/88		NT	NT	NT	NT	NT			NT	NT					
11	5/24/94															
11	8/3/94															
11	6/1/95									16						
12	9/30/87		ND	ND	ND	ND	0.064			8.2	0.38					
12	9/2/98															

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl	V
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01						
	MCL								0.2			0.006	0.004	0.002	
	RCRA														
	NMWQ							0.005	0.2						
8	12/16/86							0.042	0.1						
8	5/24/94							ND							
8	8/3/94							ND							
8	5/26/95							ND							
8	3/26/86							ND	ND						
8	6/23/86							0.005	ND						
8	9/18/86							0.097	ND						
9	3/26/86							0.304	ND						
9	6/23/86							0.372	0.4						
9	9/18/86							0.17	ND						
9	12/16/86							0.16	ND						
9	11/1/91							0.115	NT						
9	2/7/92							0.11							
9	6/10/92							0.33							
9	10/16/92							0.18	NT						
9	6/15/95														
9	12/8/95														
9	5/31/96														
9	5/22/97														
9	11/18/97														
9	5/28/98														
9	8/27/98														
9	11/24/98														
10	3/26/86							0.147	ND						
10	6/23/86							0.186	ND						
10	9/18/86							0.065	0.05						
10	12/16/86							0.055	ND						
11	9/30/87							ND	ND						
11	9/9/88							0.06	NT						
11	5/24/94							0.032							
11	8/3/94							0.024							
11	6/1/95														
12	9/30/87								ND						
12	9/2/98														

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
13	9/9/88			3220			13.1				NT	NT	728	NT
13	5/24/94													
13	8/3/94													
13	8/26/98				492	ND	27.9						994	0.003
20	11/8/91		7.2	NT	193		ND				NT	NT	20	ND
20	10/16/92		7	NT	361		0.02				NT	NT	215	ND
20	5/24/94													
20	8/3/94													
20	12/8/95		7.22											
20	5/31/96		7.1											
20	5/22/97		7.07											
20	11/18/97		6.82											
20	8/27/98				633	ND	ND			ND			161	0.004
20	2/7/92		7.2		739		ND						37	ND
20	6/10/92		7.1		554		2.43						117	ND
20	11/23/98	2998	7											
21	11/8/91		7.2	NT	481		ND				NT	NT	416	ND
21	2/7/92		7.1		420		ND						443	ND
21	10/16/92		7	NT	797		ND				NT	NT	210	ND
21	5/24/94													
21	8/3/94													
21	12/8/95		7.2											
21	5/31/96		7											
21	11/17/97		6.99											
21	6/10/92		7.3		626		0.17						165	ND
21	11/23/98	4323	6.8											
25	5/24/94													ND
25	8/4/94													0.004
26	5/24/94													0.0059
26	8/4/94													0.004
26	6/1/95						0.08				0.34		15	
27	11/24/98												27.2	
28	9/2/98	1130												
29	5/24/94													0.0057
29	8/4/94													0.014
29	8/27/98				322	ND	4.2			ND			607	ND

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se	Si	Ag
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02					
	MCL			2		0.005	0.1							0.05		
	RCRA		0.05	1		0.01	0.05							0.01		0.05
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05		0.05
13	9/9/88		NT	NT	NT	NT	NT			NT	NT					
13	5/24/94															
13	8/3/94															
13	8/26/98	ND	ND	ND	0.9	ND	ND	ND	ND	0.2	1.56	0.06	5.2	0.06	15	ND
20	11/8/91		0.005	ND	NT	ND	0.02			0.59	3.86					
20	10/16/92		0.005	ND	NT	ND	ND			0.81	5.2					
20	5/24/94															
20	8/3/94															
20	12/8/95															
20	5/31/96															
20	5/22/97															
20	11/18/97															
20	8/27/98	ND	ND	0.48	0.7	ND	ND	ND	ND	2.9	4.28	ND	11.4	ND	31.5	ND
20	2/7/92		0.007	0.7		0.003	0.06			2.52	7.9					
20	6/10/92		ND	0.7		ND	ND			1.73	5.68					
20	11/23/98															
21	11/8/91		ND	ND	NT	ND	ND			0.81	6.23					
21	2/7/92		0.011	ND		ND	ND			1	5.55					
21	10/16/92		0.005	ND	NT	ND	ND			2.49	6.8					
21	5/24/94															
21	8/3/94															
21	12/8/95															
21	5/31/96															
21	11/17/97															
21	6/10/92		ND	ND		ND	ND			1.71	5.69					
21	11/23/98															
25	5/24/94		ND				ND		ND							
25	8/4/94		ND				ND		ND							
26	5/24/94		ND				ND		ND							
26	8/4/94		ND				ND		ND							
26	6/1/95									3.9						
27	11/24/98	0.5		0.09	0.32					12.4	1.94		2.9		23.3	
28	9/2/98															
29	5/24/94		ND				ND		ND							
29	8/4/94		ND				ND		ND							
29	8/27/98	ND	ND	ND	0.4	ND	ND	0.02	0.03	ND	0.433	0.12	4.4	ND	14.7	ND

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl	V
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01						
	MCL								0.2			0.006	0.004	0.002	
	RCRA														
	NMWQ							0.005	0.2						
13	9/9/88							0.03	NT						
13	5/24/94							ND							
13	8/3/94							ND							
13	8/26/98	796	ND	331	101					3.2		ND	ND	0.2	ND
20	11/8/91							ND	NT						
20	10/16/92							ND	NT						
20	5/24/94							ND							
20	8/3/94							ND							
20	12/8/95														
20	5/31/96														
20	5/22/97														
20	11/18/97														
20	8/27/98	502	ND	123	54.2					2.3		ND	ND	0.1	ND
20	2/7/92							0.02							
20	6/10/92							ND							
20	11/23/98														
21	11/8/91							ND	NT						
21	2/7/92							ND			5.4				
21	10/16/92							ND	NT						
21	5/24/94							0.013							
21	8/3/94							0.011							
21	12/8/95														
21	5/31/96														
21	11/17/97														
21	6/10/92							0.01							
21	11/23/98														
25	5/24/94		ND					ND							
25	8/4/94		ND					ND							
26	5/24/94		0.035					0.01							
26	8/4/94		0.03					0.009							
26	6/1/95														
27	11/24/98	351	0.03	159	24.8										0.02
28	9/2/98										5.2				
29	5/24/94		0.037					ND							
29	8/4/94		0.05					ND							
29	8/27/98	508	ND	153	35.2					1.1	1.2	ND	ND	0.1	ND

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Cond.	pH	TDS	Chloride	Fluoride	NO3, NO2	Nitrate	Nitrite	Ortho P	Ammonia	TKN	SO4	Pb
	UNITS	umhos/cm		mg/L	mg/L	mg/l	mg/L			mg/l	mg/L	mg/L	mg/L	mg/L
	PQL			10	5		0.05				0.07	0.5	10	0.005
	MCL					4	10							
	RCRA													0.05
	NMWQ			1000	250	1.6	10				na	na	600	0.05
30	5/24/94													.0087
30	8/4/94													0.007
30	6/1/95						0.73				0.6		1100	
31	5/24/94													ND
31	8/4/94													ND
31	6/1/95						0.13				0.35		88	
31	8/27/98				325	ND	14.5			ND			614	ND
34	3/9/98						0.07				0.2		23	
36	9/2/98	1380			87.3	ND	ND			ND			135	0.1
37	8/27/98				136	ND	0.6			ND			193	ND
38	9/2/98	821			2.6	ND	ND			ND			9.2	0.06
39	9/2/98	9900			2310	ND	ND			ND			ND	0.1
RW-1	9/9/88			3130									4.5	
RW-1	5/24/94			NT									NT	
RW-1	8/3/94													
RW-1	9/2/98													ND
RW-15	11/8/91		7.3	NT	730		ND				NT	NT	2	ND
RW-15	10/16/92		7.2	NT	758		ND				NT	NT	3	0.001
RW-15	5/31/96		7.1											
RW-15	5/22/97		7.01											
RW-15	11/17/97		7.13											
RW-15	11/23/98													
RW-15	2/7/92		7.4		558		ND						4	ND
RW-15	6/10/92		7.2		818		ND						5	ND
RW-15	11/23/98	3578	7.3											
RW-18	11/8/91		7.1	NT	228		ND				NT	NT	24	ND
RW-18	10/16/92		7.1	NT	240		ND				NT	NT	?	0.002
RW-18	5/31/96		6.9											
RW-18	5/22/97		7.19											
RW-18	11/18/97		6.9											
RW-18	2/7/92		7.1		200		ND						34	ND
RW-18	6/10/92		7.1		239		ND						3	0.02
RW-18	11/24/98	2700	7.5											
RW-2	9/9/88			1983									ND	
RW-23	8/27/98													0.022
RW-3	9/9/88			3250									9.5	
RW-3	5/24/94			NT									NT	
RW-3	8/3/94													

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Al	As	Ba	B	Cd	Cr	Co	Cu	Fe	Mn	Ni	K	Se	Si	Ag
	UNITS	mg/l	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l	mg/L	mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL		0.01	0.02	0.1	0.001	0.02			0.03	0.02					
	MCL			2		0.005	0.1							0.05		
	RCRA		0.05	1		0.01	0.05							0.01		0.05
	NMWQ		0.1	1	0.75	0.01	0.05			1	0.2			0.05		0.05
30	5/24/94		0.011				0.015		.034							
30	8/4/94		0.01				ND		ND							
30	6/1/95									1.7						
31	5/24/94		ND	ND	ND	ND	ND			ND	ND					
31	8/4/94		ND	ND	ND	ND	ND			ND	ND					
31	6/1/95									1.8						
31	8/27/98	ND	ND	0.04	0.9	ND	ND	ND	ND	0.2	0.576	ND	6.1	ND	10.7	ND
34	3/9/98									0.21						
36	9/2/98	90.3	0.07	4.15	0.1	ND	0.15	0.06	0.19	122	9.54	0.08	13.3	ND	84.9	ND
37	8/27/98	ND	ND	0.1	0.3	ND	ND	ND	ND	0.4	1.51	ND	2.8	0.07	15.1	ND
38	9/2/98	65.4	ND	0.66	0.1	ND	0.04	0.02	0.09	64.3	1.53	ND	9.4	ND	77.7	ND
39	9/2/98	170	0.24	8.28	0.3	0.008	0.25	0.19	0.32	259	11.2	0.18	28.5	0.08	84	ND
RW-1	9/9/88															
RW-1	5/24/94															
RW-1	8/3/94															
RW-1	9/2/98						ND									
RW-15	11/8/91		ND	0.8	NT	ND	ND			2.61	4.59					
RW-15	10/16/92		ND	0.7	NT	ND	ND			1.94	4.72					
RW-15	5/31/96															
RW-15	5/22/97															
RW-15	11/17/97															
RW-15	11/23/98															
RW-15	2/7/92		0.007	0.6		ND	0.06			10.1	3.05					
RW-15	6/10/92		ND	0.6		ND	ND			ND	1.13					
RW-15	11/23/98															
RW-18	11/8/91		ND	1.1	NT	ND	ND			0.06	4.69					
RW-18	10/16/92		ND	1	NT	ND	ND			0.45	4.37					
RW-18	5/31/96															
RW-18	5/22/97															
RW-18	11/18/97															
RW-18	2/7/92		0.006	1.2		ND	0.03			10.4	4.24					
RW-18	6/10/92		ND	1.15		ND	ND			4.39	4.48					
RW-18	11/24/98															
RW-2	9/9/88															
RW-23	8/27/98						ND									
RW-3	9/9/88															
RW-3	5/24/94															
RW-3	8/3/94															

Table 8 Groundwater Analytical Results - Inorganic Parameters

Well	Parameter	Na	Zn	Ca	Mg	Mo	Hg	Phenols	Cyanide	Bromide	DO	Sb	Be	Tl	V
	UNITS	mg/l	mg/L	mg/l	mg/l			mg/L	mg/L	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	PQL							0.05	0.01						
	MCL								0.2			0.006	0.004	0.002	
	RCRA														
	NMWQ							0.005	0.2						
30	5/24/94		.039					0.08							
30	8/4/94		0.02					ND							
30	6/1/95														
31	5/24/94							0.11							
31	8/4/94							0.034							
31	6/1/95														
31	8/27/98	702	ND	262	182					6.7		ND	ND	0.2	ND
34	3/9/98														
36	9/2/98	166	ND	203	39.6					ND		ND	ND	ND	0.169
37	8/27/98	352	ND	88.3	18.7					0.8		ND	ND	0.1	ND
38	9/2/98	81.4	ND	107	24.7					ND		ND	ND	ND	0.098
39	9/2/98	1330	0.9	319	163					ND		ND	0.009	ND	0.3
RW-1	9/9/88							0.34							
RW-1	5/24/94							ND							
RW-1	8/3/94							ND							
RW-1	9/2/98														
RW-15	11/8/91							0.059	NT						
RW-15	10/16/92							0.26	NT						
RW-15	5/31/96														
RW-15	5/22/97														
RW-15	11/17/97														
RW-15	11/23/98														
RW-15	2/7/92							0.14							
RW-15	6/10/92							0.14							
RW-15	11/23/98														
RW-18	11/8/91							0.044	NT						
RW-18	10/16/92							ND	NT						
RW-18	5/31/96														
RW-18	5/22/97														
RW-18	11/18/97														
RW-18	2/7/92							0.07							
RW-18	6/10/92							0.14							
RW-18	11/24/98														
RW-2	9/9/88							0.13							
RW-23	8/27/98														
RW-3	9/9/88							50							
RW-3	5/24/94							0.016							
RW-3	8/3/94							0.04							

Table 9
Groundwater Analytical Results – Organic Parameters

Table 9 Groundwater Analytical Results - Organic Parameters

	Parameter	B	T	E	X	TOC	TOX	VOC	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
Well ID	Date										
MW-1	11/23/98		3.8		1.3						
MW-1	5/28/98	ND	ND	ND	ND						
MW-1	11/17/97	ND	ND	ND	ND						
MW-1	5/23/97	ND	ND	ND	ND						
MW-1	11/20/96	ND	ND	ND	ND						
MW-1	5/31/96	ND	0.3	ND	0.4						
MW-1	12/7/95	ND	ND	ND	ND						
MW-1	5/22/95	ND	ND	ND	ND						
MW-1	12/21/94	ND	ND	ND	ND						
MW-1	8/3/94	ND	ND	ND	ND						
MW-1	5/25/94	ND	ND	ND	ND						
MW-1	12/13/93	ND	ND	ND	ND						
MW-1	5/14/93	ND	ND	ND	ND						
MW-1	12/11/92		ND	ND	ND						
MW-1	6/9/92	ND	ND	1.4	ND						
MW-1	11/7/91	ND	ND	ND	ND						
MW-1	6/5/91	ND	ND	ND	ND						
MW-1	11/14/90	ND	ND	ND	1.1	12.8					
MW-1	6/19/90	ND	ND	ND	ND	11.3					
MW-1	12/1/89	ND	3.75	ND	ND						
MW-1	5/25/89	ND	ND	ND	ND						
MW-1	11/18/88	0.75	2.68	NT	NT						
MW-1	6/3/88	ND	ND								
MW-1	11/17/87	ND	ND								
MW-1	5/28/87	ND	ND								
MW-1	12/16/86	ND	ND	ND	ND	18	0.002				
MW-1	9/18/86	ND	ND	ND	ND	24					
MW-1	6/23/86	ND	ND	ND	ND	24	ND				
MW-1	3/26/86	ND	ND	ND	ND	18					
MW-1	11/8/85	ND	ND								
MW-1	7/10/85	ND	ND								
MW-1	3/21/85	ND	ND								
MW-1	12/13/84	15	ND								
MW-1	9/1/84	ND	ND								
MW-1	1984-85	ND	ND	ND	ND						

Table 9 Groundwater Analytical Results - Organic Parameters

	Parameter	B	T	E	X	TOC	TOX	VOC	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
MW-2	12/16/86	ND	ND	ND	ND	15					
MW-2	9/18/86	ND	ND	ND	ND	23					
MW-2	6/23/86	ND	ND	ND	ND	27					
MW-2	3/26/86	ND	ND	ND	ND	18					
MW-3	8/3/94	ND		ND	ND						
MW-3	5/24/94	ND	ND	ND	ND						
MW-3	12/16/86	ND	ND	ND	ND	12					
MW-3	9/18/86	ND	ND	ND	ND	16					
MW-3	6/23/86	ND	3	ND	30	17					
MW-3	3/26/86	ND	ND	ND	ND	29					
MW-4	9/29/98								8.4	ND	0.056
MW-4	9/2/98	12000	ND	980	4110						
MW-4	5/25/89	9200	9800	1100	10700						
MW-4	11/18/88	11130	8916	NT	NT						
MW-4	6/3/88	8900	930	ND	ND						
MW-4	11/17/87	8500	23	NT	NT						
MW-4	5/28/87	10700	7100	NT	NT						
MW-4	12/16/86	1910	1780	4480							
MW-4	9/18/86	6650	407	140							
MW-4	6/23/86	3100	290	70	NT						
MW-4	3/26/86	11800	7500	107	ND						
MW-4	11/8/85	7460	2000								
MW-4	7/10/85	8640	1740								
MW-4	3/21/85	14810	1920								
MW-4	12/13/84	3640	4470								
MW-4	9/1/84	419	296								

Table 9 Groundwater Analytical Results - Organic Parameters

	Parameter	B	T	E	X	TOC	TOX	VOC	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
MW-5	5/28/98	ND	ND	ND	ND						
MW-5	11/17/97	ND	ND	ND	ND						
MW-5	5/23/97	ND	ND	ND	ND						
MW-5	11/20/96	ND	ND	ND	ND						
MW-5	5/31/96	ND	ND	ND	ND						
MW-5	12/7/95	ND	ND	ND	ND						
MW-5	5/22/95	ND	ND	ND	ND						
MW-5	12/21/94	ND	ND	ND	ND						
MW-5	8/3/94	ND	ND	ND	ND						
MW-5	5/25/94	ND	ND	ND	ND						
MW-5	12/13/93	ND	ND	ND	ND						
MW-5	5/14/93	ND	ND	ND	ND						
MW-5	12/11/92	ND	ND	ND	ND						
MW-5	6/9/92	ND	ND	ND	1.2						
MW-5	11/7/91	ND	ND	ND	ND						
MW-5	11/14/90	ND	ND	ND	ND	8.6					
MW-5	6/19/90	ND	ND	ND	ND	7.4					
MW-5	12/1/89	10.8	92	9.8	22.3						
MW-5	5/25/89	ND	ND	ND	ND						
MW-5	11/18/88	ND	1.86	NT	NT						
MW-5	6/3/88	ND	ND								
MW-5	11/17/87	ND	ND								
MW-5	5/28/87	ND	ND								
MW-5	12/16/86	ND	ND	ND	ND	9	ND				
MW-5	9/18/86	ND	ND	ND	ND	20					
MW-5	6/23/86	ND	ND	ND	ND	21					
MW-5	3/26/86	ND	ND	ND	ND	14					
MW-5	11/8/85	ND	ND								
MW-5	6/10/85	ND	ND								
MW-5	3/21/85	ND	ND								
MW-5	1984-85	ND	ND	ND	ND						
	MW-6 was removed										
MW-7	9/2/98	8.6	5.6	3.2	16.5						
MW-7	12/16/86	9	ND	ND	ND	2					
MW-7	9/18/86	58	6	4		4					
MW-7	6/23/86	ND	ND	ND		4					
MW-7	3/26/86	15	53	7		11					

Table 9 Groundwater Analytical Results - Organic Parameters

	Parameter	B	T	E	X	TOC	TOX	VOC	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
MW-8	5/26/95	ND	ND	ND	ND						
MW-8	8/3/94	ND		ND	ND						
MW-8	5/24/94	ND	ND	ND	ND						
MW-8	12/16/86	ND	ND	ND	ND	8	ND				
MW-8	9/18/86	ND	ND	ND	ND	8	ND				
MW-8	6/23/86	ND	ND	ND	ND	13	ND				
MW-8	3/26/86	ND	ND	107	ND	5	ND				
MW-9	11/24/98	23000	270	900		89	270				
MW-9	8/27/98	13000	2700	1000	9600			naphth			
MW-9	5/28/98	20000	360	840	5590	75	430				
MW-9	11/18/97	17000	760	830	6070	71	<5				
MW-9	5/22/97	19000	510	770	7480						
MW-9	5/31/96	14900	951	766	4125	67	34				
MW-9	12/8/95	14000	1600	ND	5590	PSH	PSH				
MW-9	6/15/95	8510	4910	747	5670						
MW-9	10/16/92	17500	700	2200	7300	48.9	35.5				
MW-9	6/10/92	15600	4800	1100	6800	97.7	49				
MW-9	2/7/92	2740	1570	610	2940	109	54.5				
MW-9	11/1/91	16200	8700	309	10820	63.3	40.75				
MW-9	12/16/86	1490	754	504	ND	275					
MW-9	9/18/86	17700	10600	15		240					
MW-9	6/23/86	4000	1700	710		180					
MW-9	3/26/86	7400	6300	3200	ND	143					

Table 9 Groundwater Analytical Results - Organic Parameters

	Parameter	B	T	E	X	TOC	TOX	VOC	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
MW-10 (AKA RW-3)											
MW-10	12/16/86	14100	7400	30	ND	114					
MW-10	9/18/86	41	54	ND	NA	125					
MW-10	6/23/86	ND	ND	ND	NA	76					
MW-10	3/26/86	93	ND	ND	ND	34					
MW-11	11/23/98	780	100	130	80						
MW-11	3/25/98	4000	ND	360	8600						
MW-11	11/20/96	4700	ND	460	9700						
MW-11	8/3/94	4600		400	7800						
MW-11	5/24/94	5000	ND	500	9400						
MW-11	9/9/88	44400	840	63	3406						
MW-11	6/3/88	3000	460								
MW-11	9/30/87	5400	ND								
MW-12	9/2/98	ND	ND	ND	ND			ND			
MW-12	3/9/98	ND	ND	ND	1.8						
MW-12	11/20/96	ND	ND	ND	ND						
MW-12	8/3/94	ND		ND	ND						
MW-12	5/24/94	ND	ND	ND	ND						
MW-12	6/3/88	ND	ND	NT	NT						
MW-12	9/30/87	ND	ND								
MW-13	8/26/98	ND	ND	ND	ND						
MW-13	8/3/94	ND		ND	ND						
MW-13	5/24/94	ND	ND	ND	ND						
MW-13	9/9/88	0.23	0.24	0.29	1.56						

Table 9 Groundwater Analytical Results - Organic Parameters

	Parameter	B	T	E	X	TOC	TOX	VOC	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
MW-20	11/23/98	34	1.9	7.1	3.4	26	220				
MW-20	9/29/98								1.5	ND	0.0064
MW-20	8/27/98	13	1.2	10	2.5			naphth			
MW-20	5/28/98	370	21	61	234	41	410				
MW-20	11/18/97	160	310	51	200	36	<5				
MW-20	5/22/97	110	18	38	ND						
MW-20	11/20/96	18	ND	4.2	ND						
MW-20	5/31/96	47	17	23	320	23	109				
MW-20	12/8/95	14	0.83	2.2	1.1						
MW-20	6/15/95	0	1	3	3						
MW-20	8/3/94	6		ND	ND						
MW-20	5/24/94	5.5	ND	ND	ND						
MW-20	12/13/93	56.3	ND	5.02	2.16						
MW-20	5/14/93	27	2	5	3	17.9	66				
MW-20	10/16/92	22	ND	5	2	15.1	29				
MW-20	6/10/92	17	3	8	12	97.8	75				
MW-20	2/7/92	201	35	11	51	21.3	41				
MW-20	11/8/91	2	ND	ND	4	19.6	37				
MW-21	11/23/98	770		200	12	38	300				
MW-21	8/27/98	25	ND	39	7						
MW-21	5/28/98	300	ND	390	ND	32	690				
MW-21	11/17/97	700	ND	170	470	26	240				
MW-21	5/22/97	450	ND	34	110						
MW-21	11/20/96	2400	ND	420	230						
MW-21	5/31/96	917	2	930	ND	21	112				
MW-21	12/8/95	490	1300	230	920						
MW-21	6/15/95	982	ND	85	2						
MW-21	8/3/94	930		170	ND						
MW-21	5/24/94	1400	ND	260	ND						
MW-21	12/13/93	253	ND	57	67						
MW-21	5/14/93	895	ND	210	117	23.8	50				
MW-21	10/16/92	3010	ND	420	90	14.9	48				
MW-21	6/10/92	1940	ND	450	630	14.6	42				
MW-21	2/7/92	10	20	5	26	12.9	51				
MW-21	11/8/91	1	ND	11	1	12.2	65				

Table 9 Groundwater Analytical Results - Organic Parameters

	Parameter	B	T	E	X	TOC	TOX	VOC	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
MW-25	8/27/98	8.9	ND	17	9.7						
MW-25	8/4/94	120		55	23						
MW-25	5/24/94	88	ND	42	81						
MW-26	8/26/98	4700	ND	680	7100			naphth			
MW-26	8/4/94	4000		880	10000						
MW-26	5/24/94	4700	ND	1100	13000						
MW-27	11/24/98	24	9.7	7.9	6.2						
MW-28	9/2/98	10000	28000	2400	24700			low			
MW-29	9/29/98								ND	ND	ND
MW-29	8/27/98	ND	ND	ND	ND						
MW-29	8/4/94	ND		ND	ND						
MW-29	5/24/94	ND	ND	ND	ND						
MW-30	11/24/98	6500	3200	2000	2500						
MW-30	8/4/94	7300	13000	2800	15800						
MW-30	5/24/94	7800	20000	3500	18700						
MW-31	9/29/98								0.14	ND	ND
MW-31	8/27/98	220	72	47	288						
MW-31	8/4/94	9500	17000	2100	15100						
MW-31	5/24/94	13000	26000	2500	23300						
MW-32	8/20/98	ND	ND	ND	ND						
MW-32	11/20/96	ND	ND	ND	ND						
MW-32	3/2/95	ND	ND	ND	ND			ND			
MW-33	8/26/98	ND	ND	ND	ND						
MW-33	11/20/96	ND	ND	ND	ND						
MW-33	3/2/95	ND	ND	ND	ND			ND			

Table 9 Groundwater Analytical Results - Organic Parameters

	Parameter	B	T	E	X	TOC	TOX	VOC	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
MW-34	9/25/98	140	8.6	22	364						
MW-34	3/9/98	170	32	20	220						
MW-34	3/2/95	300	30	ND	1300						
MW-35	3/9/98	6.1	ND	2.9	54						
MW-36	9/2/98	ND	210	56	650						
MW-36	3/9/98	ND	ND	8.8	37						
MW-37	9/29/98								3.5	ND	ND
MW-37	8/26/98	ND	ND	ND	ND						
MW-37	3/9/98	ND	ND	1.5	13						
MW-38	9/2/98	ND	ND	2.5	10.5						
MW-38	3/9/98	ND	ND	3.7	9.6						
MW-39	11/24/98	3500	16000	3400	5000						
MW-39	10/28/98	2000	7800	2200	12900						
MW-40	9/2/98	1000	890	1100	1800			naphth			
MW-43	10/27/98	5900	4600	480	3850						
MW-44	10/28/98	ND	1.1	ND	1.1						
RW-1	9/2/98	1600	ND	ND	ND						
RW-1	8/3/94	3300		ND	ND						
RW-1	5/24/94	2800	ND	80	40						
RW-1	9/9/88	6400	70	540	14800						
RW-2	9/9/88	11000	10200	2900	28800						
RW-3	8/3/94	7200	ND	950	2800						
RW-3	5/24/94	8300	ND	1100	3600						
RW-3	9/9/88	12000	62	2.86	5403						

Table 9 Groundwater Analytical Results - Organic Parameters

	Parameter	B	T	E	X	TOC	TOX	VOC	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
RW-15	11/23/98	11000	17000	2500	4300	65	300				
RW-15	5/28/98	20000	24000	4600	23720	58	760				
RW-15	11/17/97	17000	20000	3400	14000	49	78				
RW-15	5/22/97	22000	21000	3200	18700						
RW-15	11/20/96	11000	4800	660	7400						
RW-15	5/31/96	18900	24300	1840	19050	32	209				
RW-15	12/8/95	18000	22000	2500	14600						
RW-15	6/15/95	18700	28200	2870	17890						
RW-15	10/16/92	17600	2500	25200	15200	26.3	180				
RW-15	6/10/92	21700	3800	27300	20900	29.9	157				
RW-15	2/7/92	4430	3850	1540	4410	40.8	115				
RW-15	11/8/91	16100	1780	23700	18760	27.2	204				
RW-18	11/24/98	2400		5300							
RW-18	11/18/97	4700	140	1200	380000	50	180				
RW-18	5/22/97	3300	ND	700	1100						
RW-18	5/31/96	461	1070	819	5890	PSH	74				
RW-18	12/8/95	1800	170	ND	700						
RW-18	6/15/95	1810	17.4	498	94.6						
RW-18	10/16/92	4410	440	ND	370	46.9	68				
RW-18	6/10/92	4500	1800	ND	3200	88	75				
RW-18	2/7/92	1990	150	361	1401	63.6	45				
RW-18	11/8/91	3830	ND	ND	ND	48.9	40				
RW-22	8/27/98	5300	6100	920	7200						
RW-23	8/27/98	16000	4300	2600	17500			naphth			

Table 9 Groundwater Analytical Results - Organic Parameters

	Parameter	B	T	E	X	TOC	TOX	VOC	Methane	Ethylene	Ethane
	UNITS	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	mg/l	mg/l	mg/l
	PQL	0.5	0.5	0.5	0.5						
	MCL	5	1000	700	10000						
	NMWQ	10	750	750	620						
P-1	9/9/88	102200	34	1.43	866						
P-2	9/9/88	4800	1430	900	7530						
P-3	9/9/88	19400	4.35	ND	35100						
SEEP	11/20/96	5900	ND	960	8320						
SEEP	6/15/95	16.5	13.1	9.3	68.9						
SEEP	12/13/93	1620	960	198	3077						
SEEP	11/17/93	946	408	ND	2233						
SEEP	6/29/92	3000	1180	ND	6460						
SEEP MW	12/13/93	17400	28600	3910	26900						
SEEP MW	11/17/93	4200	5060	604	8200						
SEEP 1	8/27/98	1000	ND	1400	2200						
SEEP 2	8/27/98	7000	ND	880	7030						
SEEP 2	8/20/98	4700	ND	780	4990						
SEEP 3	8/27/98	3700	ND	1700	10480						
SEEP 4	9/29/98	ND	ND	ND	ND						
SEEP 5	10/28/98	20	5	5	120						

*THESE WERE SAMPLED DIFFERENTLY;
THE 8/27 VALUE IS PROBABLY MORE ACCURATE

Table 10
Bacterial Enumeration Study

Well Number	CUB (CFU/ml)	THB (CFU/ml)
MW-11	5.2×10^3	6.8×10^3
MW-26	1.1×10^4	5.1×10^4
MW-30	3.2×10^2	1.3×10^3
MW-31	4.8×10^3	7.9×10^3
MW-34	4.7×10^4	5.9×10^4

Table 11
Corrective Measure Options Screening:
San Juan River Seepage Control (Surface Water) Alternatives

Corrective Measure Option	Compatible With -		Technical Limitations?	Retain? (Yes/No)	Comments
	Site	COC's			
Dewater Pumping	N	Y	Y	No	Alluvium is hydraulically connected to the San Juan River
Grount Curtain or Sheet Piling	Y	Y	N	Yes	Immediate short-term results
Air Curtain	Y	Y	Y	No	Addresses dissolved hydrocarbons in alluvium, no immediate improvement
Intercepter Trench	N	Y	Y	No	Infiltration from San Juan River would required excessive pumping.
Pumping to Reverse Gradient	N	Y	Y	No	Infiltration from San Juan River would required excessive pumping.
Clean Water Curtain Injection	N	Y	Y	No	Technically complicated, Would increase water costs or compete with refinery processes for water allocation.
SVE & IAS Source Removal	Y	Y	Y	No	Addresses hydrocarbons in alluvium, no immediate improvement in river
Enhanced In-Situ Bioremediation	Y	Y	Y	No	Addresses hydrocarbons in alluvium, no immediate improvement in river
No Action/Natural Attenuation and Monitoring	Y	Y	Y	No	Addresses hydrocarbons in alluvium, no immediate improvement in river

Table 12
Corrective Measure Options Screening: Separate-Phase Hydrocarbon Recovery Alternatives

Corrective Measure Option	Compatible With -		Technical Limitations?	Retain? (Yes/No)	Comments
	Site	COC's			
Skimming Pumps	Y	Y	N	No	Limited radius of influence would require many wells and a long time.
Dual Pump System (Groundwater & SPH)	Y	Y	N	No	No need to pump SPH and water separately because the refinery waste water treatment plant has an O/W separator.
Soil Vapor Extraction (SVE)	Y	Y	N	Yes	Pilot testing shows SVE to be feasible.
SVE and In-Situ Air Sparging (IAS)	Y	Y	Y	Yes	The thin saturated thickness would require many IAS points, but enhanced volatilization will reduce treatment time.
High-Vacuum Dual Phase Extraction	N	Y	Y	No	Thickness of saturated zone may require excessive pumping, would increase amount of water to be disposed through injection well - very expensive
Total Fluids Pumping	Y	Y	N	Yes	Already being implemented.
Water Table Depression and SVE	Y	Y	Y	Yes	Infiltration from Hammond Ditch and other Refinery sources would require excessive pumping, but increased surface area would enhance SVE.
No Action/Natural Attenuation and Monitoring	Y	Y	N	Yes	NMED generally requires removal of all measureable SPH, may not be permissable as stand alone remedy. Would require decades to remove all SPH.

Table 13
Corrective Measure Options Screening: Soil Abatement (Sorbed COCs in Unsaturated Zone) Alternatives

Corrective Measure Option	Compatible With -		Technical Limitations?	Retain? (Yes/No)	Comments
	Site	COC's			
Soil Vapor Extraction (SVE)	Y	Y	N	Yes	Pilot testing shows that SVE is feasible, relatively short abatement time
Bioventing	Y	Y	N	No	Difficult access in refinery area, further subsurface investigation required
Excavation & Disposal/ Ex-Situ Treatment	N	Y	N	No	Refinery building and tanks make area inaccesible, disposal is costly, increased exposure with ex-situ treatment
In-Situ Soil Washing	N	N	Y	No	Not compatible with constituents of concern and soils properties
Chemical Fixation/Stabilization	N	N	Y	No	Not compatible with constituents of concern and soils properties
Vitrification	N	N	Y	No	Not compatible with constituents of concern and soils properties
Steam-Injection Stripping	Y	Y	N	No	Constituents are volatile enough at ambient temperatures, no added benefit.
Enhanced Bioremediation	Y	Y	Y	No	Difficult to uniformly distribut nutrients in soil, may be other limiting factors, increased monitoring burden
No Action/Natural Attenuation and Monitoring	Y	Y	N	Yes	Historic data demonstrates effective natural attenuation is already occurring, long time frame required

Table 14
Corrective Measure Options Screening:
Groundwater Abatement (Dissolved-Phase COCs in Saturated Zone) Alternatives

Corrective Measure Option	Compatible With -		Technical Limitations?	Retain? (Yes/No)	Comments
	Site	COC's			
Altered Water Mgmt. Practices (decrease leakage from ponds)	N	Y	Y	No	Lining pond would create silting problem as material settles out, leakage allows TDS to remain relatively constant, lining ponds allows less throughput limiting refinery operations
Pump, Treat & Reinject Groundwater	Y	Y	Y	No	Not viable until SPH removal is complete.
Pump, Treat & Reinfiltrate Groundwater	N	Y	Y	No	Would require large infiltration gallery, not viable until SPHremoval is complete.
Geo-Cleanse	N	Y	Y	No	Not recommended for use with SPH thicker than 6", access in Refinery area may be difficult
In-Situ Air Sparging (IAS)	Y	Y	N	Yes	Thin saturated zone will require many IAS points, pilot tests show IAS to be feasible, relatively short abatement period, high maintenance.
Enhanced In-Situ Bioremediation	Y	Y	N	Yes	Injection of nutrients will enhance in-situ biodegradation of hydrocarbons, increased monitoring burden nutrient addition may be difficult to calibrate, low maintenance
Contaminant Source Removal/Natural Attenuation	Y	Y	N	Yes	Contributes to all abatement objectives, natural attenuation will proceed more rapidly once SPH is reduced
No Action/Natural Attenuation and Monitoring	Y	Y	N	Yes	Historic data show natural attenuation is already occurring at the site, long abatement period required, low maintenance

Table 15
Evaluation of Corrective Measure Alternatives:
Seepage Control to San Juan River (Surface Water)

Corrective Measure Alternative		Sheet Piling	SVE & IAS Source Removal	Enhanced In-Situ Bioremediation	No Action/ Natural Attenuation & Monitoring
Technical					
	Performance	1	0	1	0
	Reliability	0	-1	-1	0
	Implementability	1	-1	-1	0
	Total	2	-2	-1	0
	Importance Factor	2	2	2	2
	Overall Rating	4	-4	-2	0
Environmental					
	Rating	1	1	-1	0
	Importance Factor	3	3	3	3
	Overall Rating	3	3	-3	0
Human Health					
	Rating	1	0	0	0
	Importance Factor	3	3	3	3
	Overall Rating	3	0	0	0
Institutional					
	Rating	0	-1	-1	0
	Importance Factor	1	1	1	1
	Overall Rating	0	-1	-1	0
Estimated Cost					
	Rating	-1	-1	-1	0
	Importance Factor	1	1	1	1
	Overall Rating	-1	-1	-1	0
Total Rating		9	-3	-7	0

Table 16
Evaluation of Corrective Measure Alternatives:
Abatement of Separate-Phase Hydrocarbon (SPH) in Unsaturated Zone

Corrective Measure Alternative		SVE	SVE & IAS	Total Fluids Pumping	Water Table Depression and SVE	No Action/ Natural Attenuation & Monitoring
Technical						
	Performance	1	1	1	1	0
	Reliability	-1	-1	-1	-1	0
	Implementability	-1	-1	0	-1	0
	Total	-1	-1	0	-1	0
	Importance Factor	2	2	2	2	2
	Overall Rating	-2	-2	0	-2	0
Environmental						
	Rating	-1	-1	-1	-1	0
	Importance Factor	3	3	3	3	3
	Overall Rating	-3	-3	-3	-3	0
Human Health						
	Rating	0	0	0	-1	0
	Importance Factor	3	3	3	3	3
	Overall Rating	0	0	0	-3	0
Institutional						
	Rating	0	0	1	0	0
	Importance Factor	1	1	1	1	1
	Overall Rating	0	0	1	0	0
Estimated Cost						
	Rating	-1	-1	-1	-1	0
	Importance Factor	1	1	1	1	1
	Overall Rating	-1	-1	-1	-1	0
Total Rating		-6	-6	-3	-9	0

Table 17
Evaluation of Corrective Measure Alternatives:
Abatement of Sorbed COCs in Unsaturated Zone (Soil Remediation)

Corrective Measure Alternative		SVE	No Action/ Natural Attenuation & Monitoring
Technical			
	Performance	1	0
	Reliability	-1	0
	Implementability	-1	0
	Total	-1	0
	Importance Factor	2	2
	Overall Rating	-2	0
Environmental			
	Rating	-1	0
	Importance Factor	3	3
	Overall Rating	-3	0
Human Health			
	Rating	0	0
	Importance Factor	3	3
	Overall Rating	0	0
Institutional			
	Rating	0	0
	Importance Factor	1	1
	Overall Rating	0	0
Estimated Cost			
	Rating	-1	0
	Importance Factor	1	1
	Overall Rating	-1	0
Total Rating		-6	0

Table 18

Evaluation of Corrective Measure Alternatives:

Abatement of Dissolved-Phase COCs in Saturated Zone

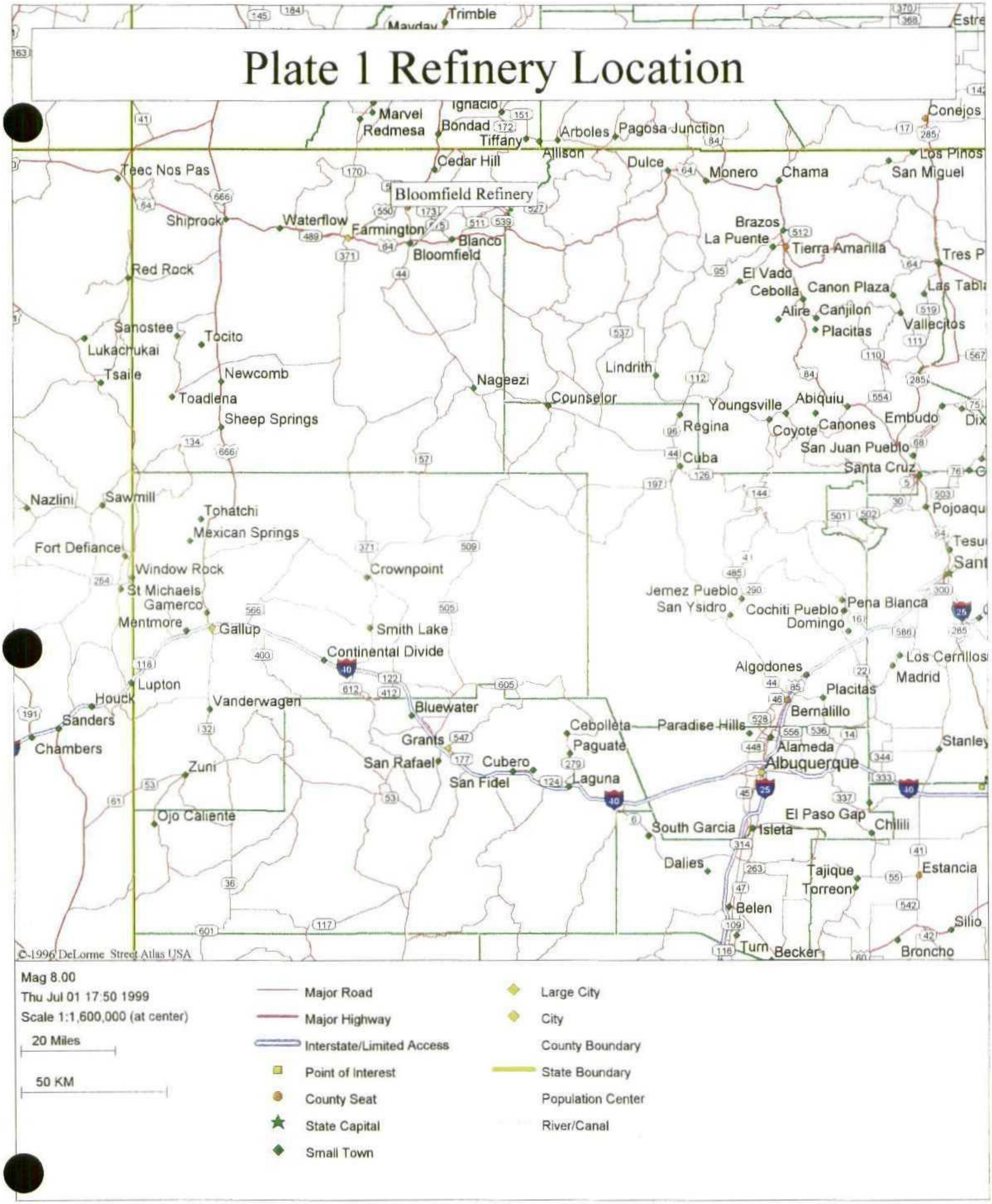
Corrective Measure Alternative		SVE & IAS	Enhanced In-Situ Bioremediation	Source Removal/Natural Attenuation	No Action/ Natural Attenuation & Monitoring
Technical					
	Performance	1	1	1	0
	Reliability	-1	-1	-1	0
	Implementability	-1	-1	0	0
	Total	-1	-1	0	0
	Importance Factor	2	2	2	2
	Overall Rating	-2	-2	0	0
Environmental					
	Rating	-1	-1	-1	0
	Importance Factor	3	3	3	3
	Overall Rating	-3	-3	-3	0
Human Health					
	Rating	0	0	0	0
	Importance Factor	3	3	3	3
	Overall Rating	0	0	0	0
Institutional					
	Rating	0	-1	1	0
	Importance Factor	1	1	1	1
	Overall Rating	0	-1	1	0
Estimated Cost					
	Rating	-1	-1	-1	0
	Importance Factor	1	1	1	1
	Overall Rating	-1	-1	-1	0
Total Rating		-6	-7	-3	0

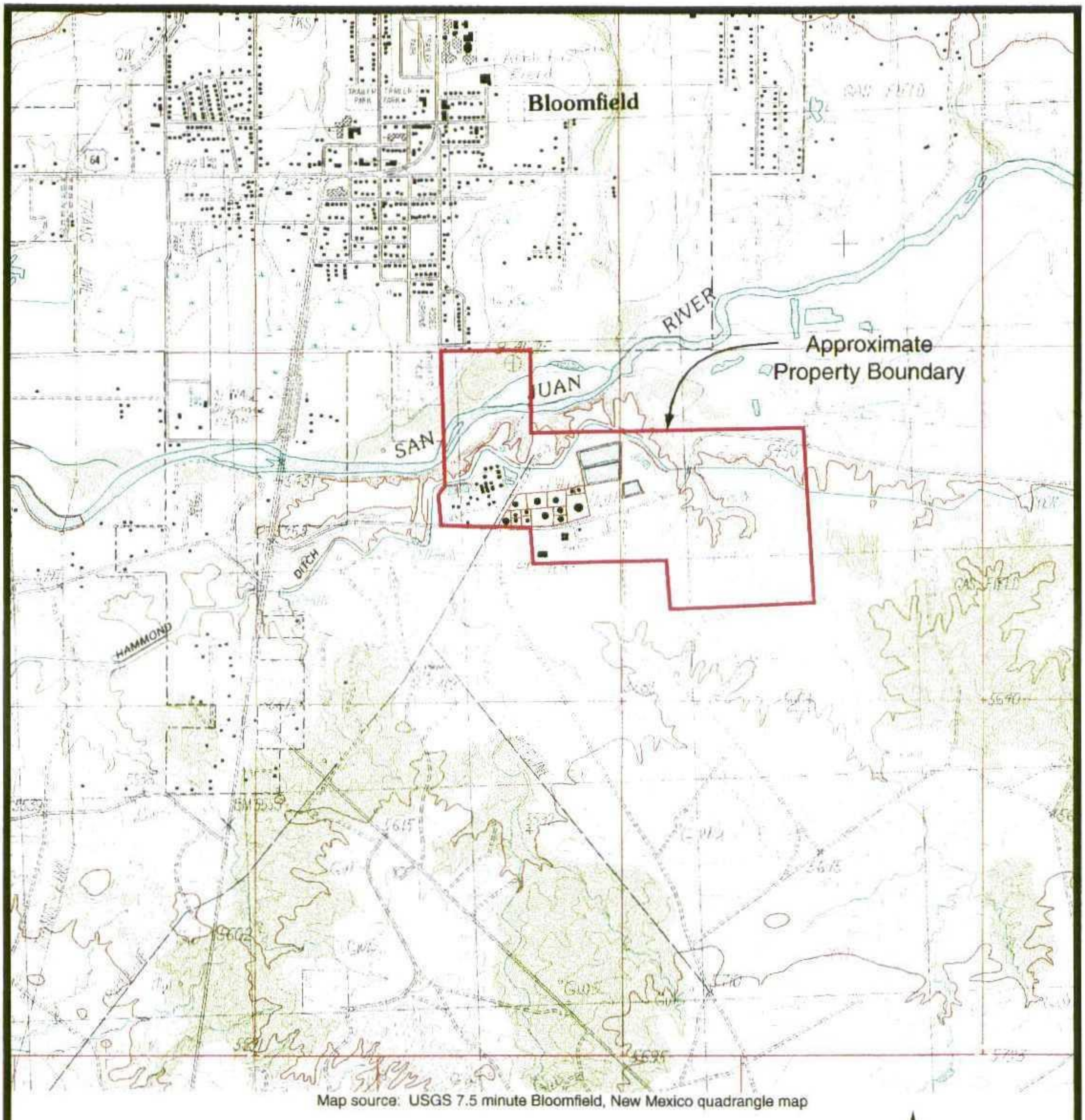
Table 19
Relative Weighting for Evaluation Critera

Criteria	Weighting Factor	Rationale
Technical	2	Performance and reliability determine effectiveness of method, time required for remediation and probability of exposure through new pathways.
Environmental	3	Purpose of remediation is to reduce/prevent exposure to natural environment. Proximity of San Juan River creates sensitive natural environment near release site.
Human Health	3	Proximity to town of Bloomfield and number of employees at Refinery make protection of human health extremely important.
Institutional	1	Relative popularity with regulators is unimportant as long as method is approved. Community opinion of the Refinery is already very high; choice of method will have little influence on this.
Cost Estimate	1	Method should be cost effective, but all measures will be expensive due to long cleanup time; more costly method may be most protective.

PLATES

Plate 1 Refinery Location





Map source: USGS 7.5 minute Bloomfield, New Mexico quadrangle map

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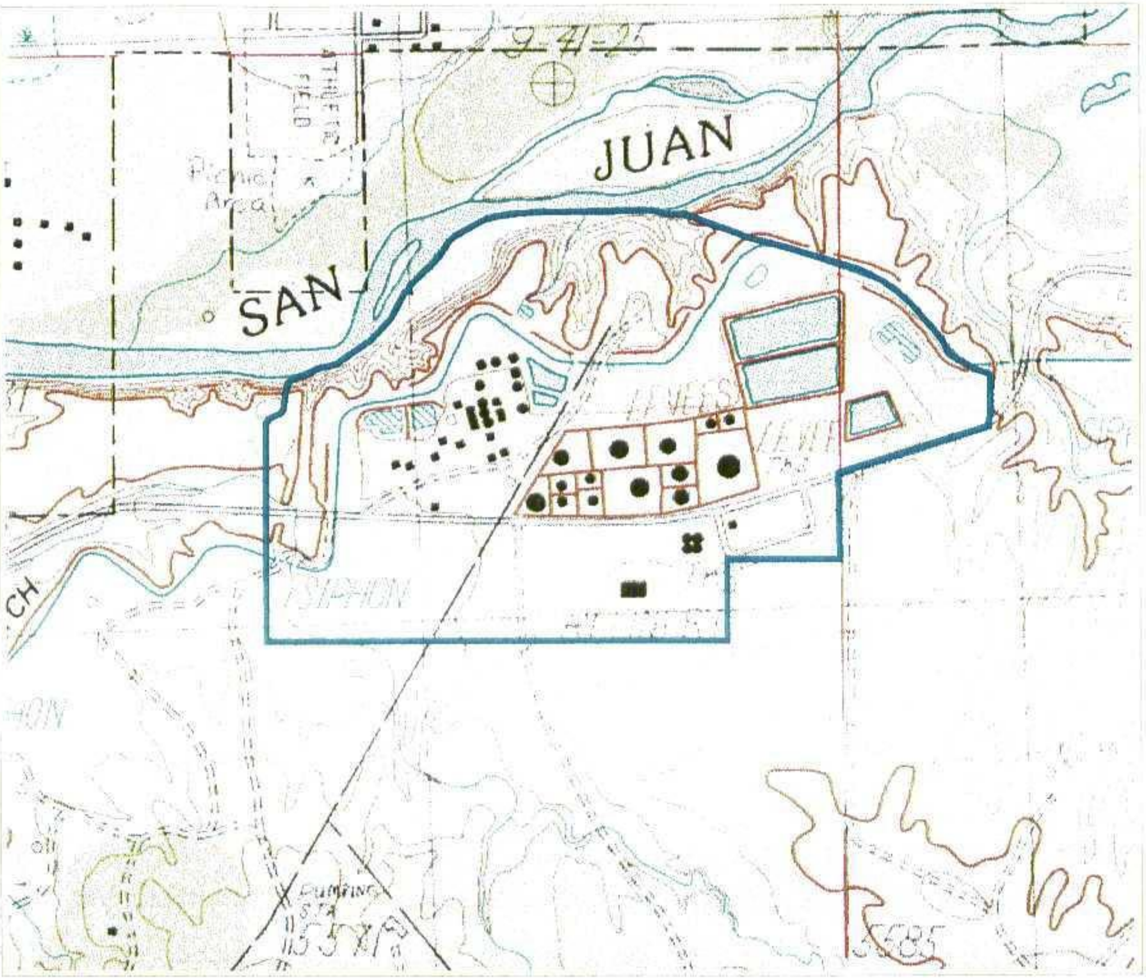
Bloomfield Refinery

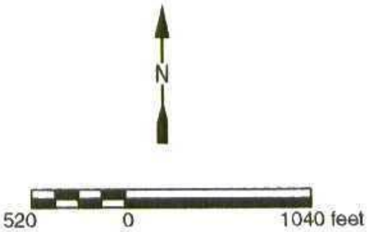
Location of Bloomfield Refinery

Plate 2

June, 1999



Map source: USGS 7.5 minute Bloomfield, New Mexico quadrangle map



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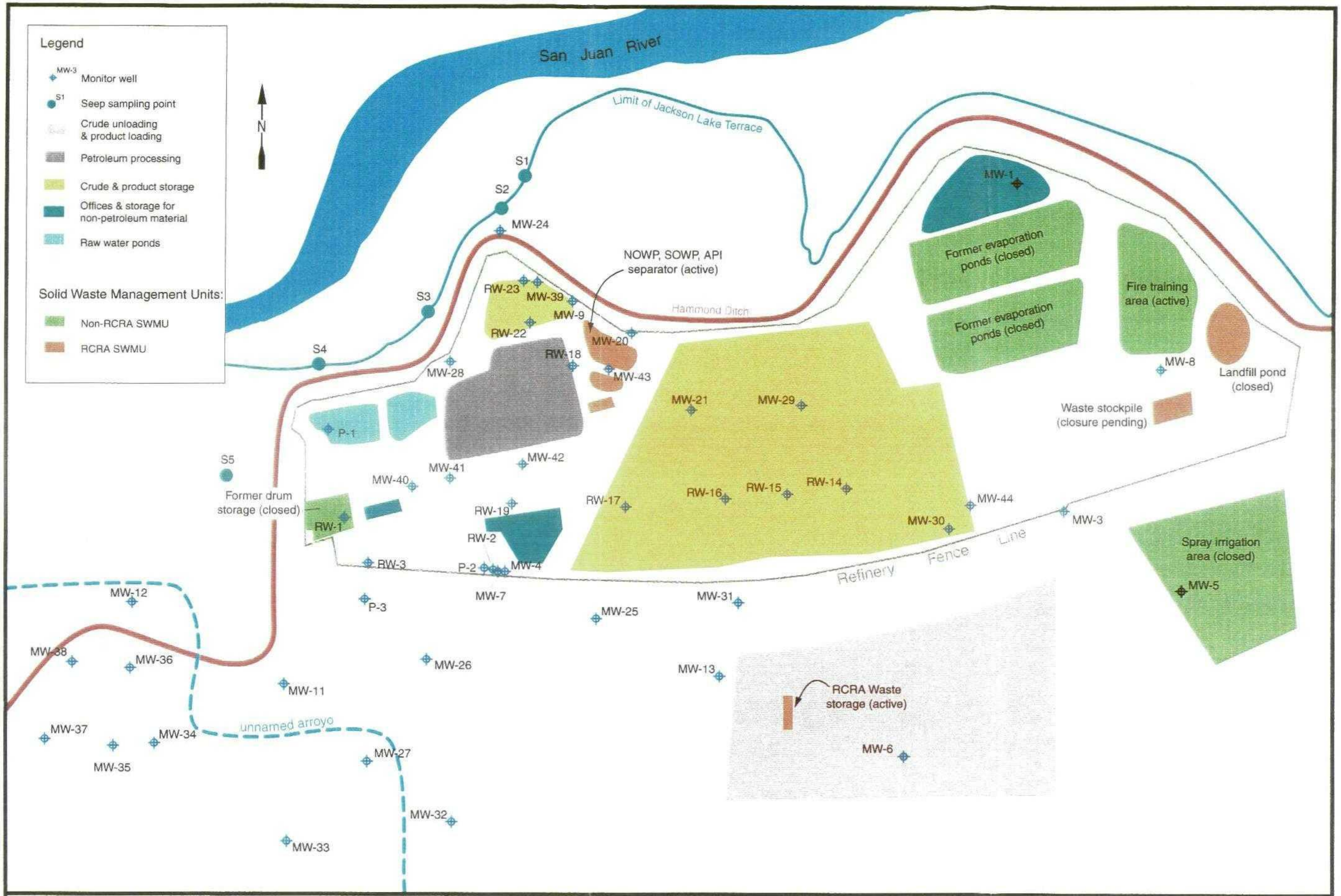
Bloomfield Refinrey	Plate 3
Bloomfield Refinery Study Area	June, 1999



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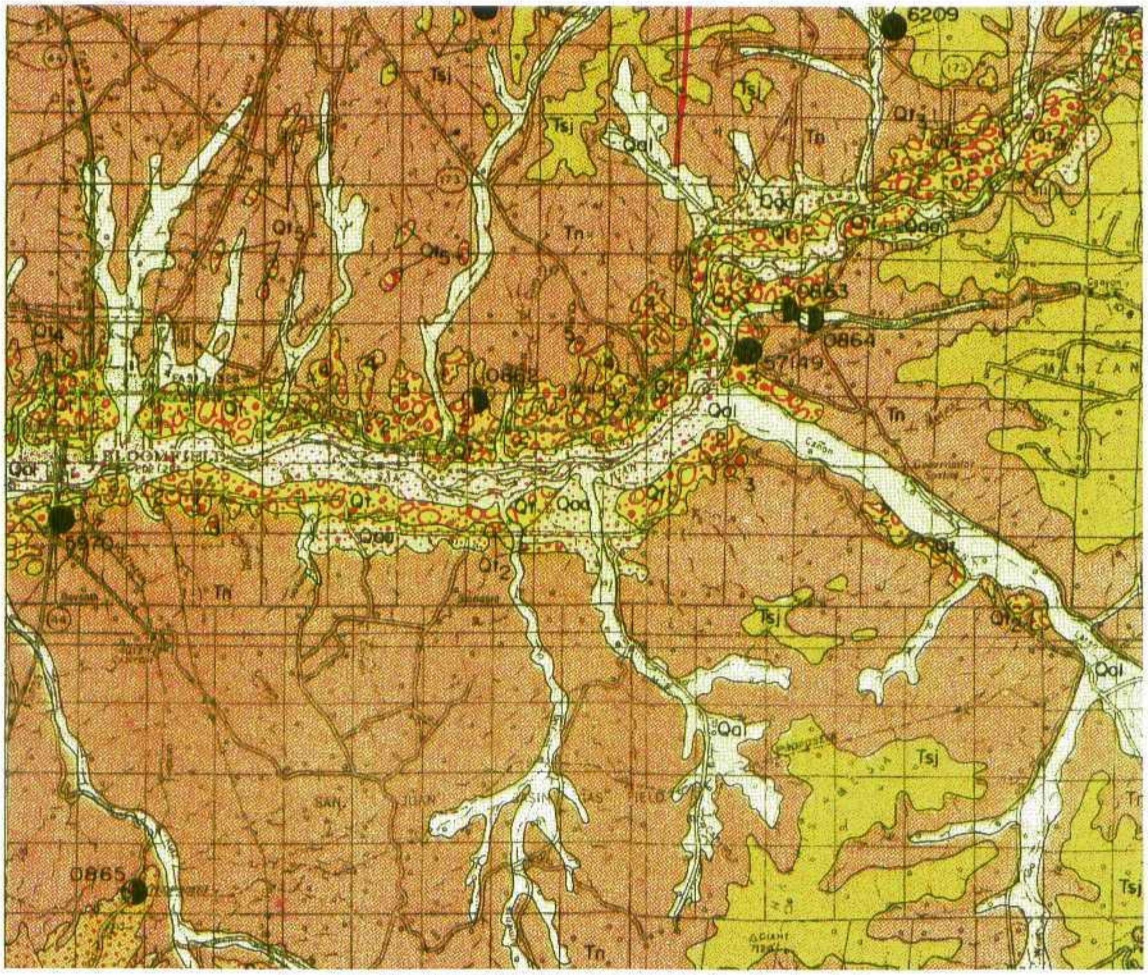
Giant Refining Company

Possible Petroleum Hydrocarbon Source Areas
Northern Portion Study Area

Plate 4

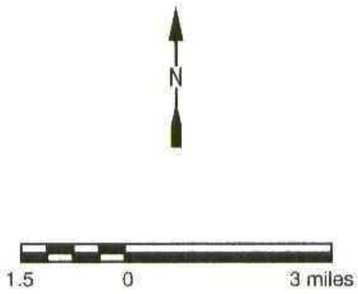
November 2, 1998



Map source: New Mexico State Highway Department Aztec Quadrangle Map

Legend

Qal	Alluvium
Qaa	Alluvial apron deposits typically adjacent to cliffs along River
Qt	Post-glacial terrace deposits
Qt 2	Jackson Lake terrace deposits
Qt 3	Late Bull Lake terrace deposits
Qt 4	Early Bull Lake terrace deposits
Qt 5	Pre-Wisconsin terrace deposits
Tn	Nacimiento Formation



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Bloomfield Refinrey

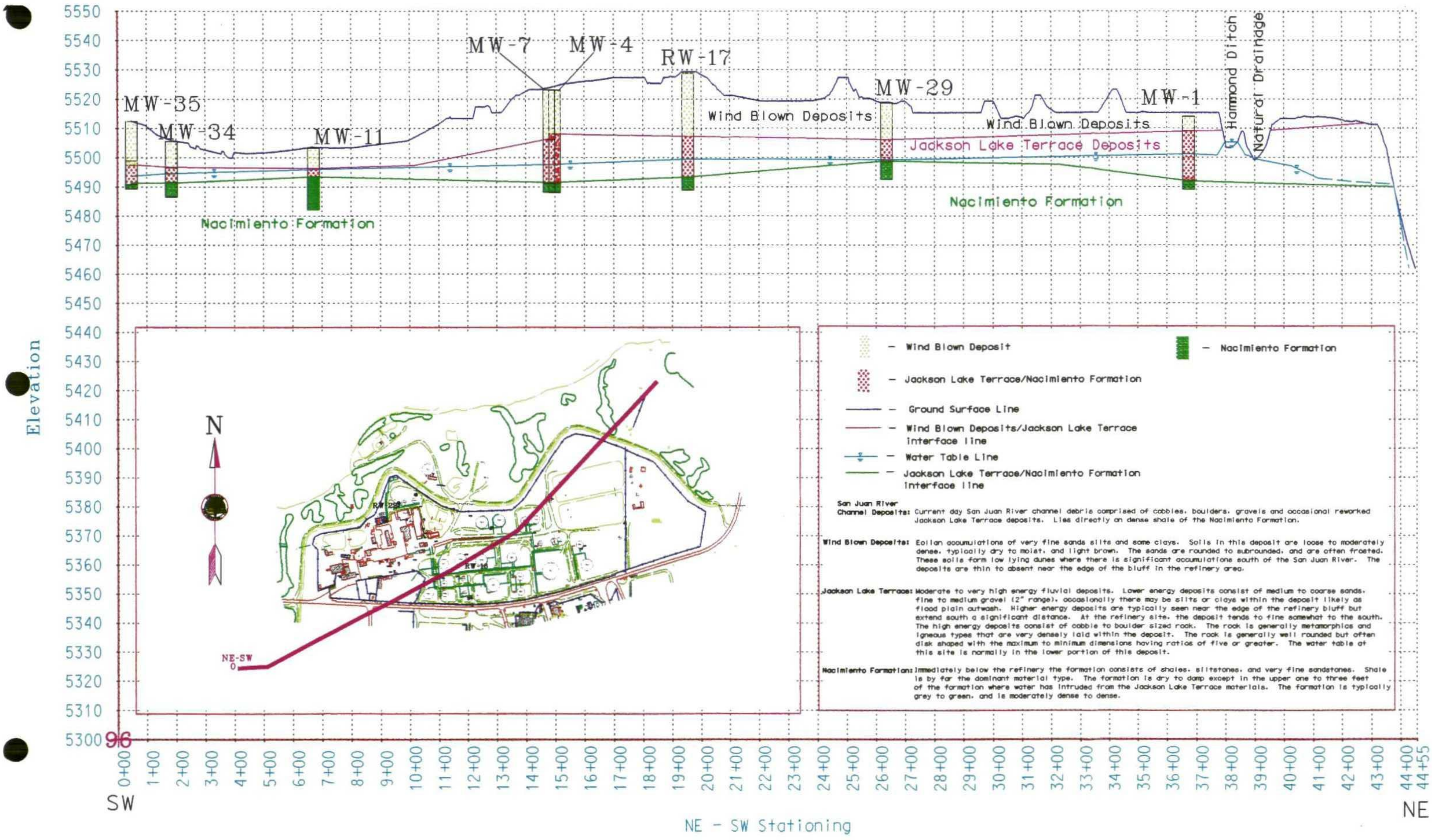
Plate 5

Surface Geology Map

June, 1999

PLATE 6

NE-SW Profile Bloomfield Refinery



San Juan River Channel Deposits: Current day San Juan River channel debris comprised of cobbles, boulders, gravels and occasional reworked Jackson Lake Terrace deposits. Lies directly on dense shale of the Nacimiento Formation.

Wind Blown Deposits: Eolian accumulations of very fine sands silts and some clays. Soils in this deposit are loose to moderately dense, typically dry to moist, and light brown. The sands are rounded to subrounded, and are often frosted. These soils form low lying dunes where there is significant accumulations south of the San Juan River. The deposits are thin to absent near the edge of the bluff in the refinery area.

Jackson Lake Terrace: Moderate to very high energy fluvial deposits. Lower energy deposits consist of medium to coarse sands, fine to medium gravel (2" range), occasionally there may be silts or clays within the deposit likely as flood plain outwash. Higher energy deposits are typically seen near the edge of the refinery bluff but extend south a significant distance. At the refinery site, the deposit tends to fine somewhat to the south. The high energy deposits consist of cobble to boulder sized rock. The rock is generally metamorphics and igneous types that are very densely laid within the deposit. The rock is generally well rounded but often disk shaped with the maximum to minimum dimensions having ratios of five or greater. The water table at this site is normally in the lower portion of this deposit.

Nacimiento Formation: Immediately below the refinery the formation consists of shales, siltstones, and very fine sandstones. Shale is by far the dominant material type. The formation is dry to damp except in the upper one to three feet of the formation where water has intruded from the Jackson Lake Terrace materials. The formation is typically grey to green, and is moderately dense to dense.

PLATE 7

N-S Profile Bloomfield Refinery

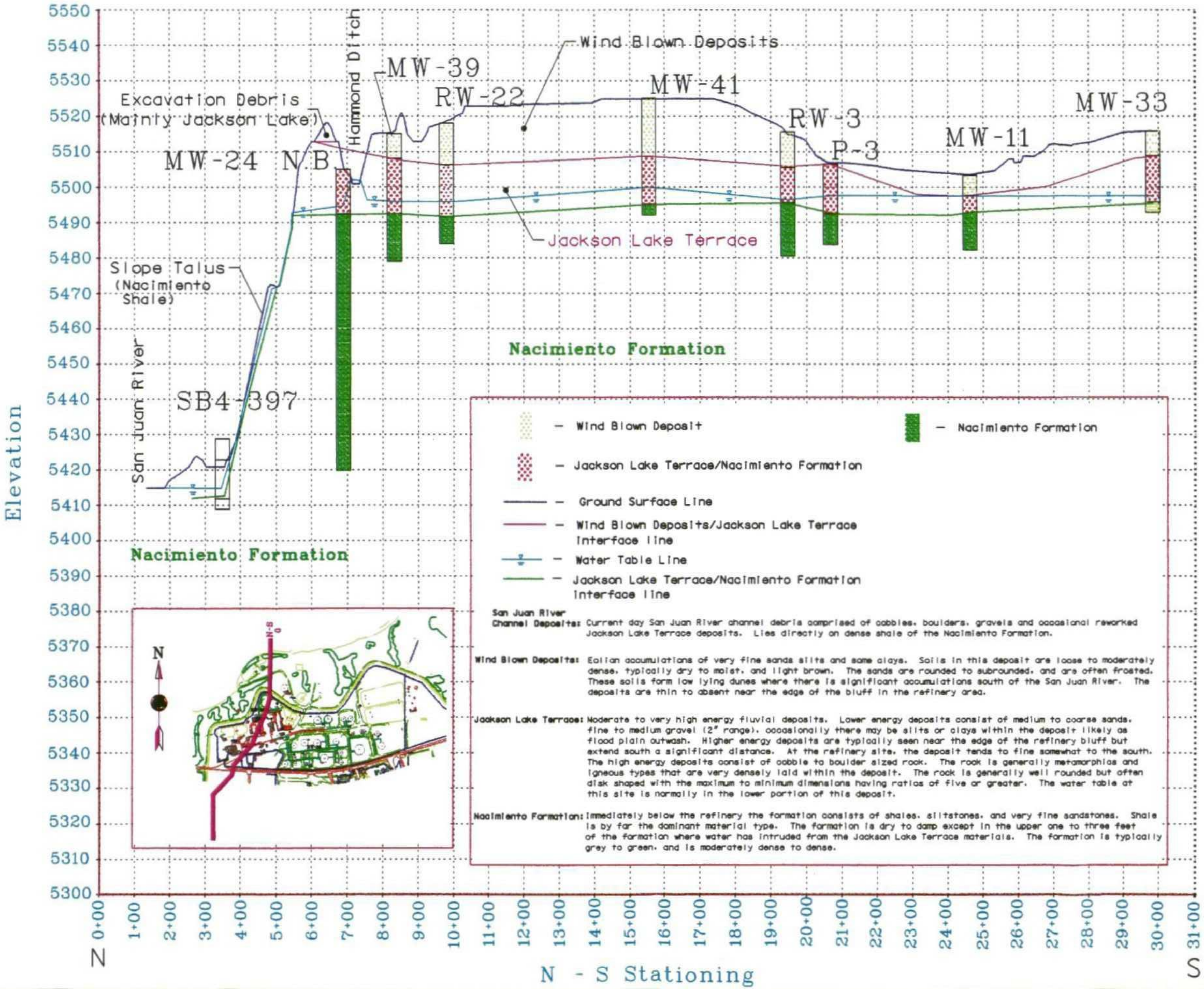


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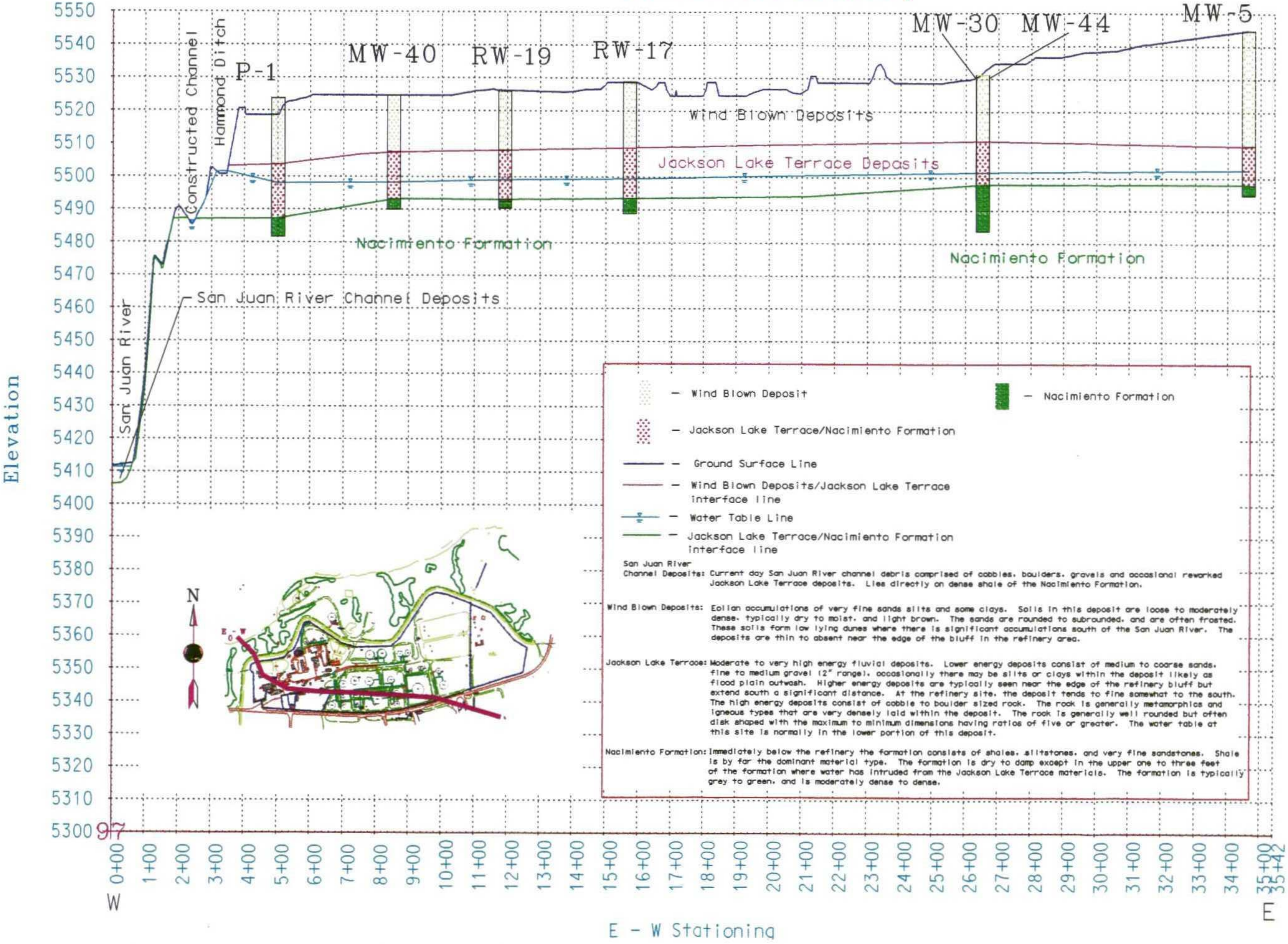
PLATE 8

E-W Profile Bloomfield Refinery



▨ – Wind Blown Deposit

▨ – Jackson Lake Terrace/Nacimiento Formation

🟩 – Nacimiento Formation

– Ground Surface Line

– Wind Blown Deposits/Jackson Lake Terrace interface line

– Water Table Line

– Jackson Lake Terrace/Nacimiento Formation interface line

San Juan River Channel Deposits: Current day San Juan River channel debris comprised of cobbles, boulders, gravels and occasional reworked Jackson Lake Terrace deposits. Lies directly on dense shale of the Nacimiento Formation.

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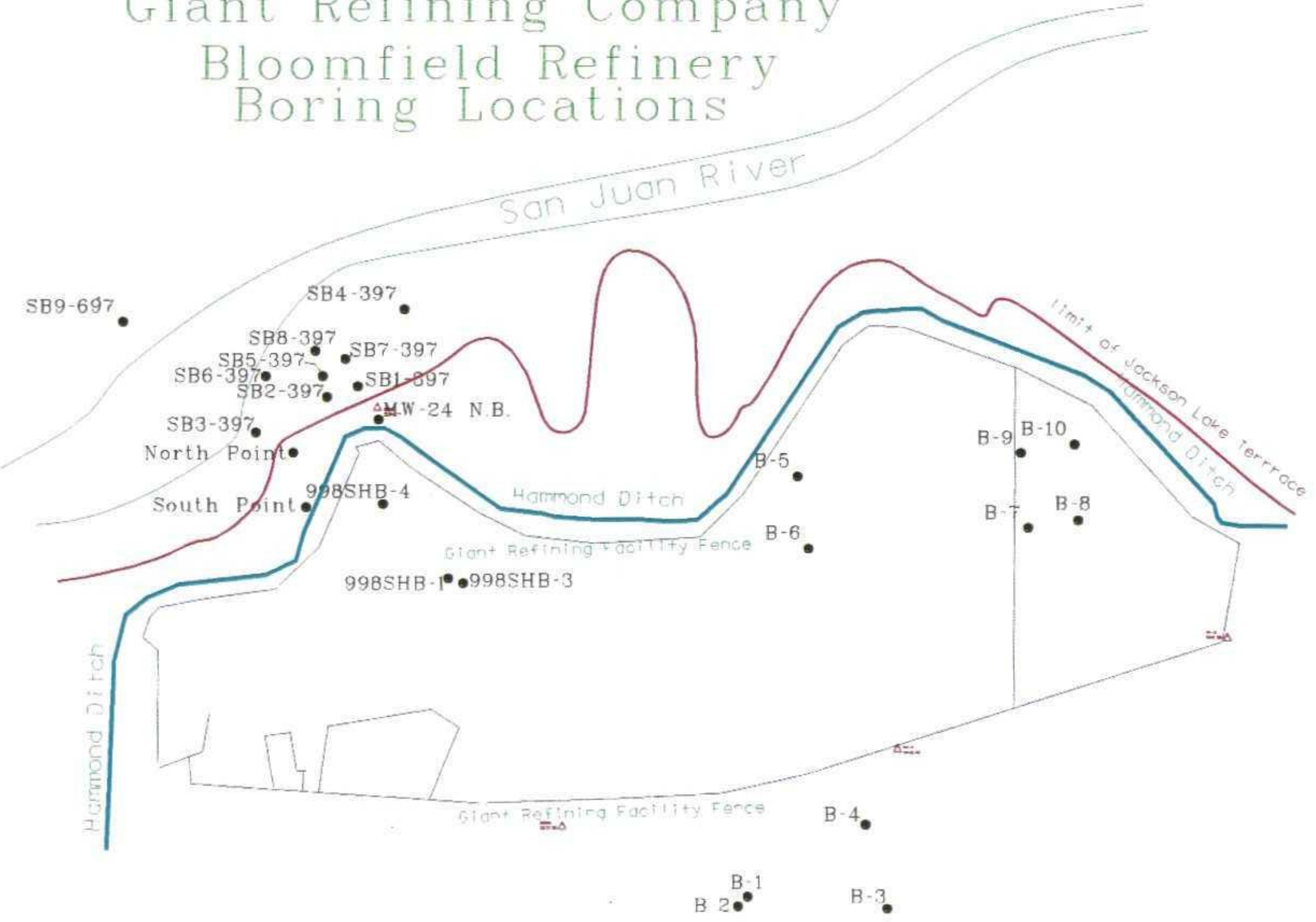
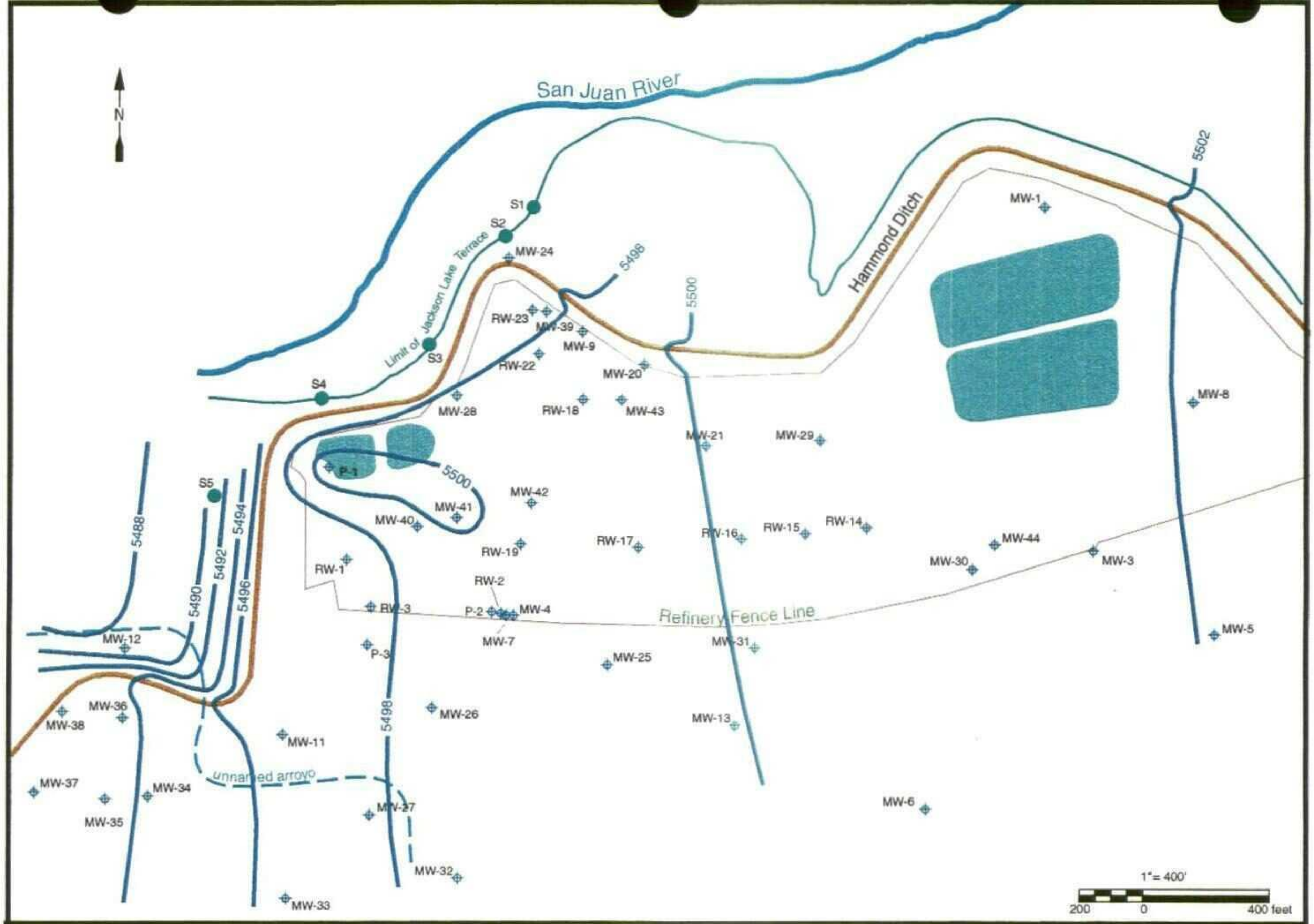
R.T. HICKS CONSULTANTS, LTD. 4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Bloomfield Refinery	Plate 9
	Top of Nacimiento Elevation Map	June 1999

Plate 10

Giant Refining Company
Bloomfield Refinery
Boring Locations





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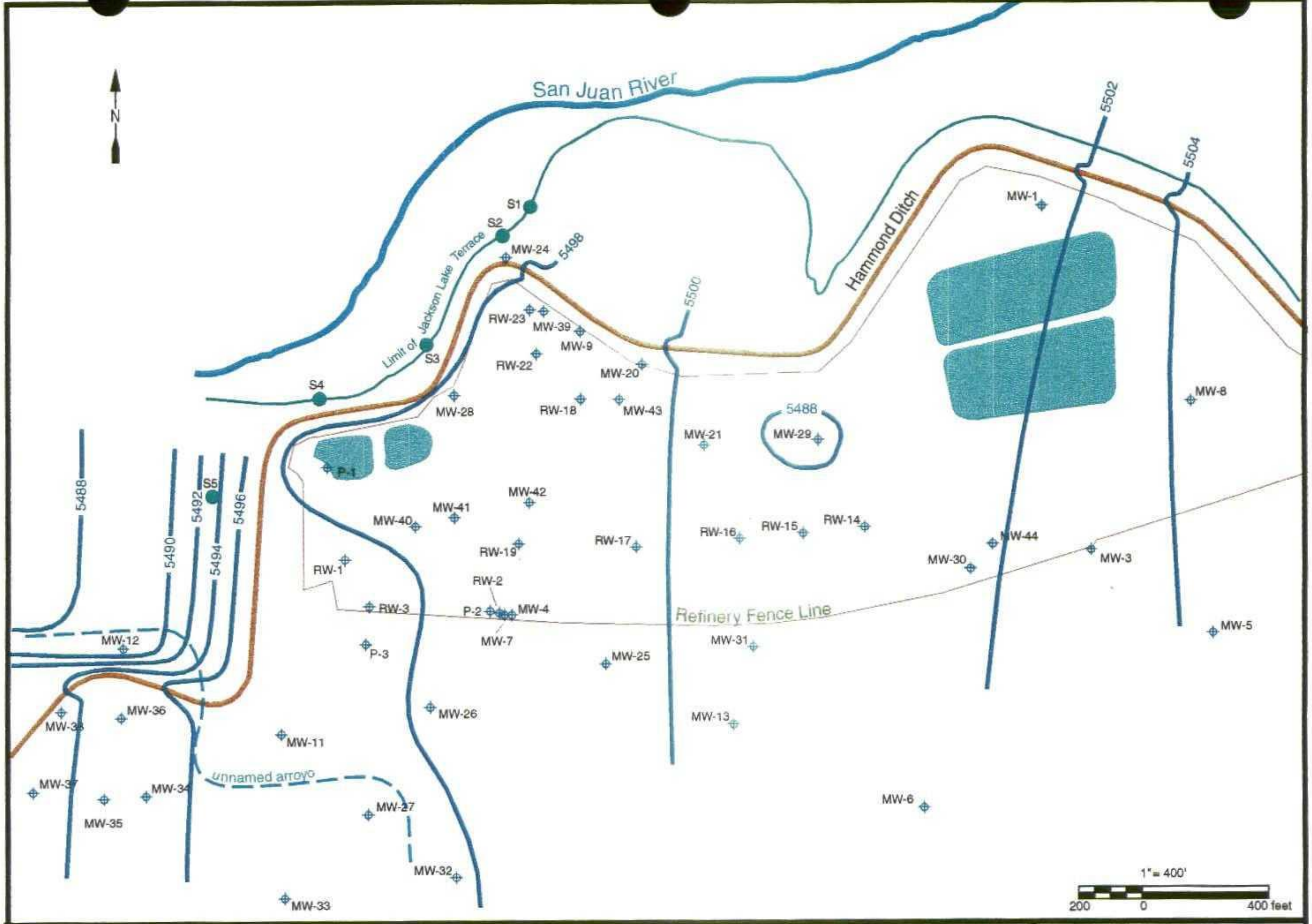
Bloomfield Refinery	Plate 11
April 1999 Potentiometric Surface Map	June 1999



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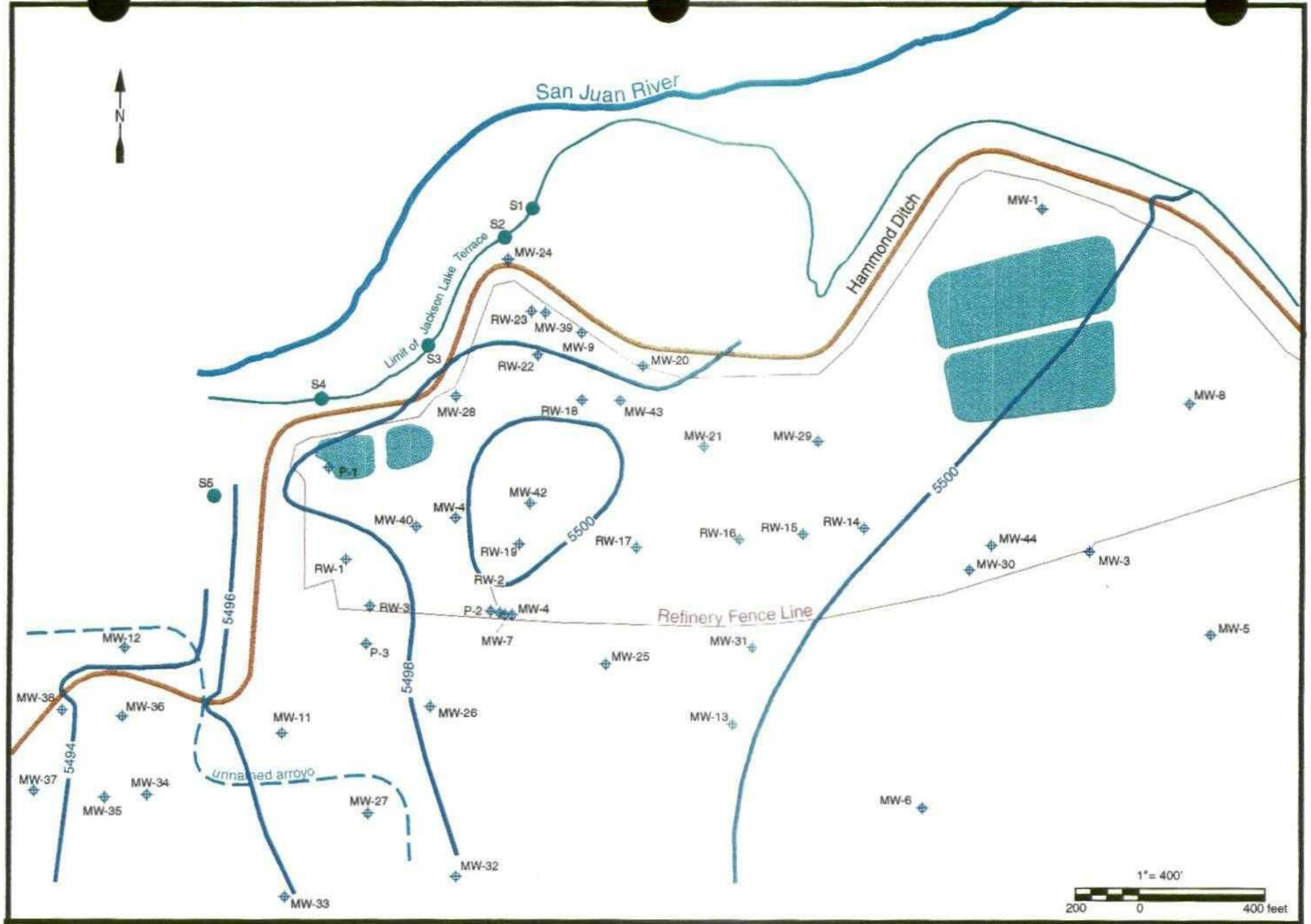
	October 1998 Potentiometric Surface Map	June 1999



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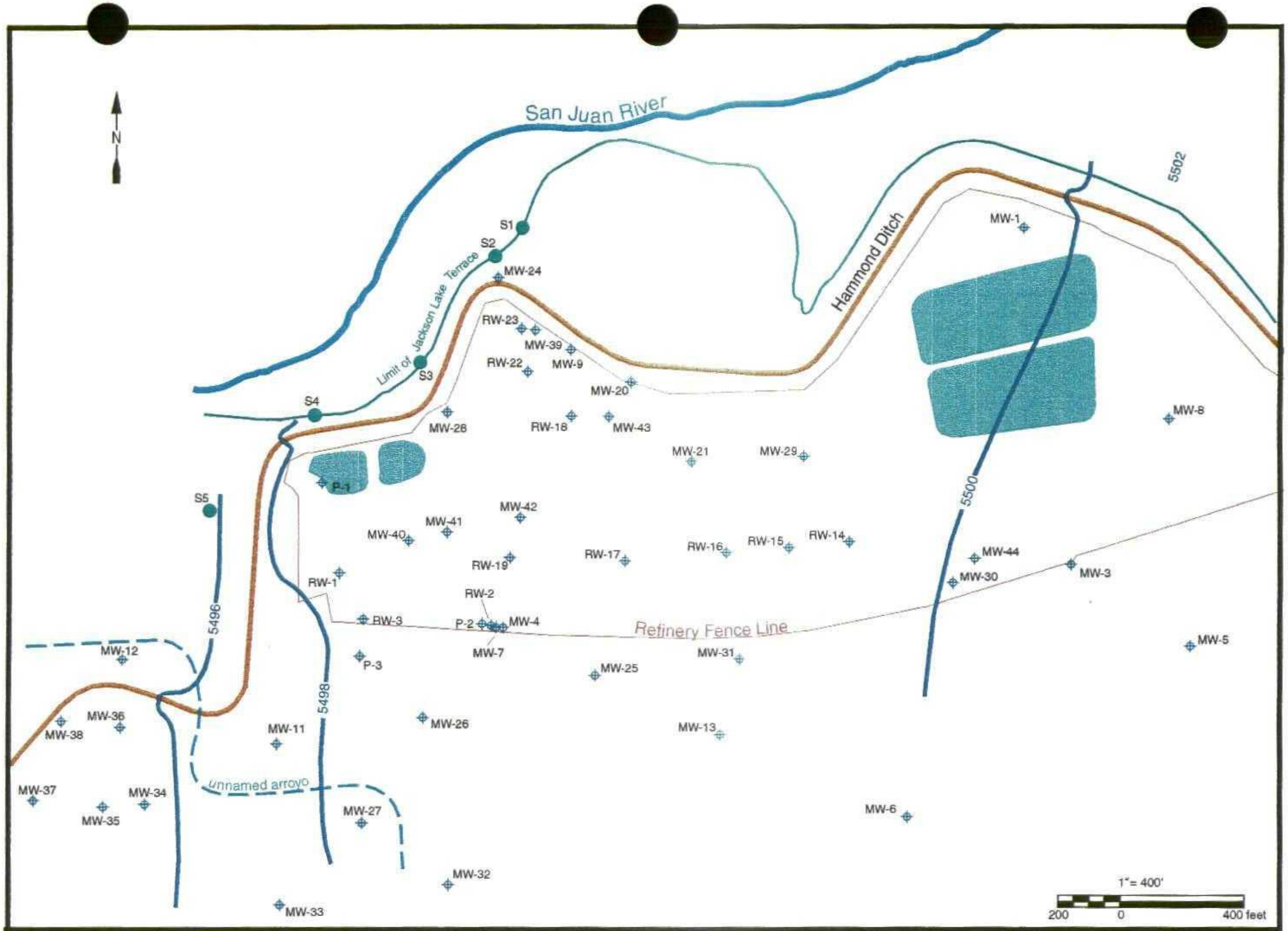
Bloomfield Refinery

March 1995 Potentiometric Surface Map

Plate 13

June 1999



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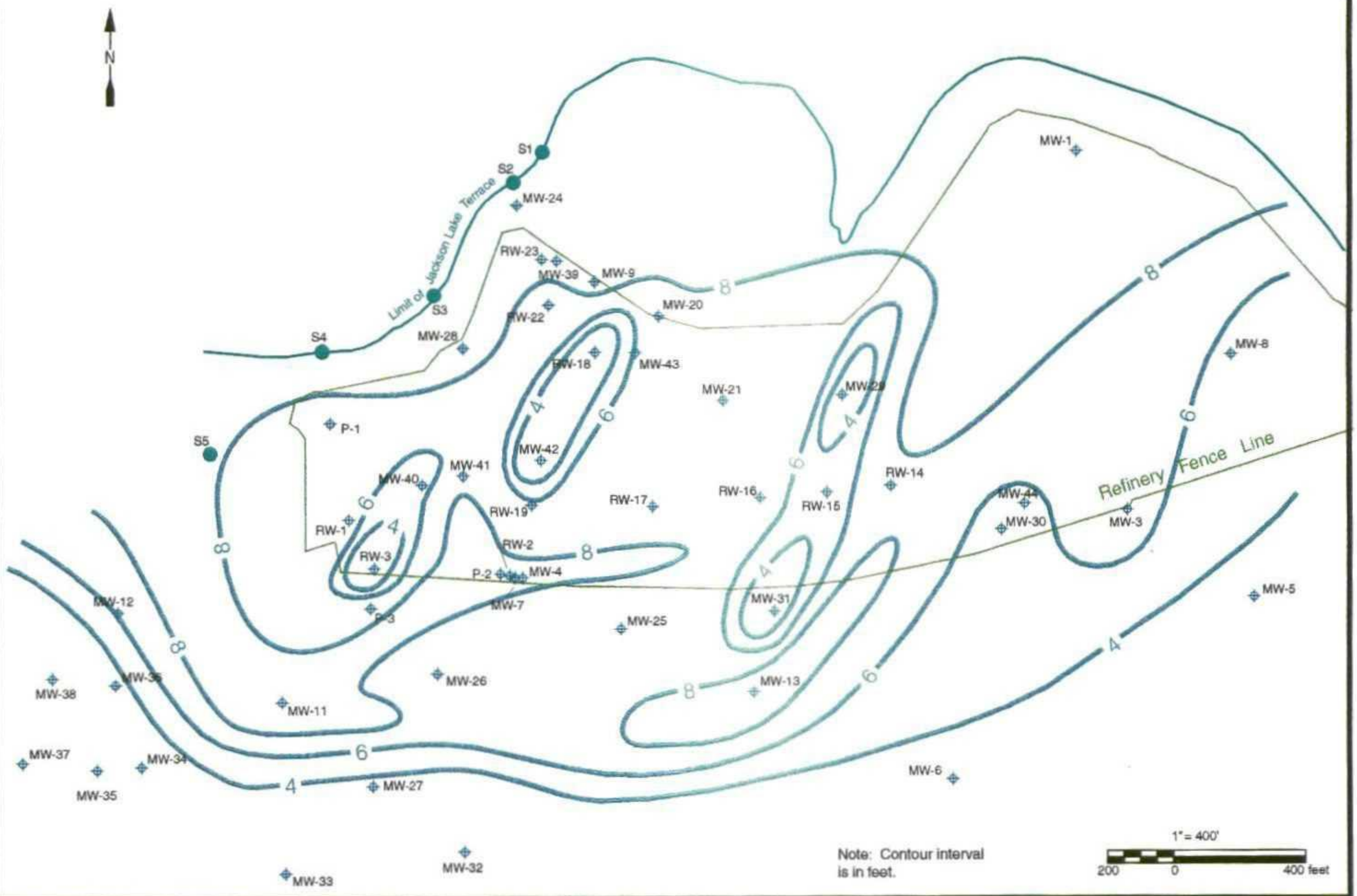
Bloomfield Refinery

October 1986 Potentiometric Surface Map

Plate 14

June 1999



Note: Contour interval
is in feet.

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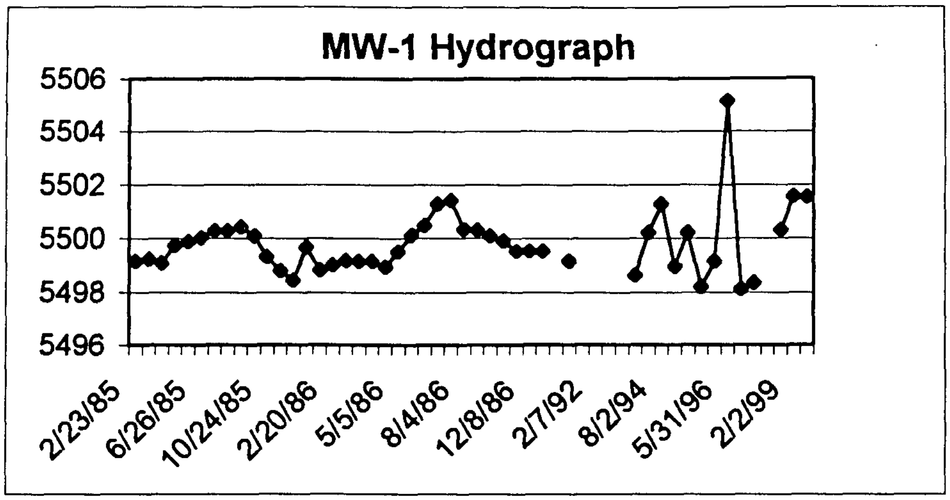
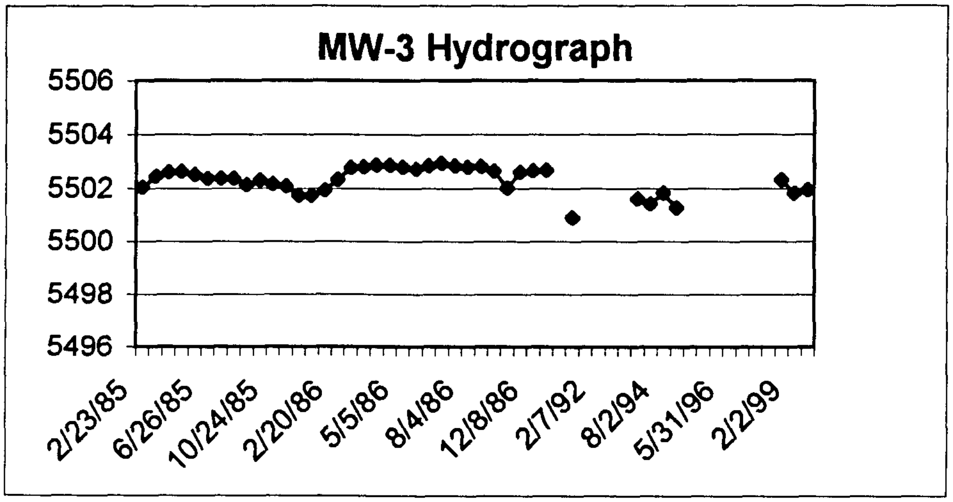
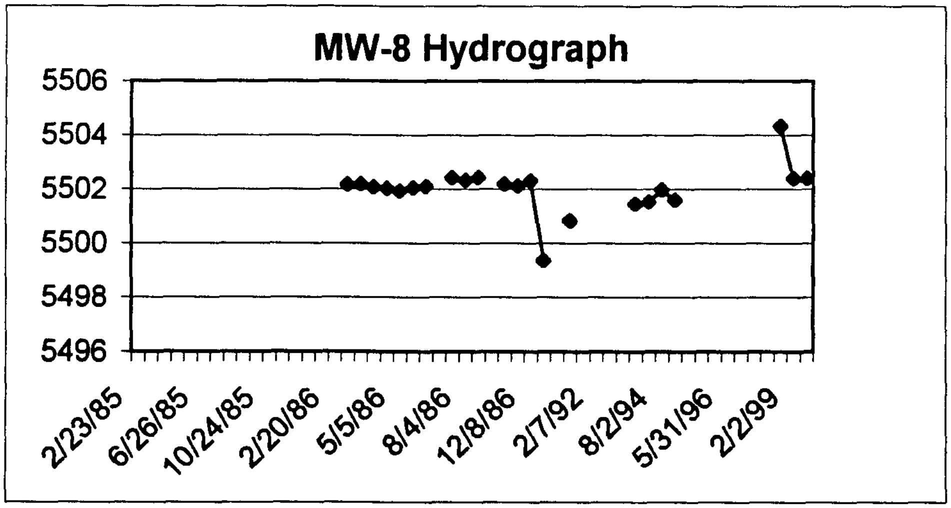
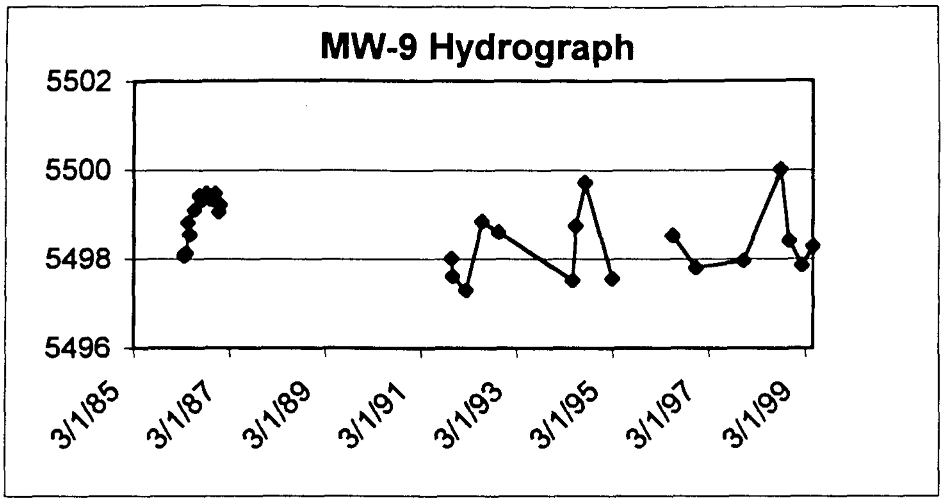
	Saturated Thickness of the Jackson Lake Terrace	June 1999

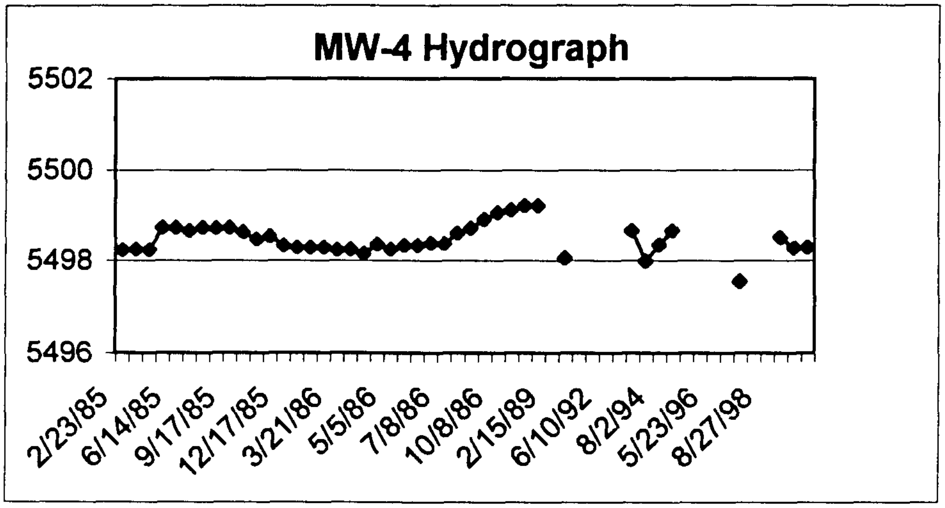


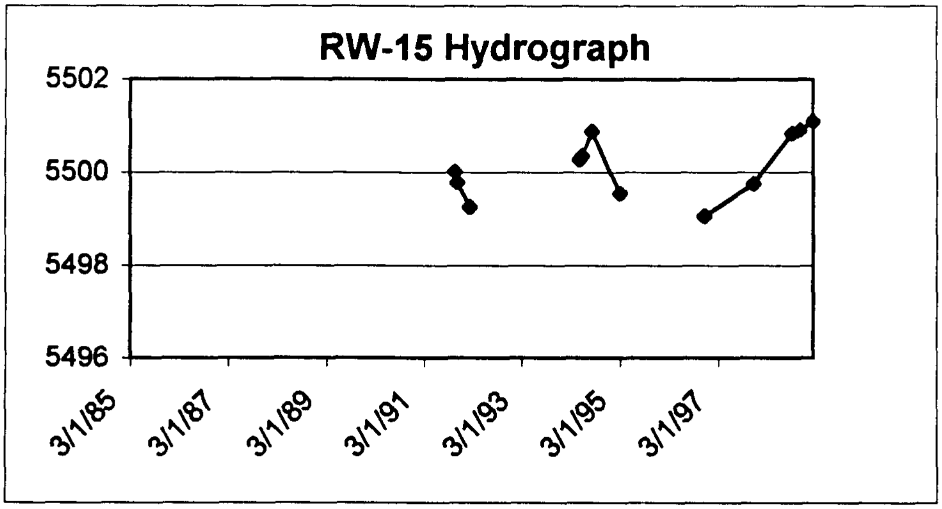




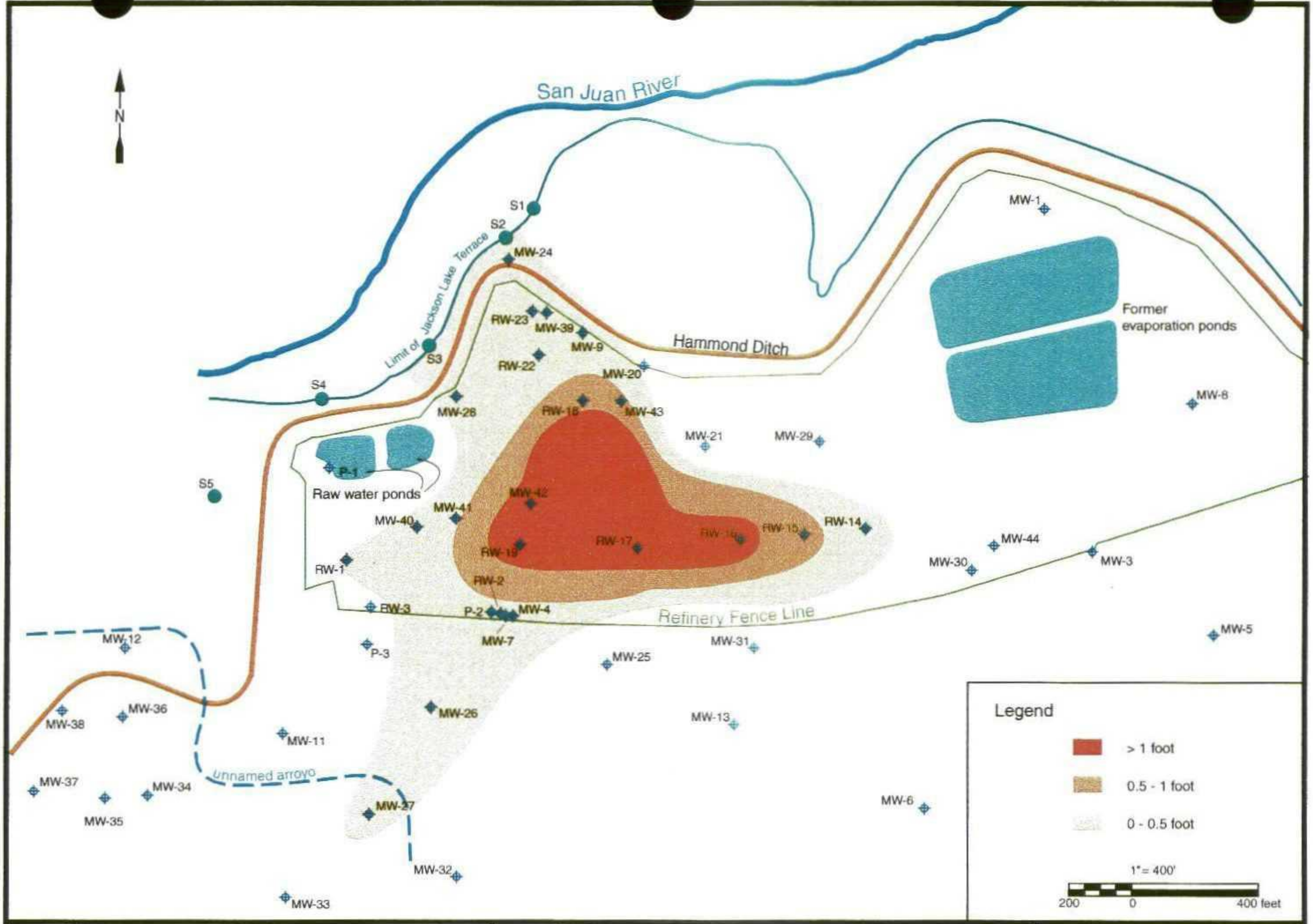
Bloomfield Refinery	**Plate 16**
Hydrographs of Background Wells (Elevations in Feet)	**June 1999**


MW-9 Hydrograph


MW-4 Hydrograph


RW-15 Hydrograph

Bloomfield Refinery	**Plate 17**
Hydrographs of Central Refinery Area Wells (Elevations in Feet)	**June 1999**



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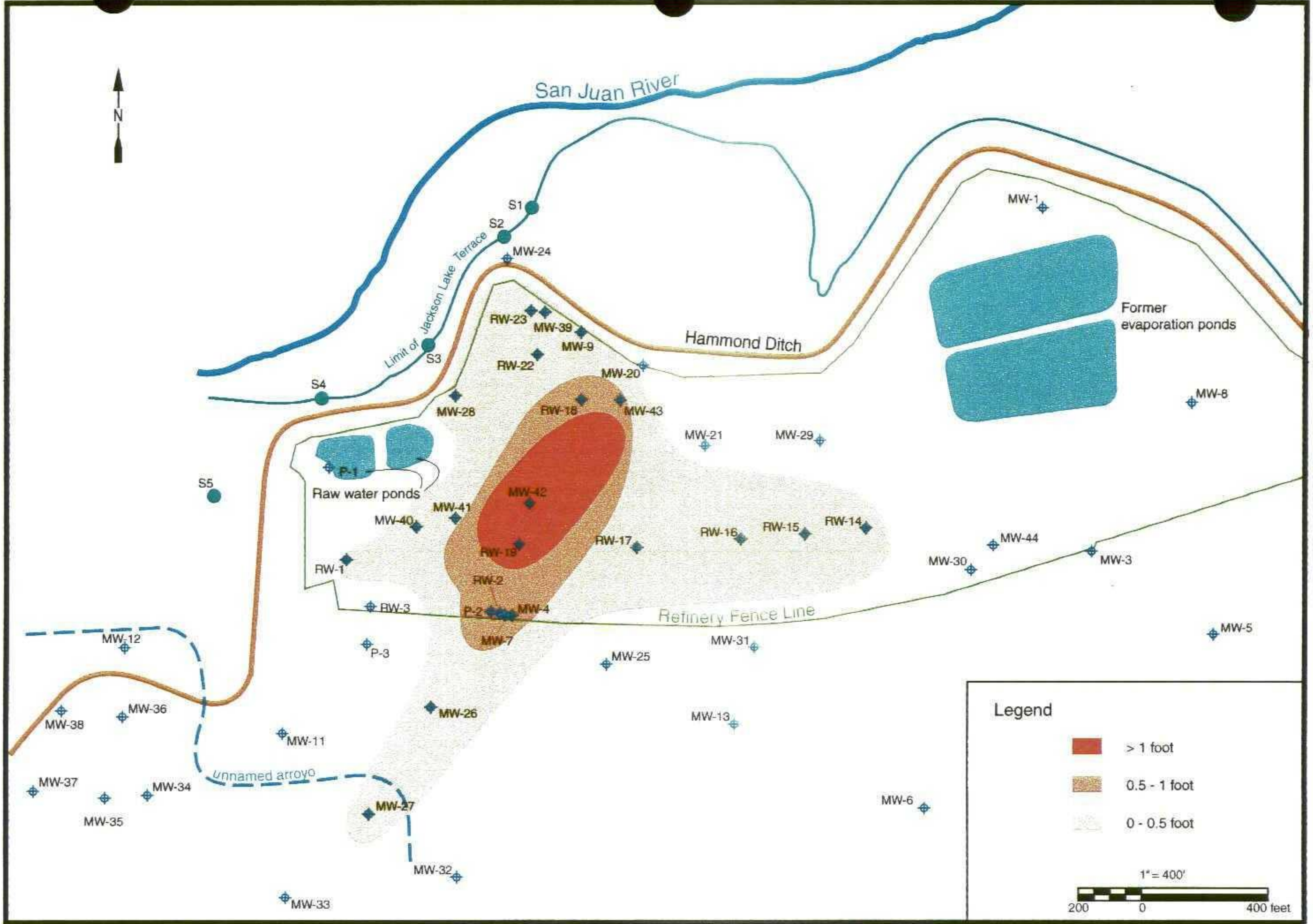
Bloomfield Refinery

Pre 1991 Separate Phase Hydrocarbon Isopleth Map

Plate 18

June 1999



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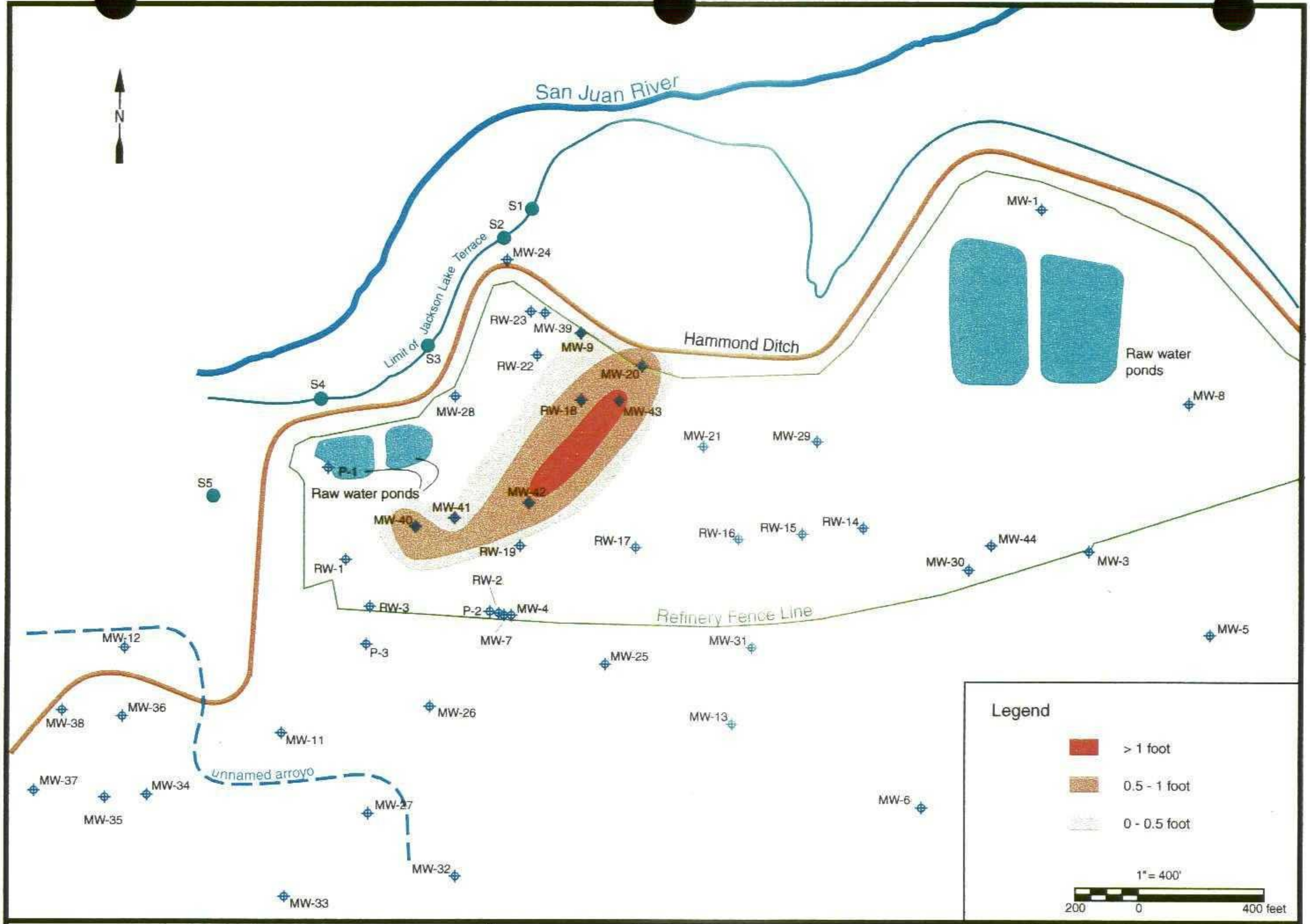
Bloomfield Refinery

March 1995 Separate Phase Hydrocarbon Isopleth Map

Plate 19

June 1999



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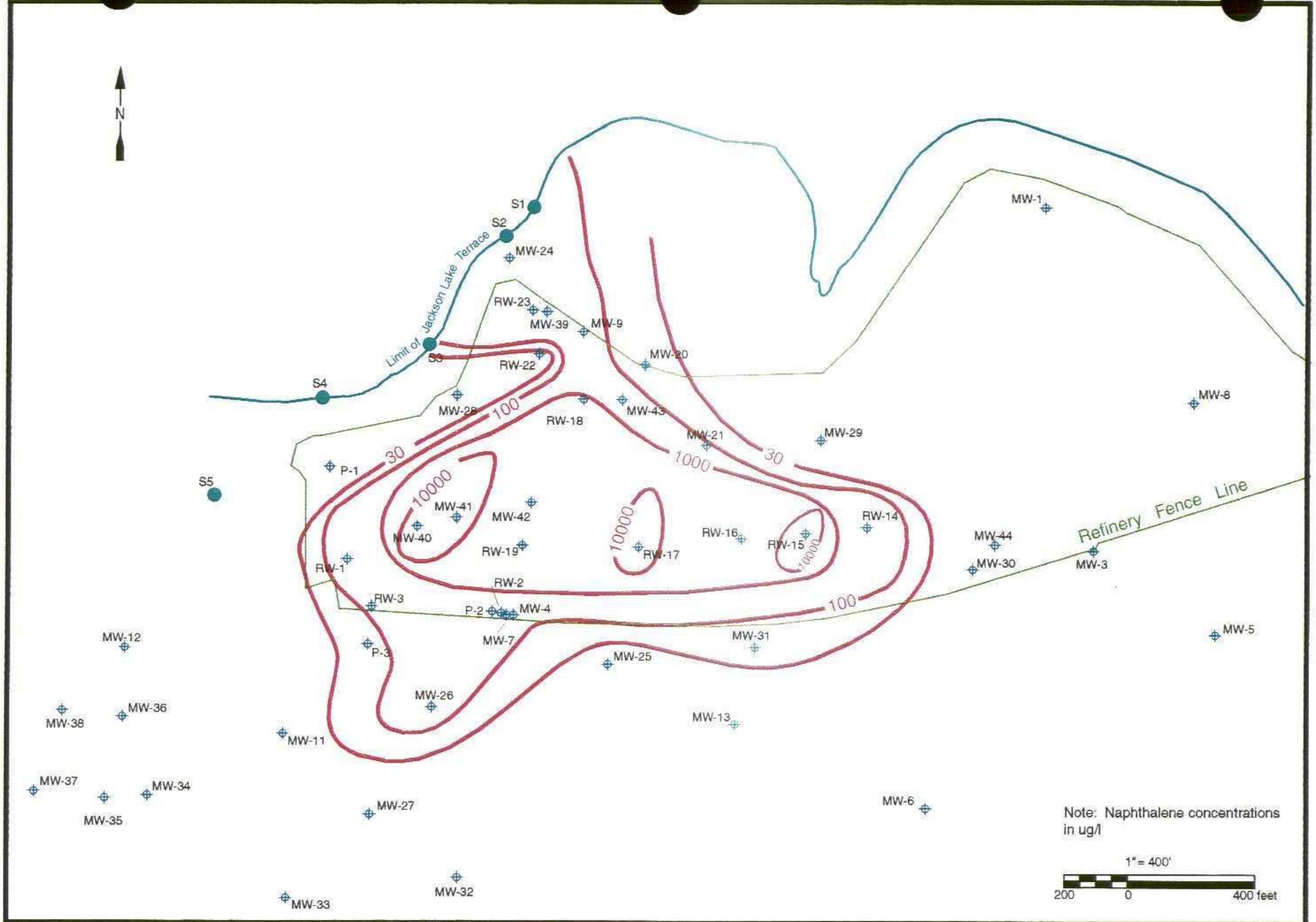
Bloomfield Refinery	Plate 20
April 1999 Separate Phase Hydrocarbon Isopleth Map	June 1999



Note: Naphthalene concentrations in ug/l

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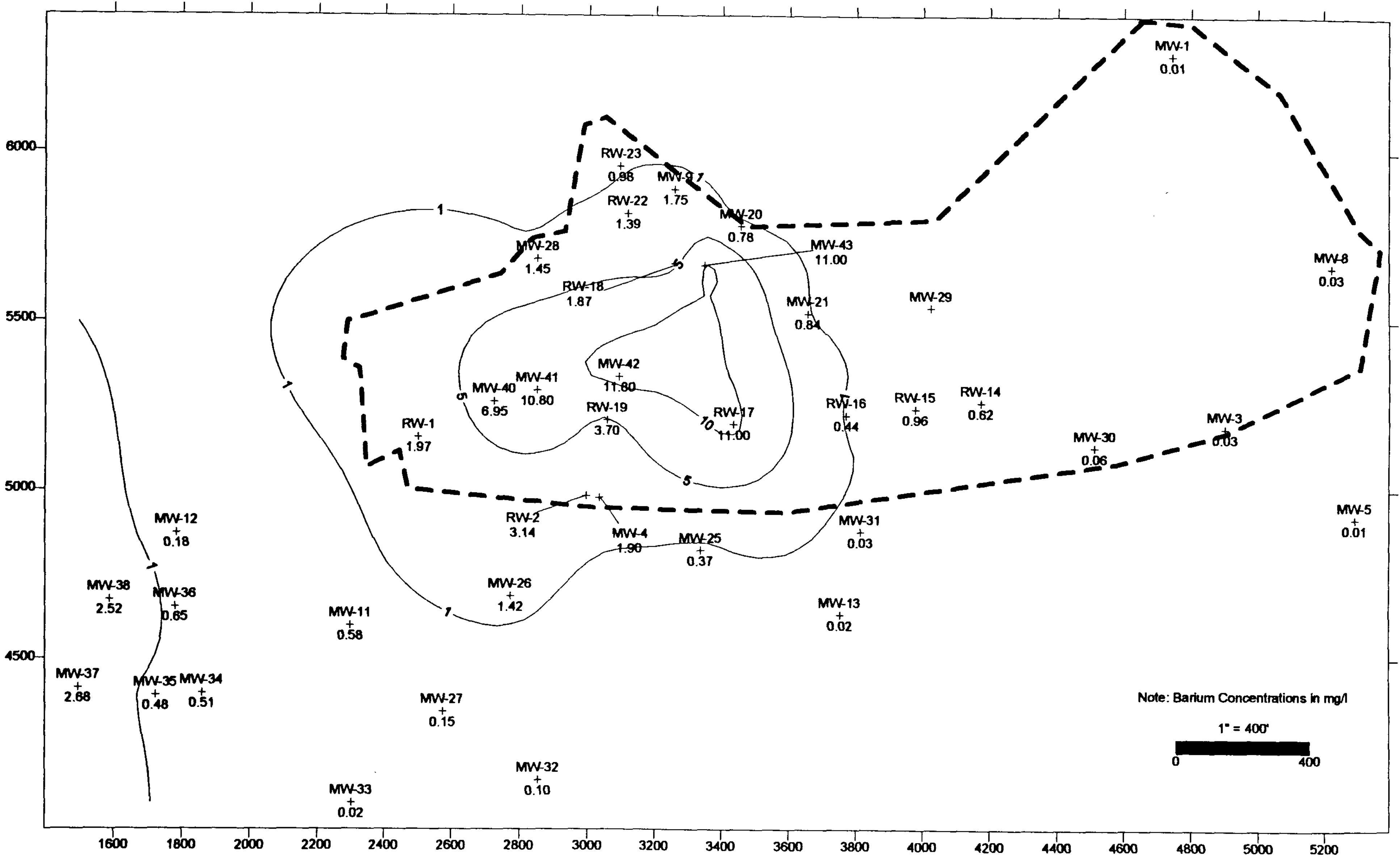
Bloomfield Refinery

Naphthalene Concentrations April 1999

Plate 21

June 1999



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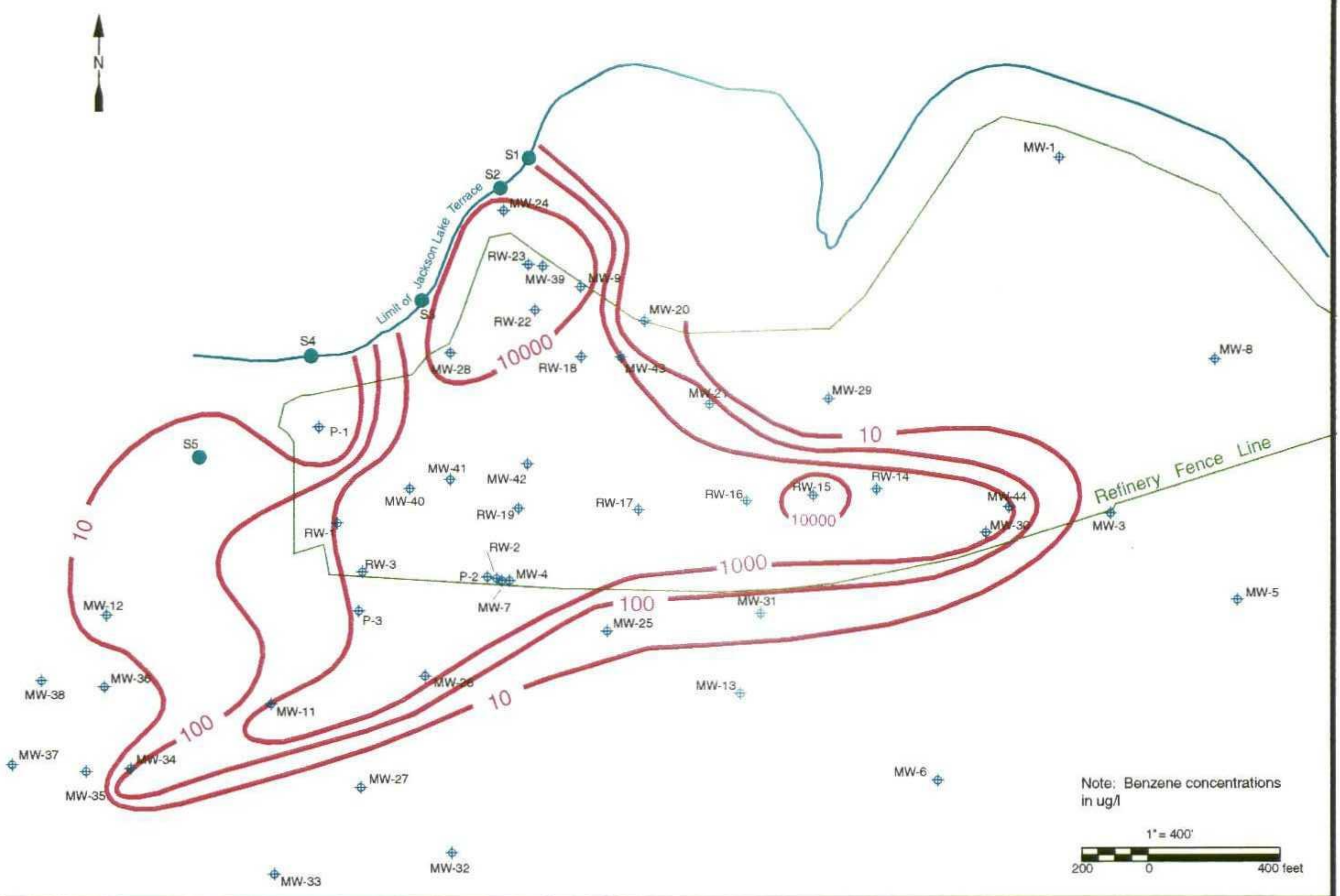
Bloomfield Refinery

Barium Concentrations April 1999

Plate 22

June 1999



Note: Benzene concentrations in ug/l

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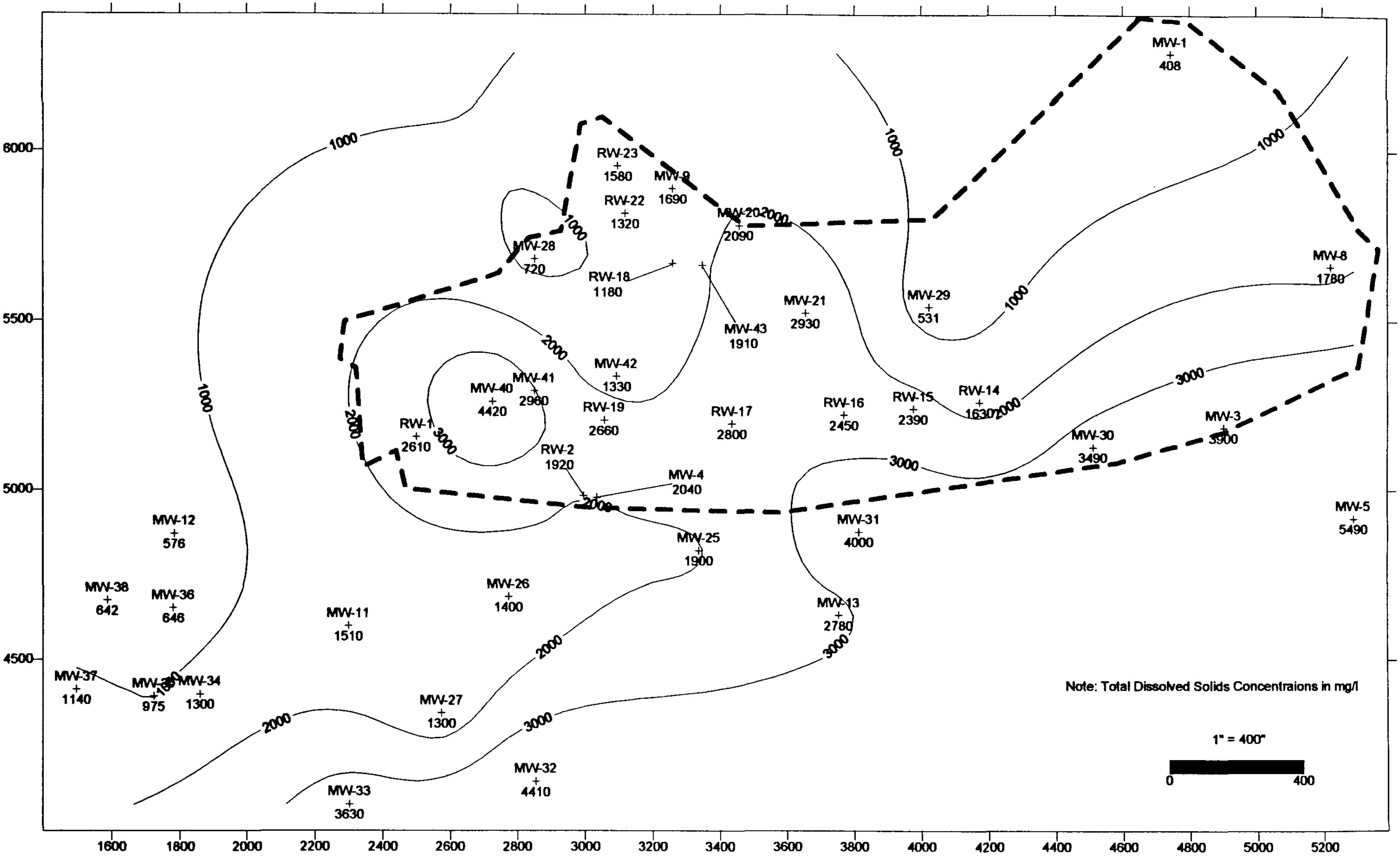
Bloomfield Refinery

Benzene Concentrations April 1999

Plate 23

June 1999



Note: Total Dissolved Solids Concentraions in mg/l

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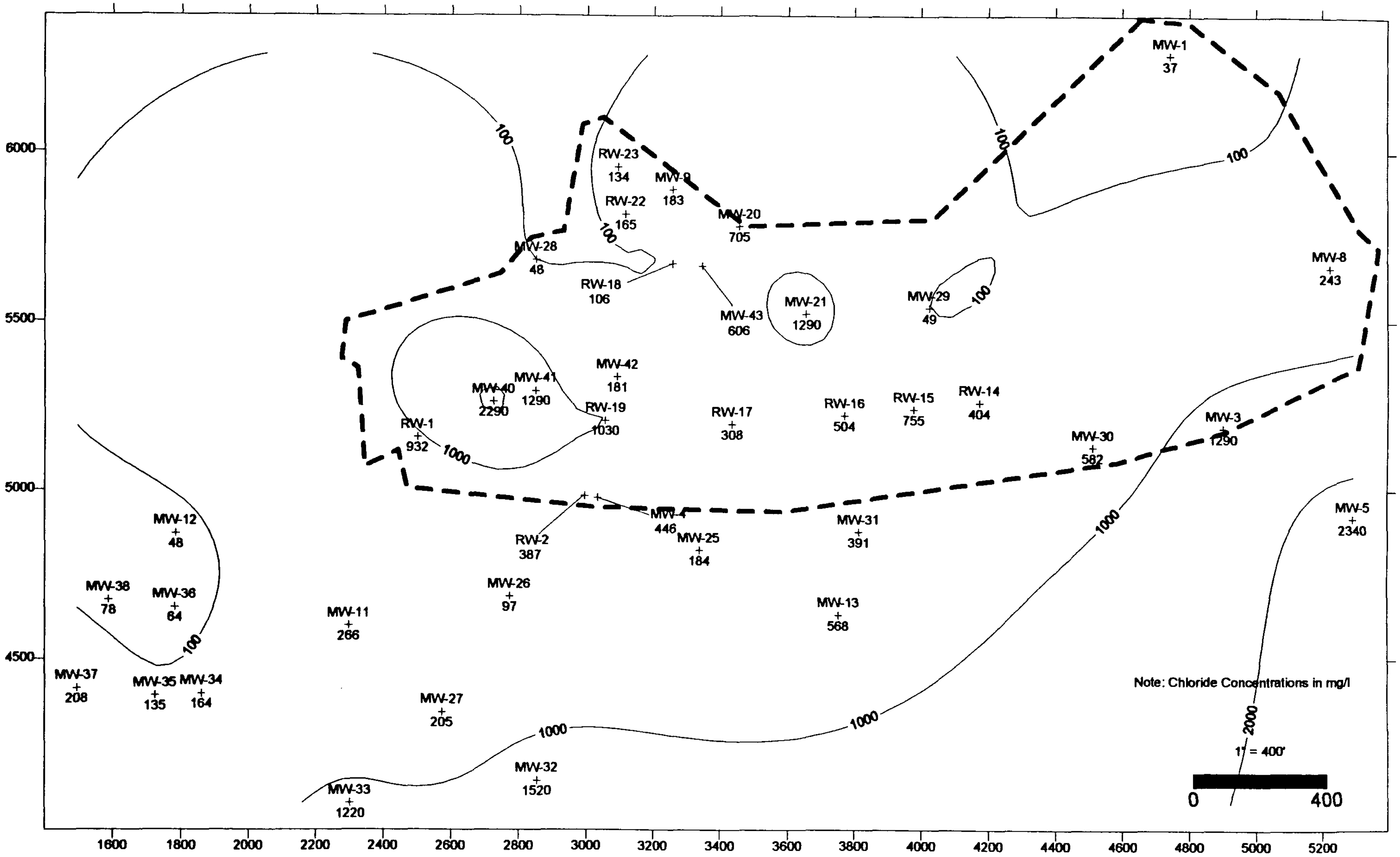
Bloomfield Refinery

Total Dissolved Solids Concentrations April 1999

Plate 24

June 1999



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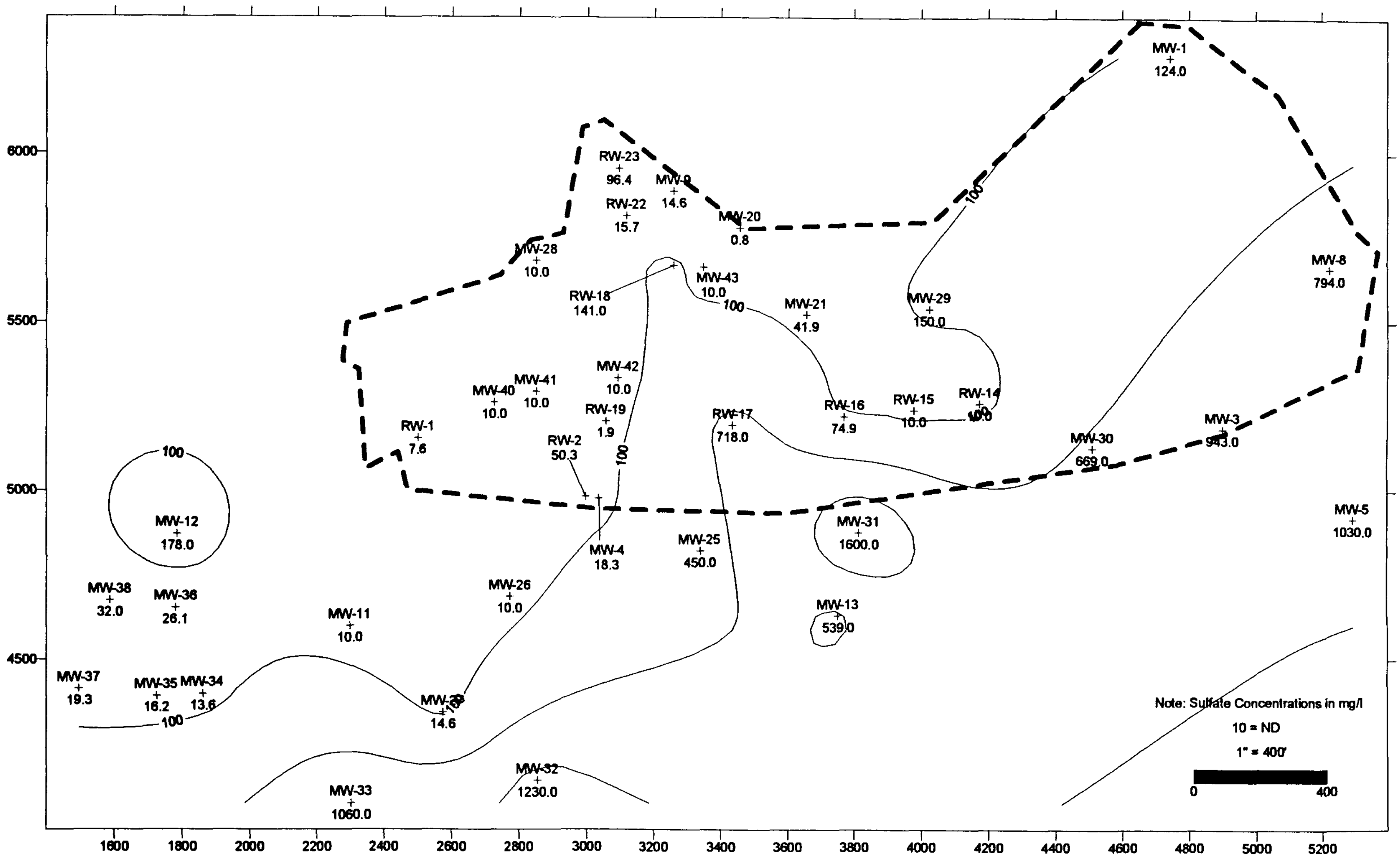
Bloomfield Refinery

Chloride Concentrations April 1999

Plate 25

June 1999



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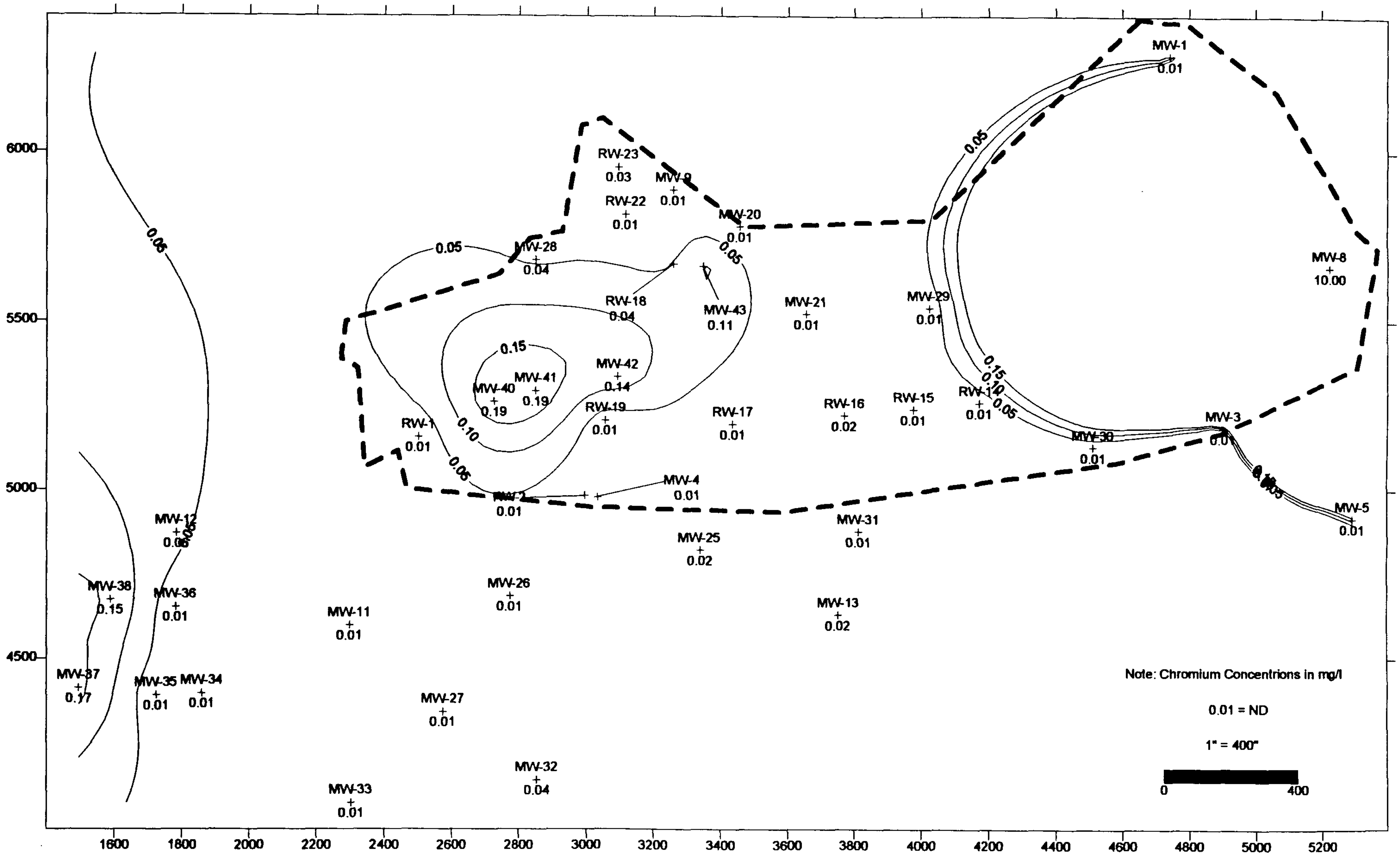
Bloomfield Refinery

Sulfate Concentrations April 1999

Plate 26

June 1999



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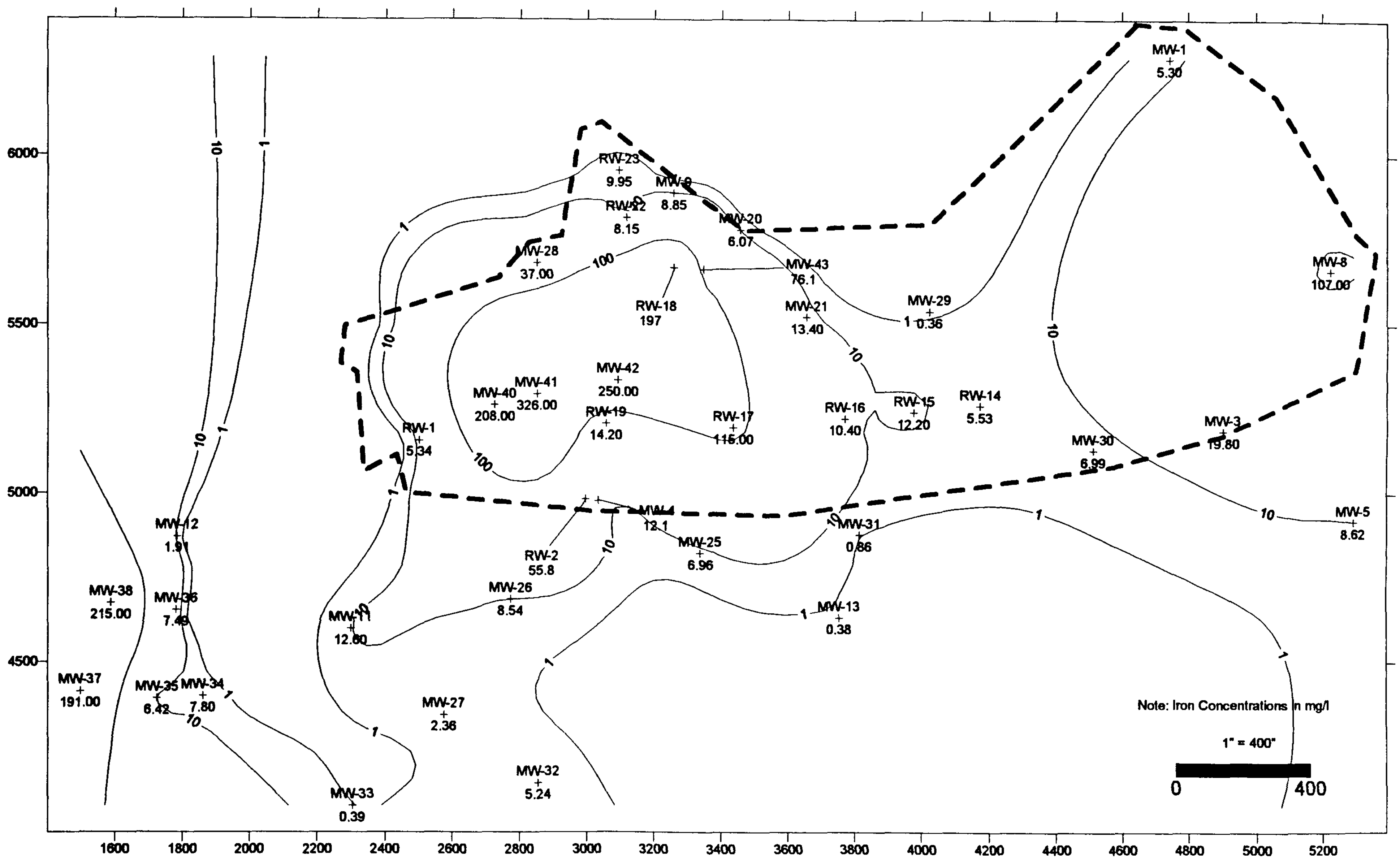
Bloomfield Refinery

Chromium Concentrations April 1999

Plate 27

June 1999



Note: Iron Concentrations in mg/l

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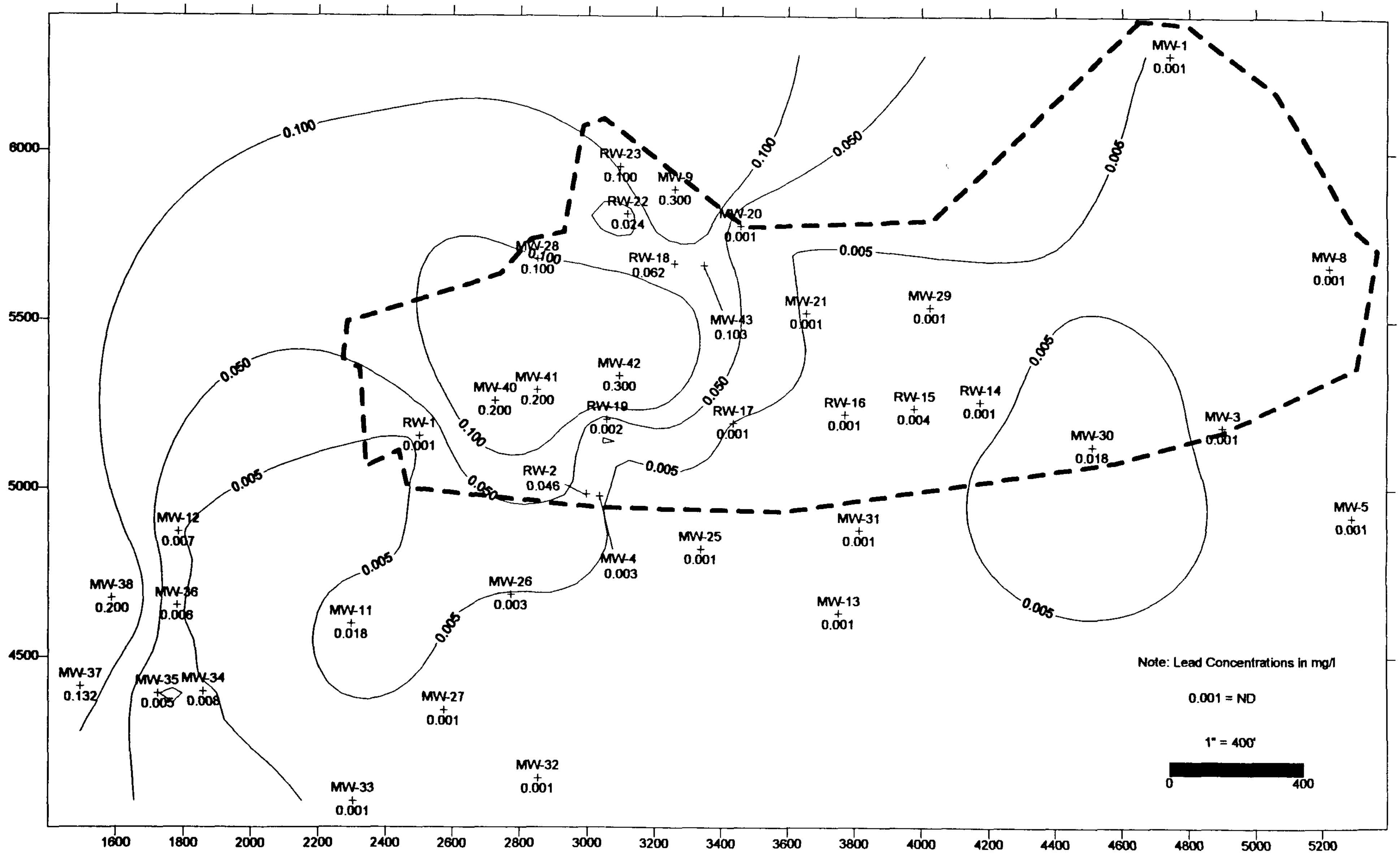
Bloomfield Refinery

Iron Concentrations April 1999

Plate 28

June 1999



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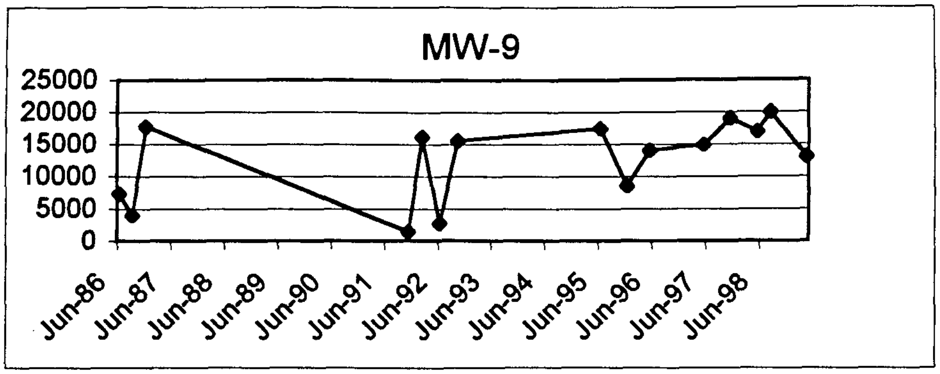
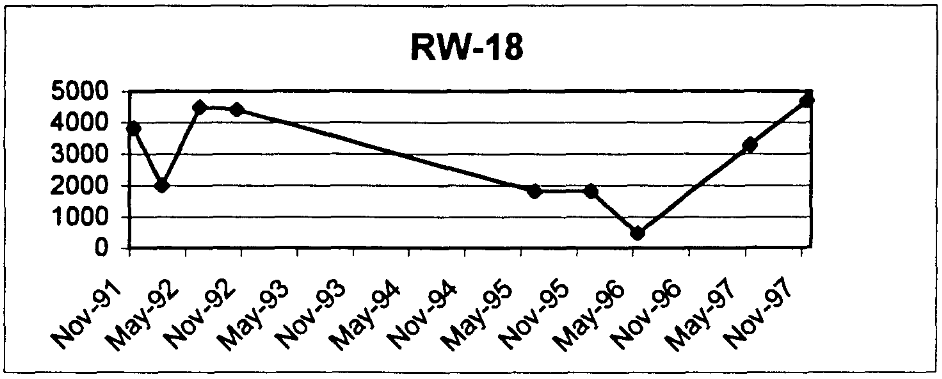
Bloomfield Refinery

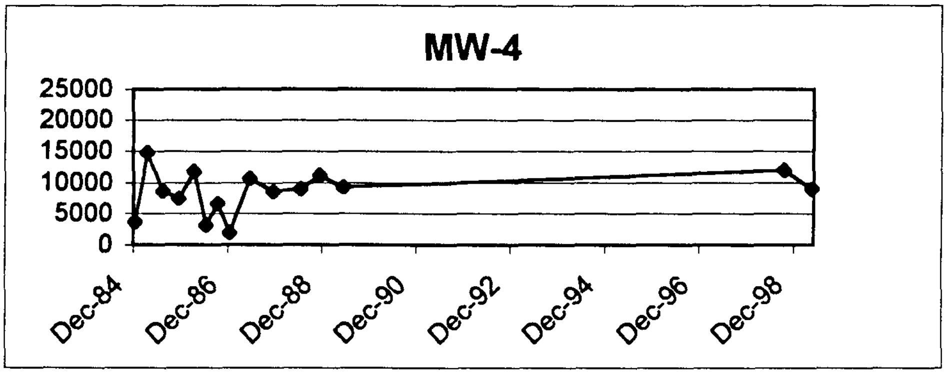
Lead Concentrations April 1999

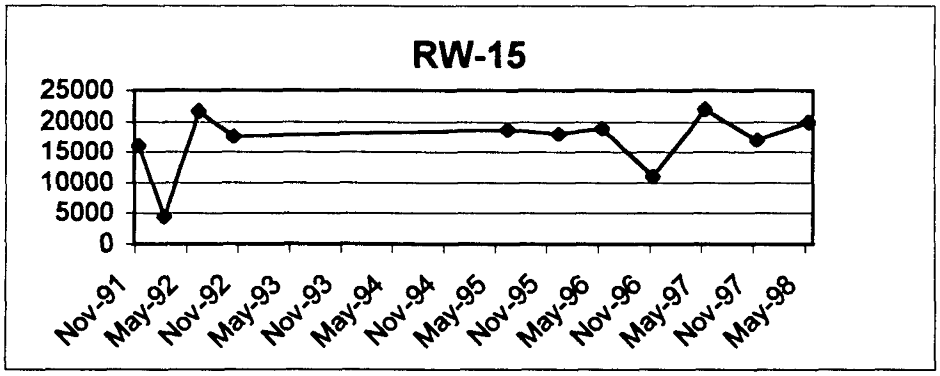
Plate 29

June 1999

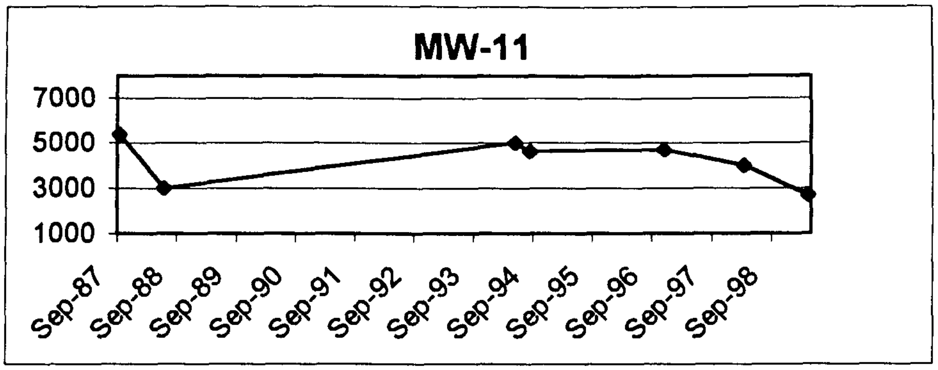


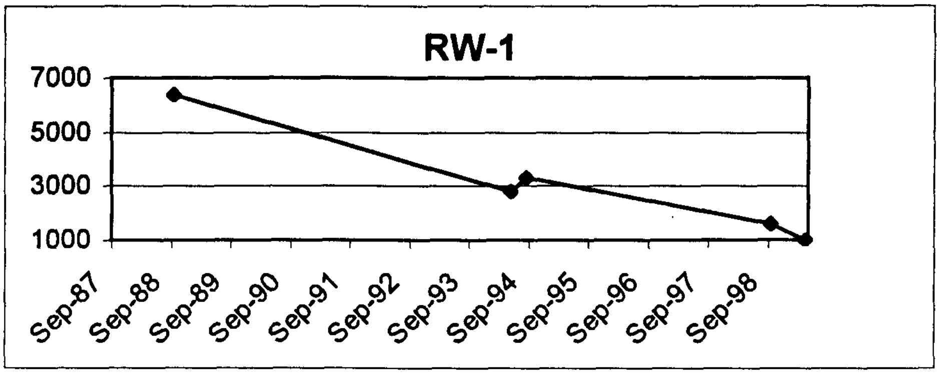


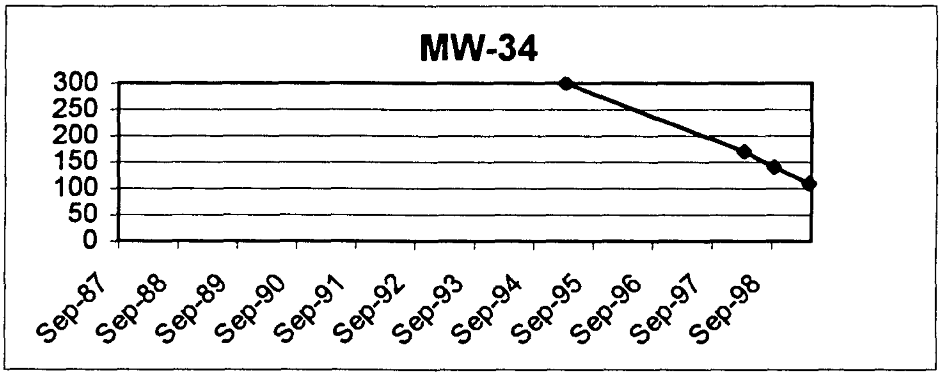


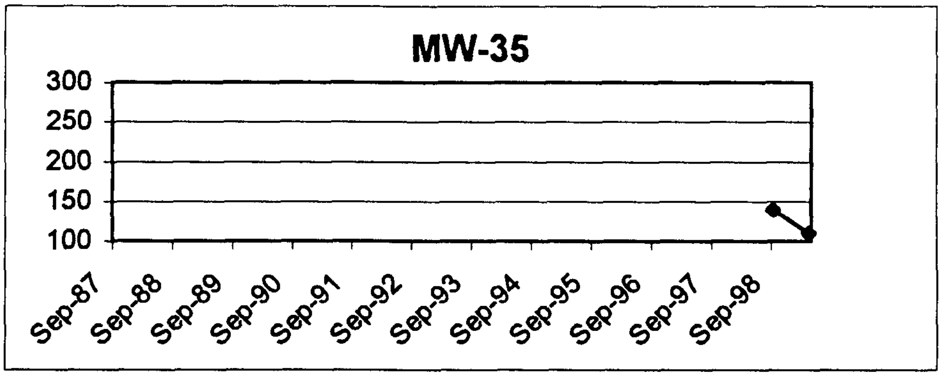


Giant Bloomfield Refinery	**Plate 30**
Benzene Concentrations (ug/l) Over Time in Central Refinery Area	**June 1999**

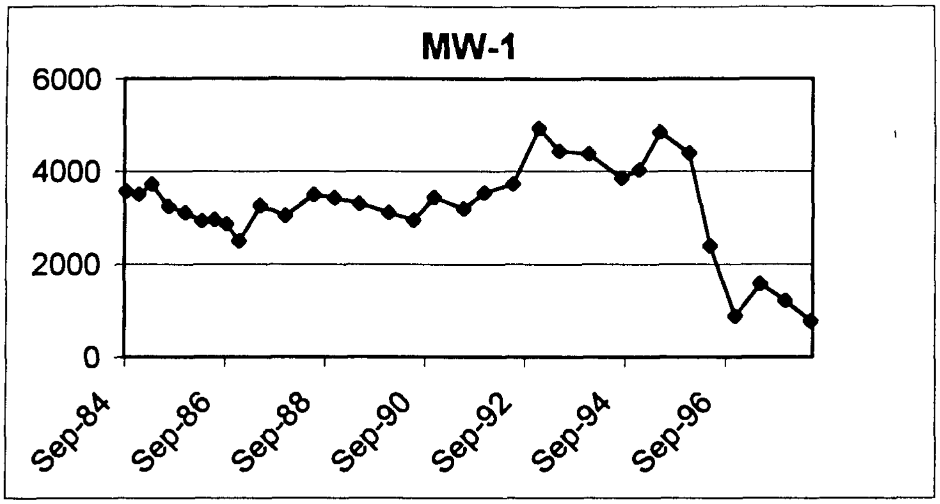

MW-11

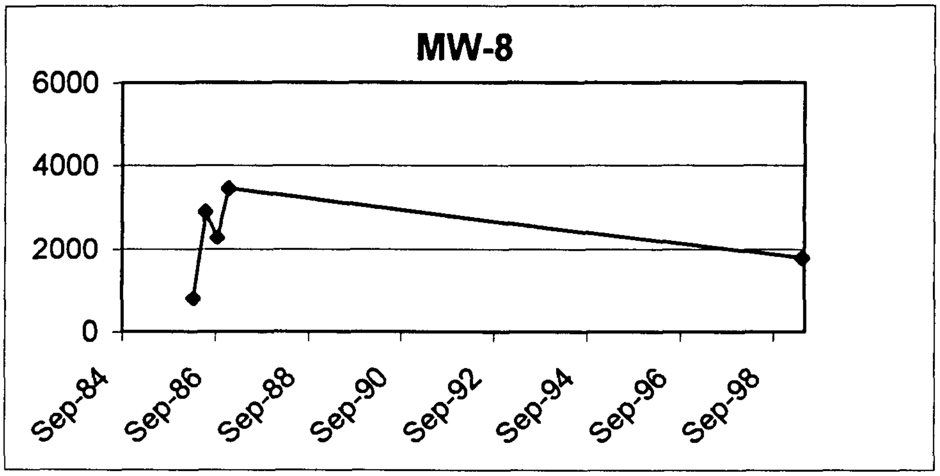

RW-1

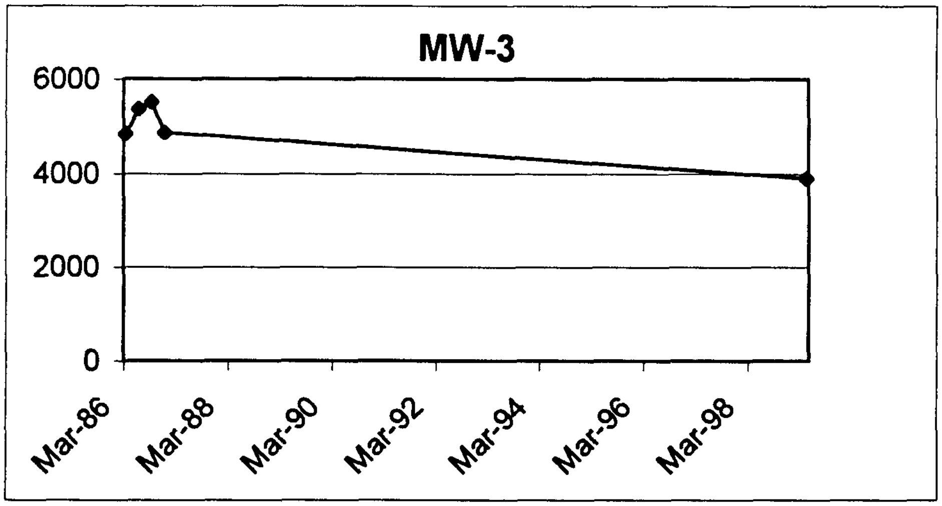

MW-34


MW-35

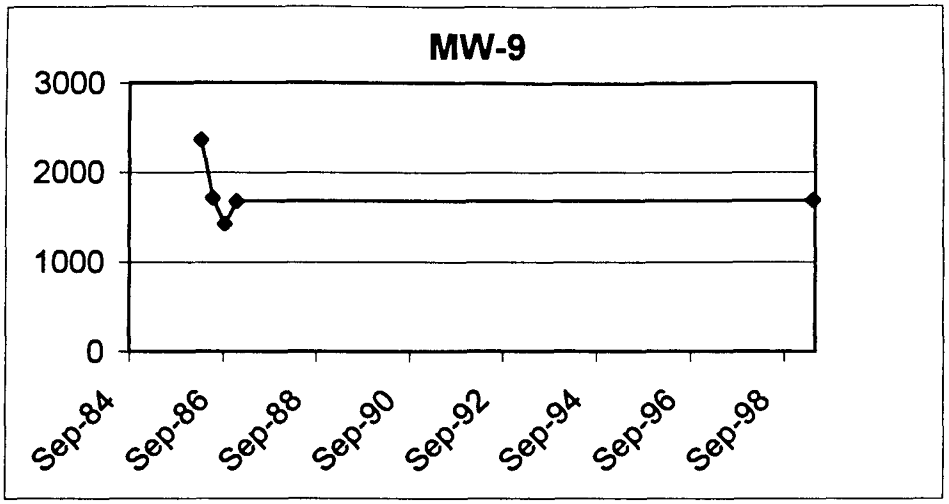
Bloomfield Refinery	**Plate 31**
Benzene Concentrations (ug/l) Over Time in Southwestern and Western Study Area	**June 1999**

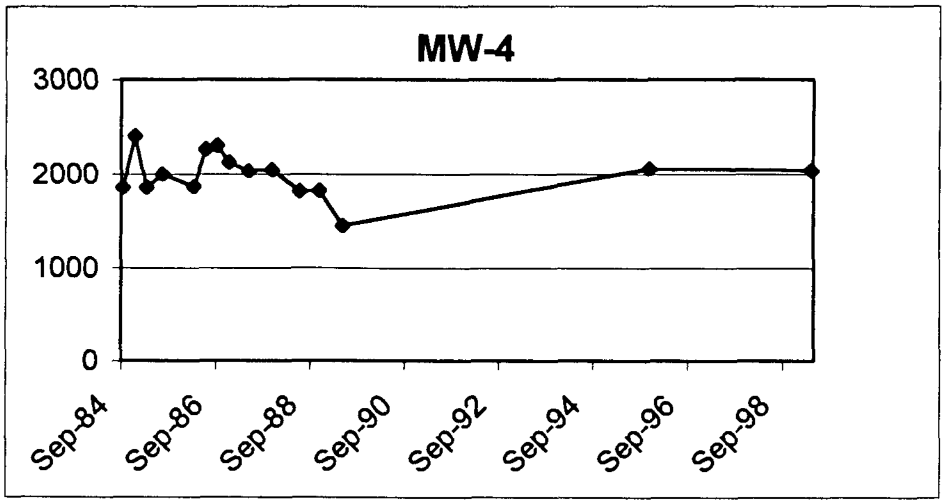


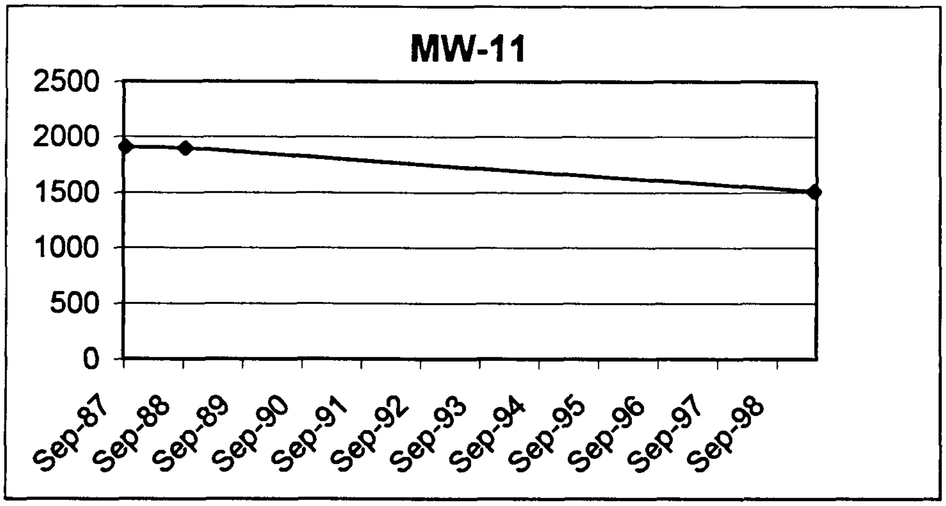




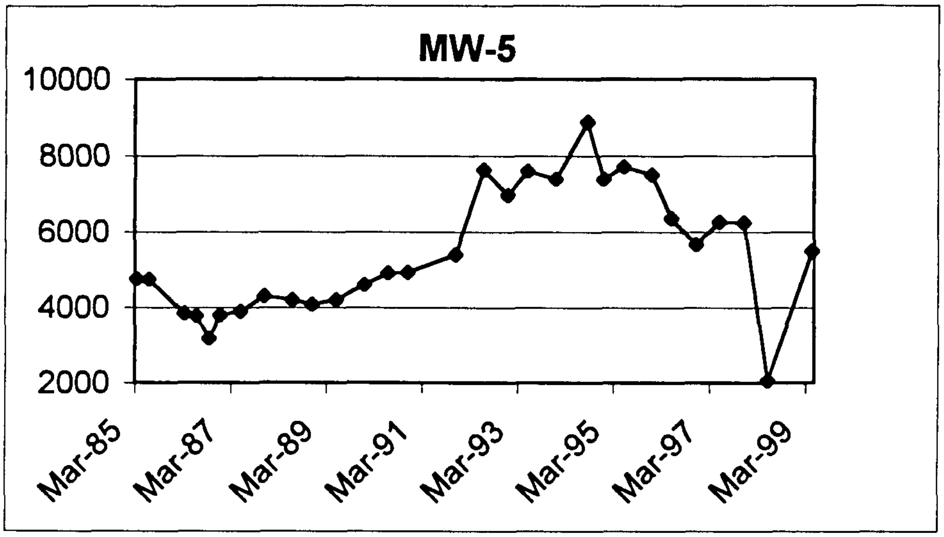
Bloomfield Refinery	**Plate 32**
TDS Concentrations (mg/l) Over Time in Background Wells	**June 1999**



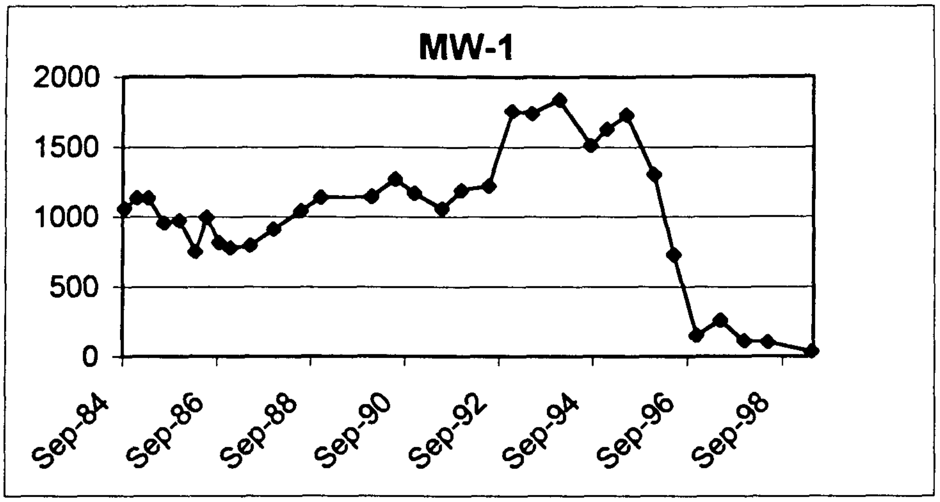


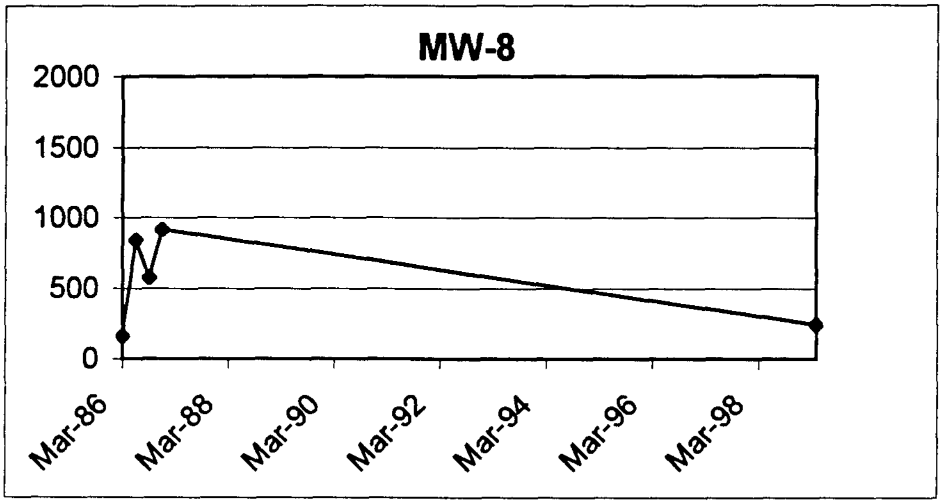


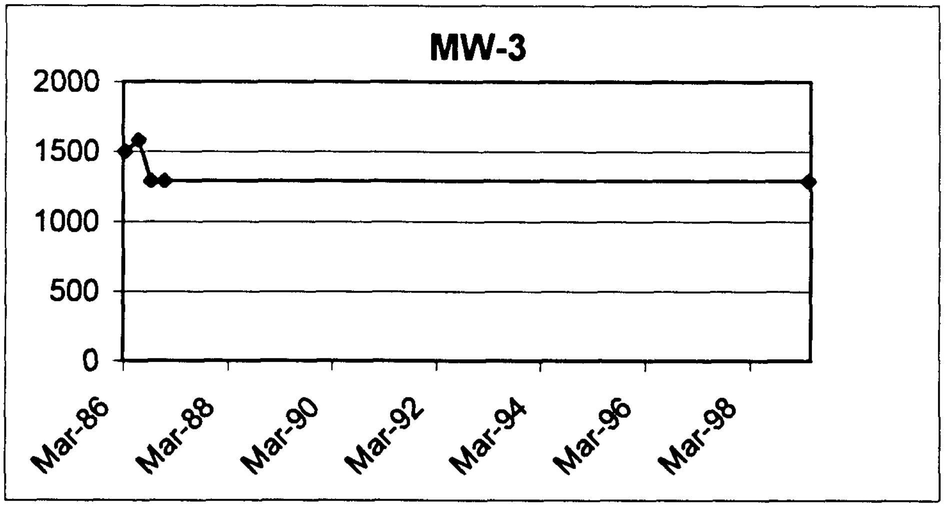
Bloomfield Refinery	**Plate 33**
TDS Concentrations (mg/l) Over Time in Central Refinery Wells	**June 1999**



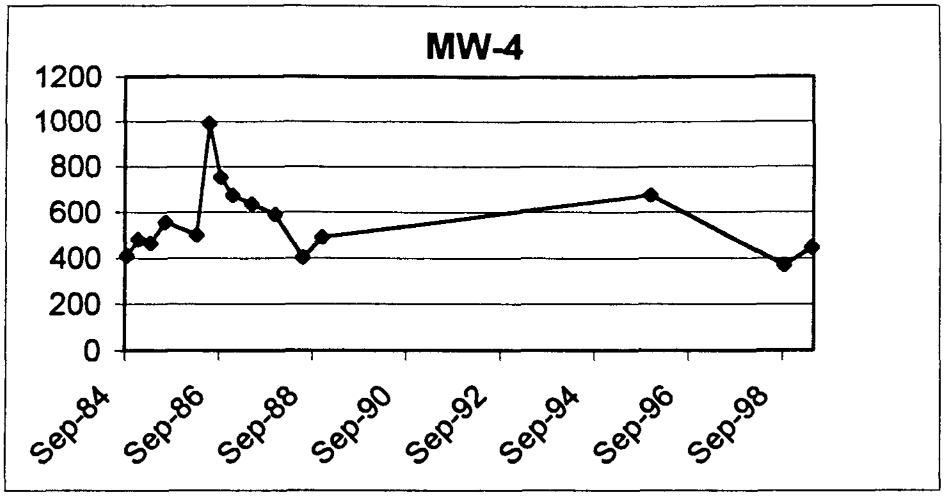
Bloomfield Refinery	Plate 34
TDS Concentrations (mg/l) Over Time in MW-5	June 1999

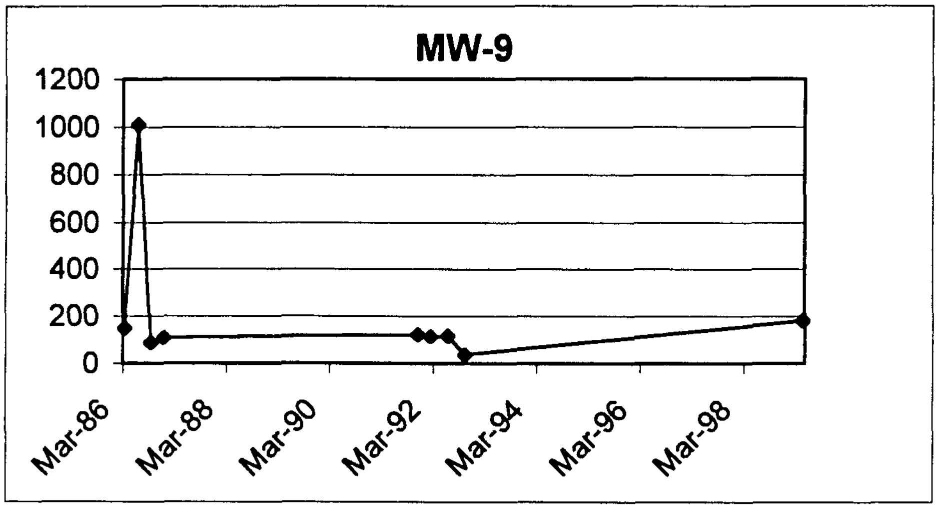


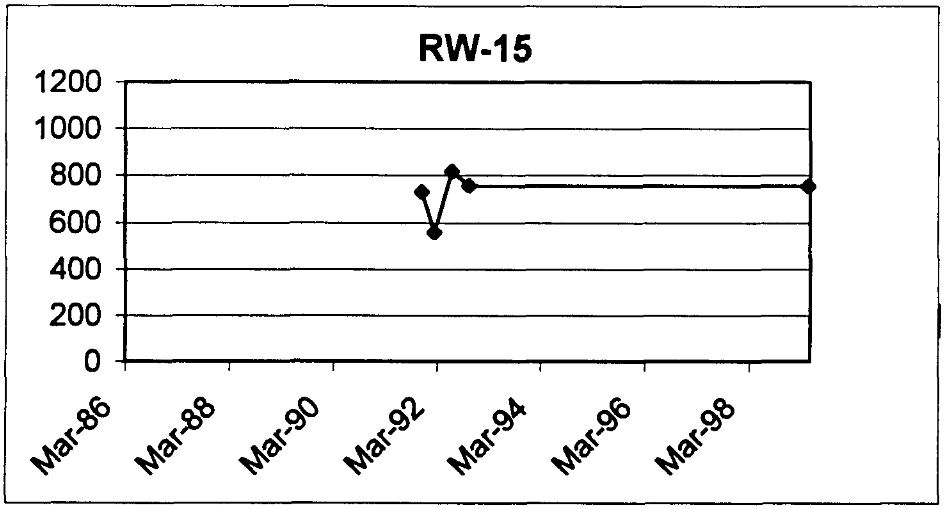




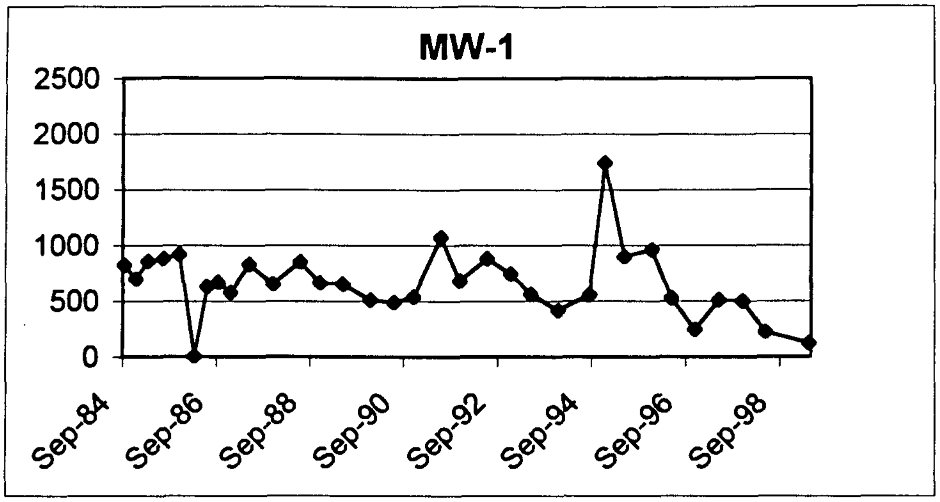
Bloomfield Refinery	**Plate 35**
Chloride Concentrations (mg/l) **Over Time in Background Wells**	**June 1999**

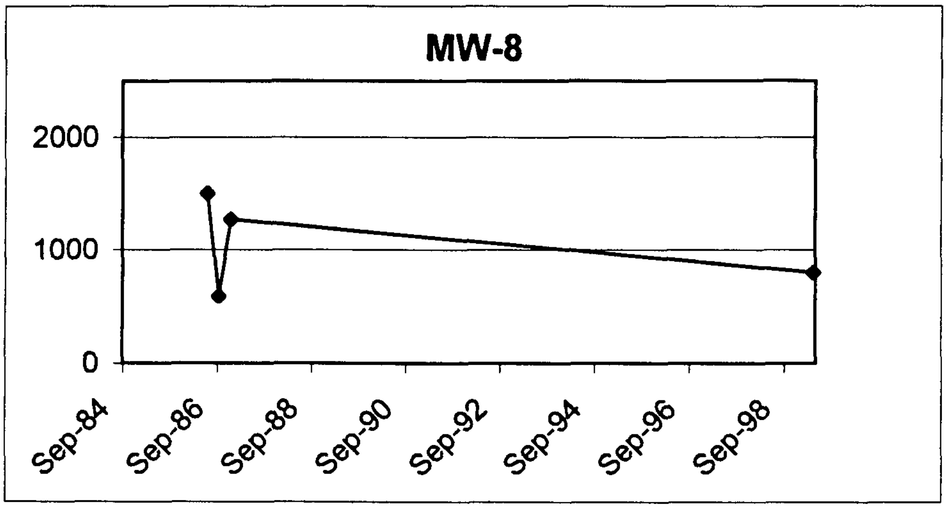


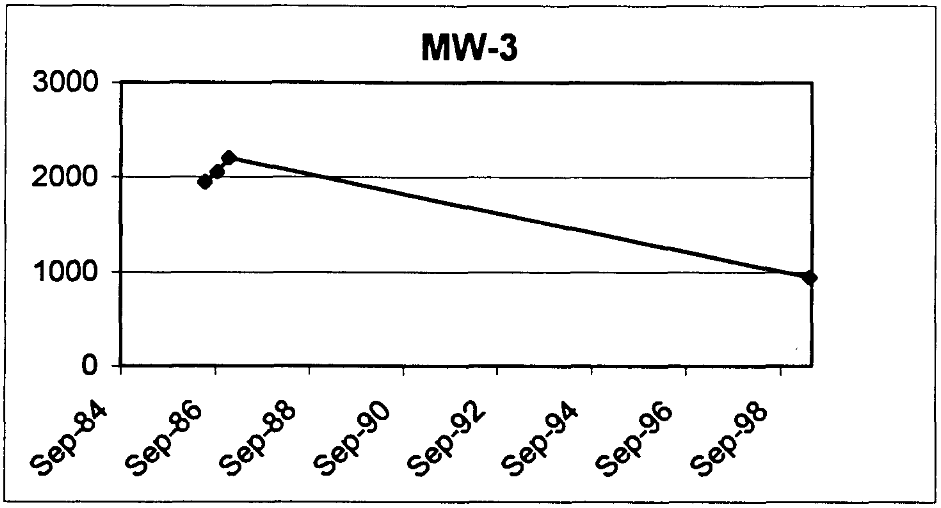




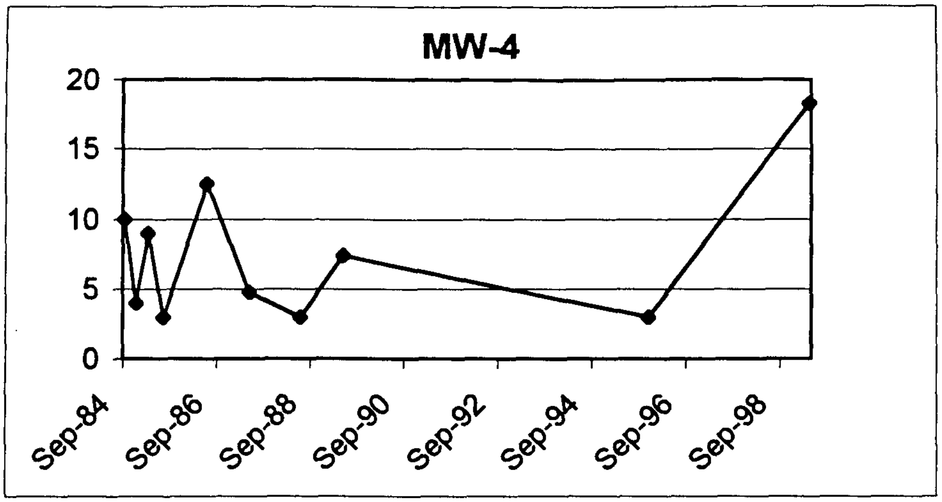
Bloomfield Refinery	**Plate 36**
Chloride Concentrations (mg/l) Over Time in Central Refinery Wells	**June 1999**

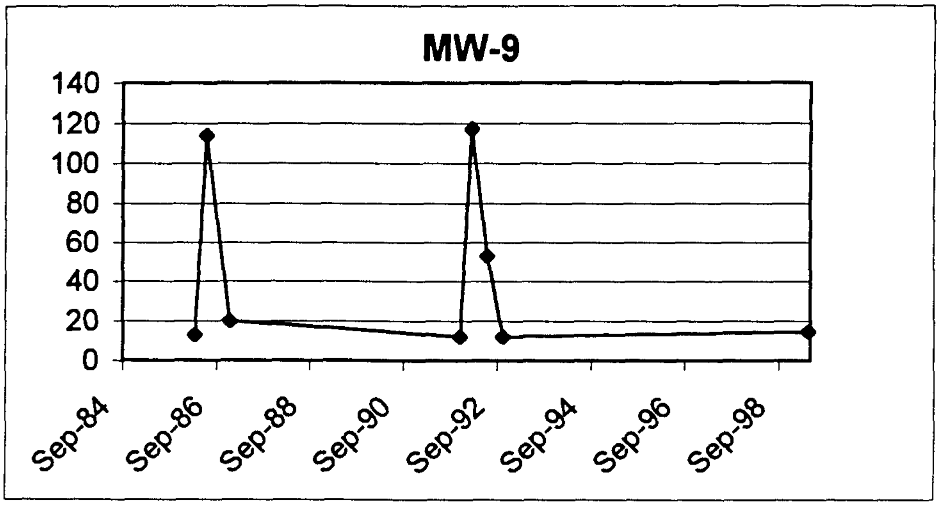


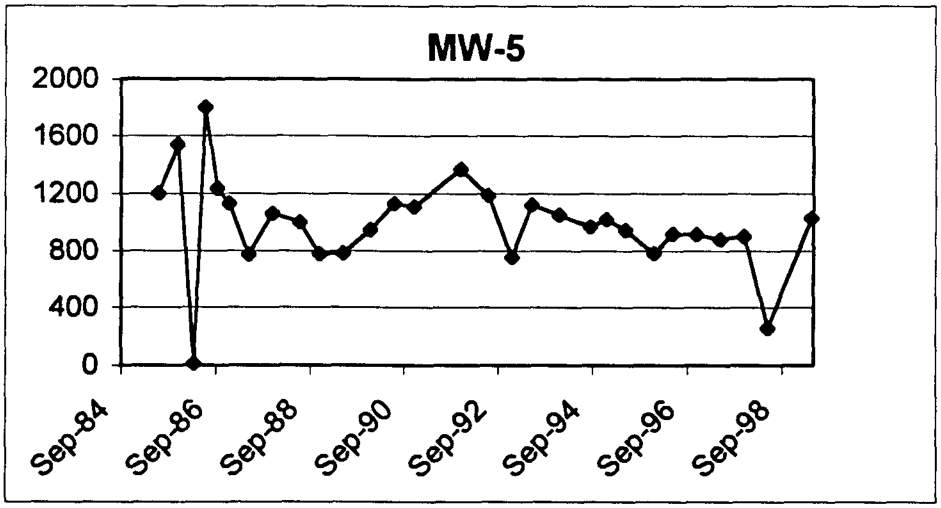




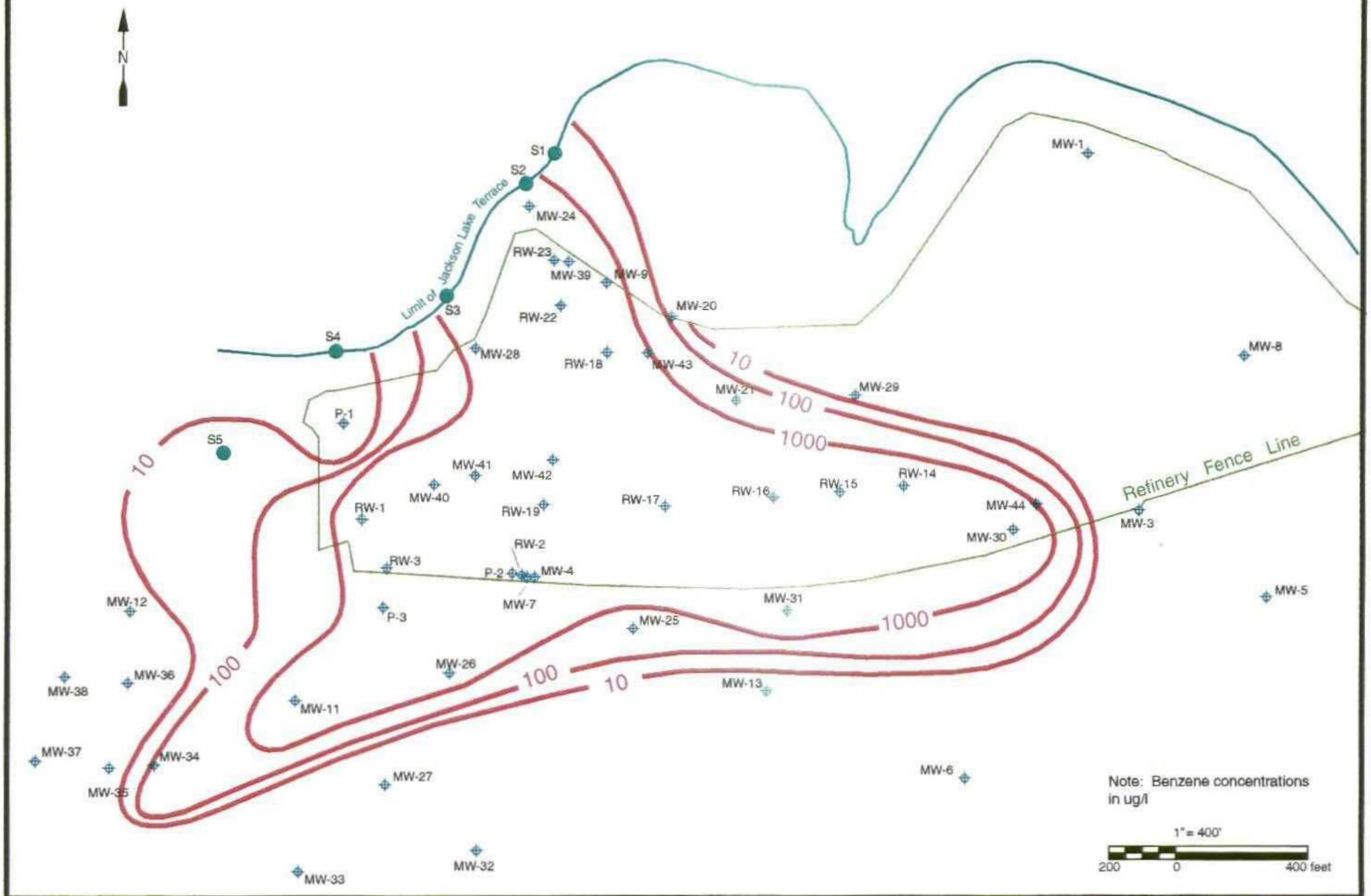
Bloomfield Refinery	**Plate 37**
Sulfate Concentrations (mg/l) Over Time in Background Wells	**June 1999**


MW-4

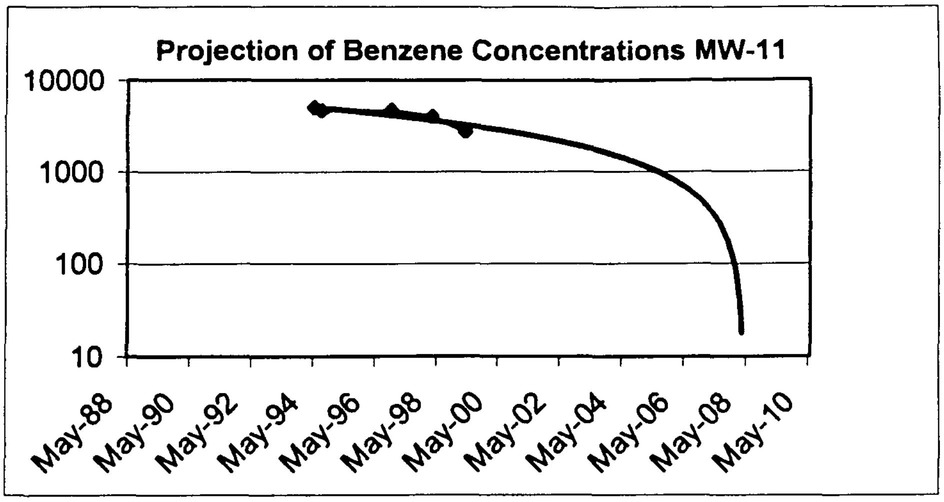

MW-9

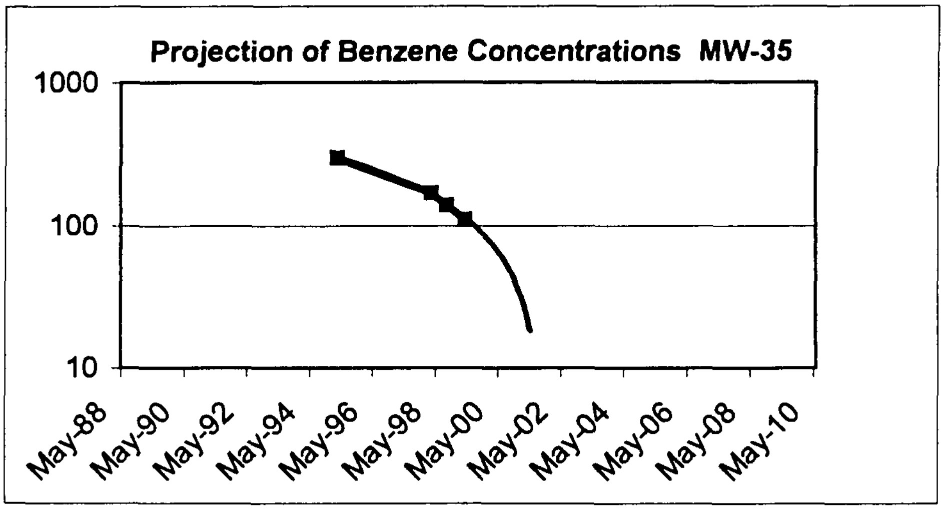

MW-5

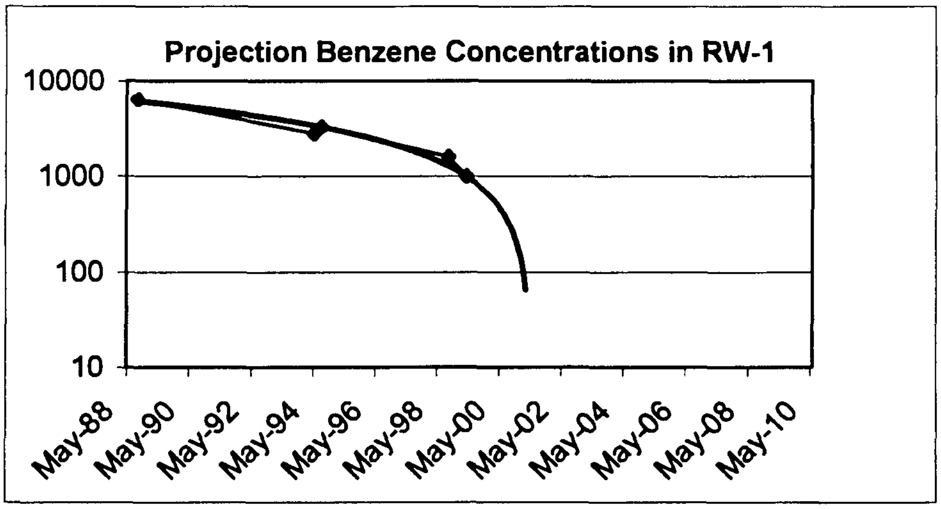
Bloomfield Refinery	**Plate 38**
Sulfate Concentrations (mg/l) Over Time in Central Refiery Area and Spray Irrigation Area	**June 1999**



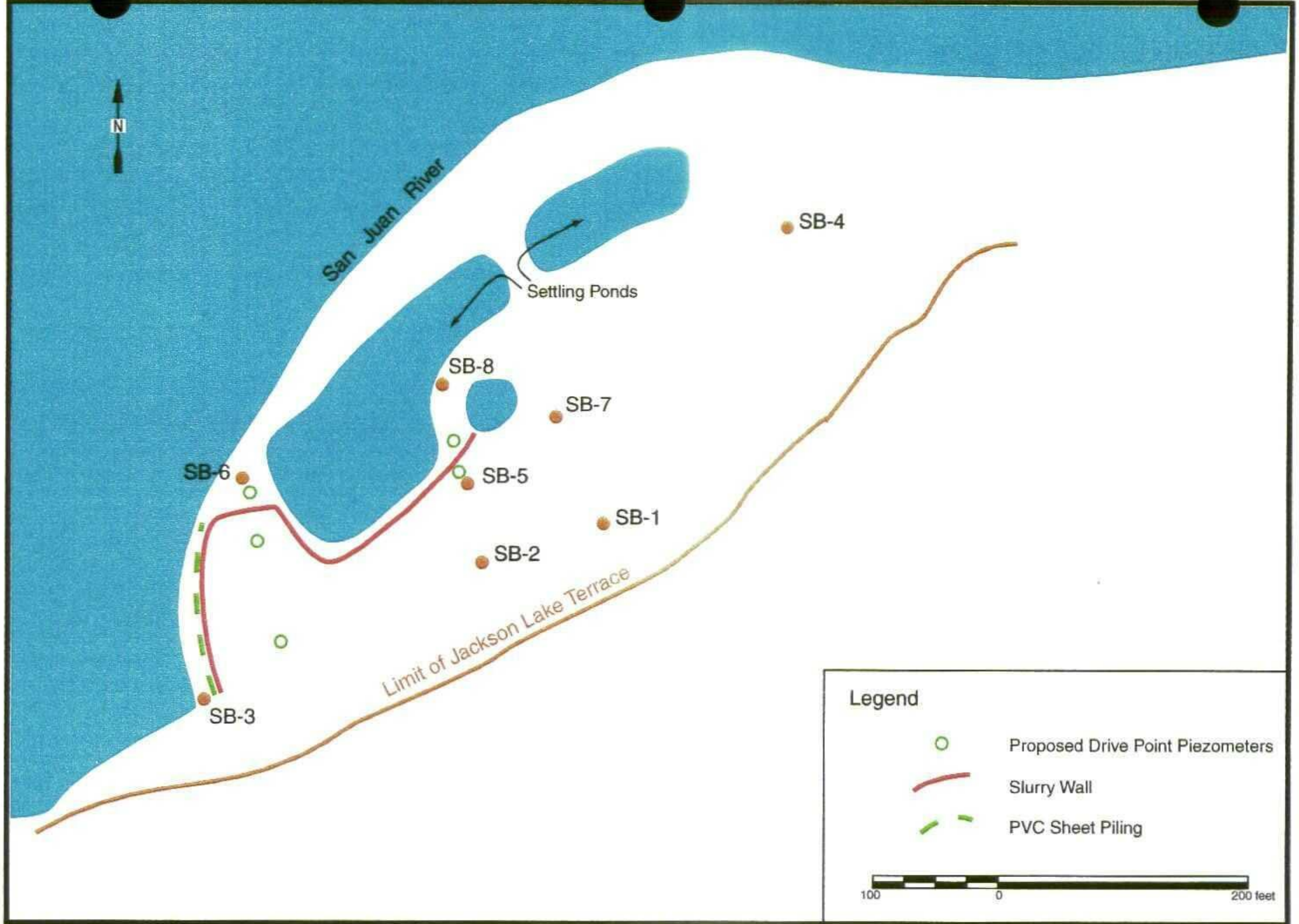
R.T. HICKS CONSULTANTS, LTD. 4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Bloomfield Refinery	Plate 39
	Benzene Concentrations 1994 - 1995	June 1999


Projection of Benzene Concentrations MW-11


Projection of Benzene Concentrations MW-35


Projection Benzene Concentrations in RW-1

Bloomfield Refinery	**Plate 40**
Projected Benzene Concentrations (ug/l)	**June 1999**



R.T. HICKS CONSULTANTS, LTD. 4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Bloomfield Refinery	Plate 41
	Hydraulic Barrier Between River and Alluvium	June 1999

APPENDIX A

View Record Detail

Faxback 11434

9441.1989(30)

United States Environmental Protection Agency
Washington, D.C. 20460
Office of Solid Waste and Emergency Response

June 19, 1989

Mr. Thomas C. Jorling
Commissioner
Department of Environmental
Conservation
State of New York
Albany, New York 12233-1010

Dear Mr. Jorling:

I am writing in response to your letter of May 5, 1989, in which you ask numerous questions concerning the regulatory status, under the Resource Conservation and Recovery Act (RCRA), of environmental media (ground water, soil, and sediment) contaminated with RCRA-listed hazardous waste.

As you point out in your letter, it is correct that the Agency's "contained-in" interpretation is that contaminated environmental media must be managed as if they were hazardous wastes until they no longer contain the listed waste, or are delisted. This leads to the critical question of when an environmental medium contaminated by listed hazardous waste ceases to be a listed hazardous waste. In your letter, you discuss three possible answers (based on previous EPA positions and documents) which you believe address this question, and request the Agency to clarify its interpretation. Each of these is discussed below.

The first possible answer you cite would be that the contaminated media would be a hazardous waste unless and until it is delisted, based on the "mixture" and "derived-from" rules. As you correctly state in your letter, a waste that meets a listing description due to the application of either of these rules remains a listed hazardous waste until it is delisted. However, these two rules do not pertain to contaminated environmental media. Under our regulations, contaminated media are not considered solid wastes in the sense of being abandoned, recycled, or inherently waste-like as those terms are defined in the regulations. Therefore, contaminated environmental media cannot be considered a hazardous waste via the "mixture" rule (i.e., to have a hazardous waste mixture, a hazardous waste must be mixed with a solid waste per 40 CFR 261.3(a)(2)(iv)). Similarly, the "derived-from rule does not apply to contaminated media. Our basis for stating that contaminated environmental media must be managed as hazardous wastes is that they "contain" listed hazardous waste. These environmental media must be managed as hazardous waste because, and only as long as, they "contain" a listed hazardous waste, (i.e., until decontaminated).

The second possibility you mention is that environmental media contaminated with a RCRA listed waste no longer have to be managed as a hazardous waste if the hazardous constituents are completely removed by treatment. This is consistent with the Agency's "contained-in" interpretation and represents the Agency's current policy.

The third possibility you discuss comes from Sylvia Lowrance's January 24, 1989, memorandum that you cited in your letter. This memorandum indicates that OSW has not issued any definitive guidance as to when, or at what levels, environmental media contaminated with listed hazardous waste are no longer considered to contain that hazardous waste. It also states that until such definitive guidance is issued, the Regions may determine these levels on a case-specific basis. Where this determination involves an authorized State, such as New York, our policy is that the State may also make such a determination.

Related to such a determination, you ask whether a risk assessment approach that addressed the public health and environmental impacts of hazardous constituents remaining in treatment residuals would be acceptable. This approach would be acceptable for contaminated media, but would not be acceptable for "derived-from" wastes under our current rules. Additionally, consistent with the statute, you could substitute more stringent standards or criteria for contaminated environmental media than those recommended by the Federal EPA if you determined it to be appropriate.

The Agency is currently involved in a rulemaking effort directed at setting de minimis levels for hazardous constituents below which eligible listed wastes, treatment residuals from those wastes, and environmental media contaminated with those listed wastes would no longer have to be managed as hazardous wastes. The approach being contemplated in the De Minimis program would be similar to that used in the proposed RCRA Clean Closure Guidance in terms of the exposure scenario (direct ingestion), the management scenario (not in a waste management unit), and the levels (primarily health-based).

Your final question related to whether the "remove and decontaminate" procedure set forth in the March 19, 1987 Federal Register preamble to the conforming regulations on closing surface impoundments applies when making complete removal determinations for soil. These procedures do apply when one chooses to clean close a hazardous waste surface impoundment by removing the waste. The preamble language states that the Agency interprets the term "remove" and "decontaminate" to mean removal of all wastes, liners, and/or leachate (including ground water) that pose a substantial present or potential threat to human health or the environment (52 FR 8796). Further discussion of these requirements is provided in a clarification notice published on March 28, 1988, (53 FR 1144) and in OSWER Policy Directive # 9476.00-18 on demonstrating equivalence of Part 265 clean closure with Part 264 requirements (copy enclosed).

I hope that this response will be helpful to you in establishing and implementing New York's hazardous waste policies on related issues. Should you have additional questions, please contact Bob Dellinger, Chief of the Waste Characterization Branch at (202) 475-8551.

Sincerely yours,
Jonathan Z. Cannon
Acting Assistant Administrator
☐

View Record Detail

Faxback 11140

9441.1986(23)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

MAR 21 1986

Mr. Thomas J. Jackson
Thorp, Reed, and Armstrong
One Riverfront Center
Pittsburgh, Pennsylvania 15222

Dear Mr. Jackson:

This is in response to your letter dated, February 28, 1986. In your letter, you requested an interpretation of the Federal hazardous waste rules concerning a mixture of methanol and a non-hazardous waste which does not exhibit the ignitability characteristic. Under the Federal hazardous waste rules, this mixture would not be defined as a hazardous waste, provided the waste does not exhibit any of the other hazardous waste characteristics (i.e., corrosivity, reactivity, and extraction procedure (EP) toxicity). In particular, a mixture of a characteristic hazardous waste, including wastes that are listed solely because they exhibit one or more of the hazardous waste characteristics and a solid waste is not hazardous if the mixture does not exhibit any of the hazardous waste characteristics. In the example described in your 1/ letter, methanol (a hazardous waste due to its ignitability) is mixed with a non-hazardous wastestream; the resulting mixture is no longer ignitable. Therefore, this mixture would not be considered hazardous (as long as the waste does not exhibit any of the other hazardous waste characteristics) under the Federal hazardous waste rules (i.e., a delisting petition is not necessary). States, however, may have rules that are more stringent or broader in scope than the Federal rules. Therefore, this waste remains hazardous under Pennsylvania law, unless it is exempted in accordance with State law.

1/ If the methanol is being used as a solvent, the spent methanol would be defined as EPA Hazardous Waste No. F003.

Please feel free to give me a call at (202) 475-8551 if you have any further questions.

Sincerely,

Matthew A. Straus
Chief
Waste Identification Branch

cc: Bob Allen, EPA Region III
David Freidman, Pennsylvania Department of Natural Resources

View Record Detail

Faxback 13743

9441.1995(20)

Hotline Questions and Answers

May 1995

1. Solid Waste Determination for Spilled Commercial Chemical Products

According to 40 CFR □261.2, Table 1, hazardous commercial chemical products, when recycled, are exempt from RCRA because they are not solid wastes. If a manufacturer spills a commercial chemical product into the soil and intends to reclaim the spill residue, is the spill residue exempt from RCRA standards?

The intent to recycle a commercial chemical product spill residue does not exempt the material from RCRA jurisdiction. In fact, EPA has stated that contaminated soils and other cleanup residues generally are solid wastes because of the difficulty associated with recycling wastes contained within environmental media (54 FR 48494; November 22, 1989). Sometimes, however, a spill residue can be returned to a process or otherwise put to use, and thus remain exempt from RCRA standards.

In order to demonstrate that a spill residue is not a solid waste, the generator has the burden of proving that legitimate recycling will take place. The Agency has adopted objective considerations to evaluate a generator's claim that a spilled product will be legitimately recycled. The length of time the spill residue has existed is one such consideration. In order to prove that legitimate recycling will occur, a generator may also show that recycling has already begun, the material is valuable, the material can feasibly be recycled and/or the company has recycled such material in the past (55 FR 22671; June 1, 1990).

In the absence of strong, objective indicators of recycling or intent to recycle a spill residue, "the materials are solid wastes immediately upon being spilled because they have been abandoned" (54 FR 48494; November 22, 1989), and must be managed in accordance with all applicable RCRA standards.

APPENDIX B

TABLE 3.5

WELL LOG FOR MONITORING WELL NUMBER 1

Drilling Date: February 8, 1984
Location: 29.11.27.24221

Depth in Feet	Description
0-5	Light brown clayey sand, coarse, poorly sorted, quartzose, and slightly calcareous
5-10	Yellowish gray sandy pebbles and cobbles, poorly sorted, rounded to subrounded
10-12	Yellowish gray pebbly sand, very coarse, poorly sorted, felospathic and noncalcareous
12-22	Dark gray pebbly and sandy cobbles, some quartz pebbles, most are volcanic, subrounded cobbles and pebbles, some clay, a little water at about 16 feet
22-25	Gray-green clayey sand becoming light yellow clayey sandstone and sandy claystone

TABLE 3.6

WELL LOG FOR MONITORING WELL NUMBER 2

Drilling Date: February 7, 1984
Location: 29.11.27.24321

Depth in Feet	Description
0-5	Light yellow brown silty sandy clay, very calcareous
5-10	Light yellow brown clayey sand, subrounded to subangular, moderately to poorly sorted, very calcareous
10-15	Light brown pebbly sand, clayey, very calcareous, cobbles at 15 feet
15-20	Gray sandy pebbles, poorly sorted coarse quartzose sand, pebbles are dark gray and volcanic
20-25	Dary gray cobbles, some quartz pebbles, mostly volcanic, some sand
25-26	Yellow gray clayey sandstone and sandy claystone

TABLE 3.7

WELL LOG FOR MONITORING WELL NUMBER 3

Drilling Date: February 8, 1984
Location: 29.11.27.24443

Depth in Feet	Description
0-5	Yellow brown sandy silt and clay, very calcareous quartzose
5-10	Yellow brown sand, calcareous, silty and clayey, quartzose
10-15	Yellow brown sand, silty and clayey, fine-grained, very calcareous, quartzose
15-27	Light brown clay, sandy, very clacareous, becoming pebbly with depth
27-35	Gray yellow brown cobbly sand, coarse, poorly sorted, silty and clayey, volcanic pebbles, small amount of water at about 35 feet
35-40	Gray cobbles, pebbly and sandy, coarse sand, yellow gray clayey sandstone at about 40 feet

TABLE 3.8

WELL LOG FOR MONITORING WELL NUMBER 4

Drilling Date: February 9, 1984
Location: 29.11.27.23344

Depth in Feet	Description
0-5	Yellow gray-brown sandy silt and clay, calcareous
5-10	Yellow brown silty sandy clay and clayey silt, very slightly calcareous
10-15	Reddish yellow-brown clayey sandy silt, silty clay, fine-grained quartzose sand, noncalcareous
15-19	Light brown coarse sand with clay and pebbles, calcareous
19-25	Gray pebbly sand, very coarse, poorly sorted, some clay and silt, subrounded to subangular, quartzose, pebbles rounded, slightly calcareous
25-30	Gray cobbles and pebbles, subrounded to rounded, volcanic; at about 28 feet, hydrocarbon smell and color
30-32	Gray cobbly sand, with hydrocarbon smell and color, coarse-grained, sand is quartzose and feldspathic, subrounded and subangular quartz grains are clear
32	Yellow gray clayey sandstone

TABLE 3.9

WELL LOG FOR MONITORING WELL NUMBER 5

Drilling Date: February 6, 1984
Location: 29.11.26.31112

Depth in Feet	Description
0-5	Pale yellow brown clay, silty, some sand, calcareous
5-10	Pale yellow brown clayey sand and quartzose silt, poorly sorted, calcareous
10-15	Yellow brown sand, subrounded quartzose sand slightly calcareous
15-20	Yellow brown sand, clayey, moderately coarse-grained, very calcareous
20-25	Yellow brown sand, clayey, silty, fine- to medium-grained, moderately sorted, noncalcareous
25-35	Yellow brown sand, silty and slightly clayey, fine- to medium-grained, well sorted, subangular, noncalcareous, becoming more clayey with depth
35-37	Yellow brown pebbly and cobbly sand, clayey, calcareous
37-47	Dark gray sandy and clayey cobbles and pebbles, water at 42 feet
47-50	Dark gray cobbles with greenish clay
50-54	Green-gray pebbly clay

TABLE 3.10

WELL LOG FOR MONITORING WELL NUMBER 6

Drilling Date: February 7, 1984
Location: 29.11.27.42144 or 42233

Depth in Feet	Description
0-15	Pale yellow brown sand, clayey and silty, subangular, poorly sorted, quartzose, very calcareous, becoming more clayey with depth
15-20	Pale yellow brown silt, sandy and clayey, silt is coarse, sand is very fine, moderate sorting, quartzose and calcareous
20-25	Pale yellow sand, slightly clayey, subrounded, well sorted, quartzose, noncalcareous
25-35	Pale yellow sand, coarse- to medium-grained, quartzose, noncalcareous
35-41	Pale yellow sand, clayey, fine-grained, silty, quartzose, slightly calcareous
41-49	Gray-black cobbles and pebbles, volcanic
49-52	Gray-green clayey sandstone and sandy claystone

TABLE 3.1

WELL LOG FOR MONITORING WELL NUMBER 7

Drilling Date: February 25

Depth in Feet	Description
0-1	Gravel fill
1-5	Brown sandy silt and clay with small gravels
5-10	Brown sandy silt and clay, more firm and sticky
10-15	Lighter brown sandy silt and sticky clay
15-20	Lighter brown sandy silt and clay, larger cobbles and pebbles
20-25	Sand with cobbles and pebbles
25-30	Sand
30-35	Greenish clay with pebbles, top of Nacimiento estimated at 32 feet
35-40	Greenish clay, few pebbles
40-45	Green to gray clay, smooth drilling
45-50	Green to gray clay, smooth drilling
50-65	Sticky gray to green clay

Elevation of Top of Pipe: 5524.09 feet

Total Depth of Casing: 62.11 feet

Description of Casing: Bottom of casing has a 2 foot stainless steel blank section for a silt trap, followed by a 10 foot section of 6" I.D. stainless steel screen, in turn followed by 6" I.D. schedule 40 PVC casing to the top of pipe. Sand was added to 45 feet below grade, bentonite to 41 feet below grade, and grout to the surface.

TABLE 3.2

WELL LOG FOR MONITORING WELL NUMBER 8

Drilling Date: February 28, 1986

Depth in Feet	Description
0-20	Light brown sandy clay, similar to that found on the ground surface
20-34	Cobbles and pebbles
34	Green-gray clay and sandstone, intermixed with small pebbles and sand. Top of Nacimiento.

Elevation of Top of Casing: 5531.12 feet

Total Depth of Casing: 34.94 feet

Description of Casing: Bottom of casing has a 2 foot stainless steel blank section for a silt trap, followed by 20 feet of 6" I.D. stainless steel screen, followed by 6" I.D. schedule 40 PVC to the surface. The screened section of the hole was sanded to within 7 feet of the surface, a bentonite seal (1/2 bucket) was added and concrete was used for a surface seal.

TABLE 3.3

WELL LOG FOR MONITORING WELL NUMBER 9

Drilling Date: March 3, 1986

Depth in Feet	Description
0-5	Fill material, some rock
5-10	Sticky reddish brown silty clay
10-15	Lighter color silty clay, some pebbles
15-20	Lighter color silty clay, some pebbles
20-25	Cobbles, pebbles, sand
25-30	Cobbles, greenish clay, top of Nacimiento

Elevation of Top of Casing: 5519.70 feet

Total Depth of Casing: 33.99 feet

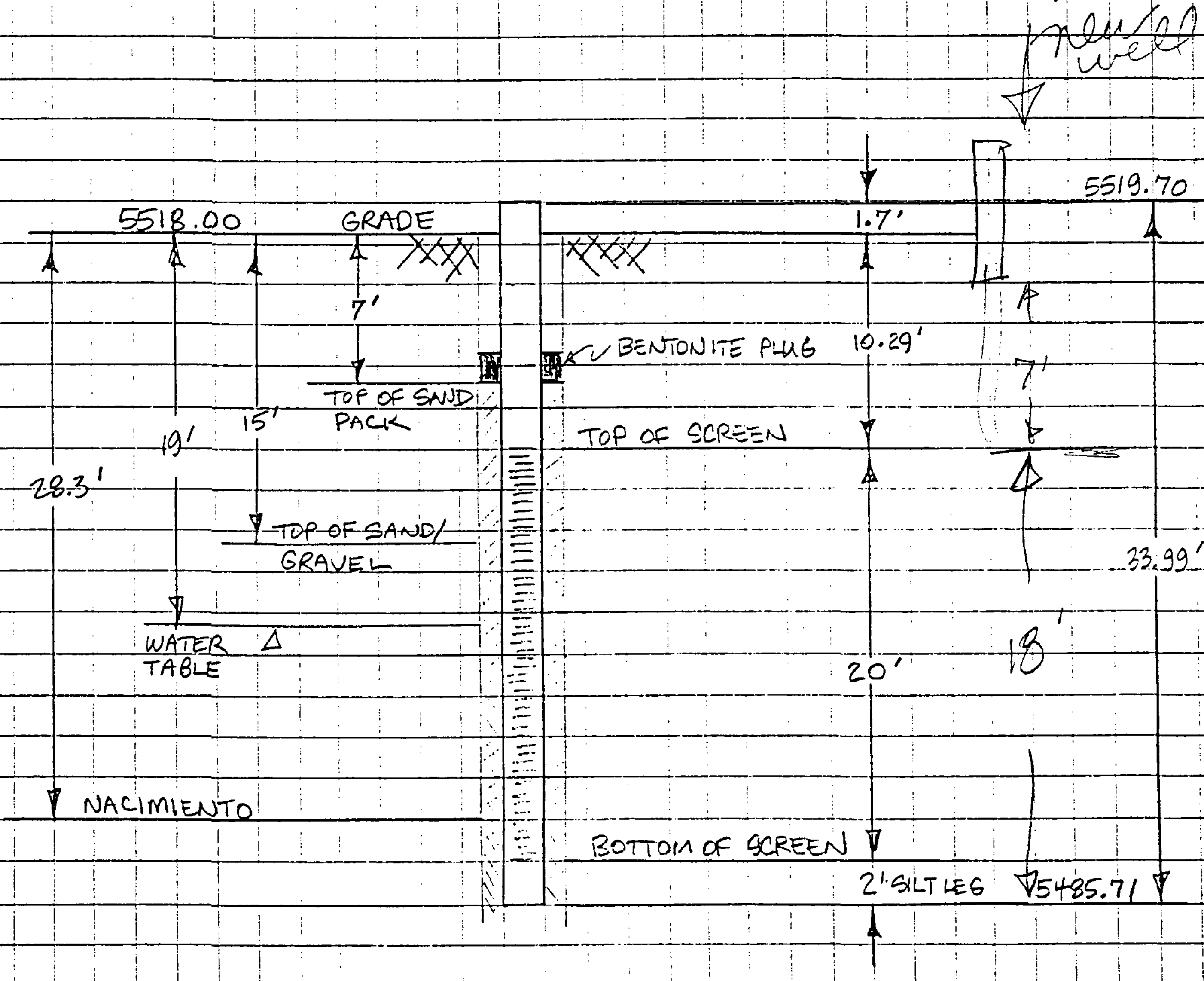
Description of Casing: Bottom of casing has a 2 foot stainless steel blank section for a silt trap followed by 20 feet of 6" I.D. stainless steel screen, followed by 6" I.D. schedule 40 PVC to the surface. The screened section of the hole was sanded to within 7 feet of the surface, a bentonite seal (1/2 bucket) was added and concrete was used for a surface seal.

CALCULATION SHEET

MW-9

CONSTRUCTION COMMENTS: DRILLED UTILIZING DRILLING MUD THEN THOROUGHLY DEVELOPED. BOTTOM OF CASING TO THE TOP OF SCREEN IS 6" I.D. STAINLESS STEEL, REST OF CASING TO SURFACE IS 6" SCH. 40 PVC. TOP OF CASING HAS CONCRETE SURFACE SEAL AND STEEL PIPE, WITH LOCKING LID, CASING PROTECTOR (NOT SHOWN).

LOCATION: NEAR TANK 5, NORTHWEST OF NOWP.



INITIALS: CA

PROJECT No.: GROUNDWATER MONITORING - SOWP & NOWP

DATE: 9-17-91

SUBJECT: MW-9

DATE OF INSTALLATION: 3-3-86

SHEET 1 OF 1

TABLE 3.4

WELL LOG FOR MONITORING WELL NUMBER 10

Drilling Date: March 4, 1986

Depth in Feet	Description
0-5	Topsoil, roadbase, reddish brown sandy clay
5-10	Reddish brown silty, sandy clay
10-15	Cobbles, pebbles
15-20	Gravel, cobbles, pebbles
20-25	Greenish clay at 23 feet, top of Nacimiento
25-30	Greenish clay, Nacimiento
30-35	Nacimiento, color changed from yellow-green to blue-gray

Elevation of Top of Casing: 5516.86 feet

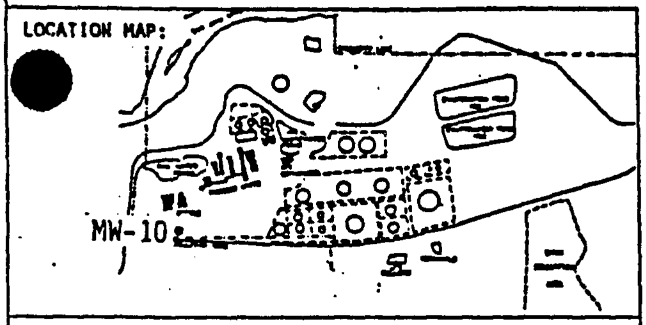
Total Depth of Casing: 33.93 feet

Description of Casing: Bottom of casing has a 2 foot stainless steel blank section for a silt trap, followed by 20 feet of 6" I.D. stainless steel screen, followed by 6" I.D. schedule 40 PVC to the surface. The screened section of the hole was sanded to within 7 feet of the surface, a bentonite seal (1/2 bucket) was added and concrete was used for a surface seal.

LITHOLOGIC LOG (SOIL)

Page 1 of 1

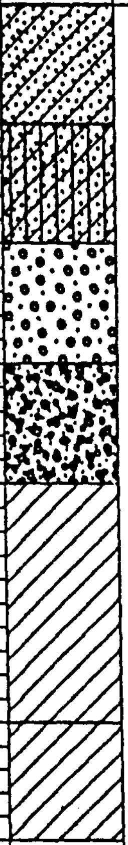
LOCATION MAP:



___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: MW-10 (RW-3)
SITE COORDINATES (ft.):
N ___ E ___
GROUND ELEVATION (ft. MSL): ~5516
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Auger
DRILLING CONTR.: Earl & Sons, Inc.
DATE STARTED: 4 March 1986 DATE COMPLETED: 4 March 1986
FIELD REP.: Engineering-Science, Inc.
COMMENTS:

LOCATION DESCRIPTION:

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-5' Topsoil, Roadbase, Sandy Clay
5					5'-10' Silty, Sandy Clay
10					10'-15' Cobbles and Pebbles
[illegible]5					15'-20' Gravel, Cobbles, and Pebbles
20					20'-30' Green Clay; Nacimiento Formation
25					30'-35' Nacimiento Formation - Yellow-green to blue-gray.
30					
35		T.D. 35'			
40					
45					

LITHOLOGIC LOG

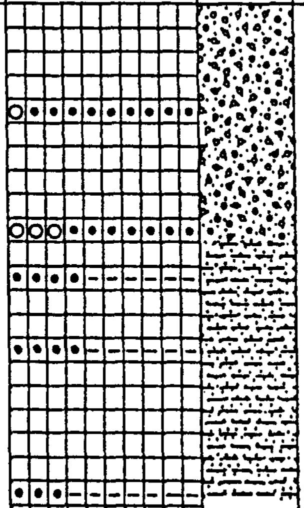
Page 1 of 1

LOCATION MAP:

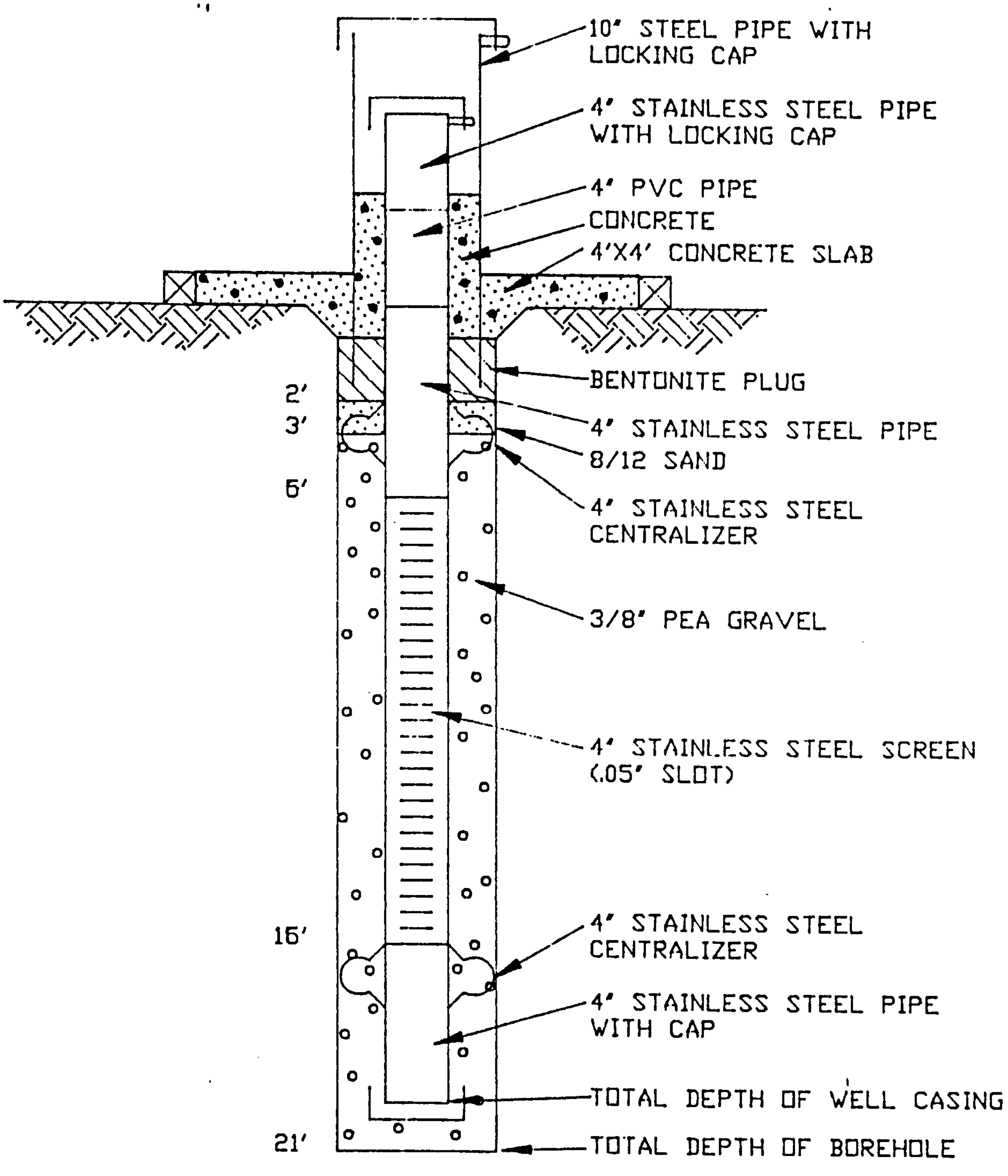
__1/4 __1/4 __1/4 __1/4 S__ T__ R__

SITE ID: BRC LOCATION ID: BRC-11
SITE COORDINATES (ft.):
N ______ E ______
GROUND ELEVATION (ft. MSL): ______
STATE: NEW MEXICO COUNTY: SAN JUAN
DRILLING METHOD: AIR CASING DRIVER ROTARY
DRILLING CONTR.: BEEMAN
DATE STARTED: 7-31-87 DATE COMPLETED: 7-31-87
FIELD REP.: KASZUBA/SELKE
COMMENTS: STEAM CLEANED RIG AND ALL TOOLS PRIOR TO DRILLING.

LOCATION DESCRIPTION: TD-21'



Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description	
5				0- 5'	0 - 5'	SAND, mod yelsh brn (10YR5/4), fine to med. gr. sand w/minor crs gr. sand and pebble gravel (up to 1"). Unconsolidated, moderately well sorted, subrounded, no odor.
10				5-10'	5 -10'	GRAVELLY SAND, olive gray (5Y4/1), fine to med. gr. sand w/minor crs gr. sand unconsolidated, mod. well sorted, subrounded, gravel clasts (¼" to 2") subrounded. Moderate degradation odor.
15				10-12½'	10 -12.½'	SANDY CLAY, lt. olive gray (5Y5/2), fine to med. gr. sand in clay matrix no odor.
				12½-15'	12½-15'	SANDY CLAY, as above.
20				15-21'	15 -21'	SANDY CLAY, yelsh gray (5Y7/2), fine gr. sand in clay matrix, clay chips up to 1½" from moderately consolidated clay (or weathered shale).
25					NOTE:	Saturation from ~7-8' to ~12½'
30						
35						
40						
45						
50						



MONITOR WELL BRC-11

LITHOLOGIC LOG

Page 1 of 1

LOCATION MAP:

___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: BRC-12

SITE COORDINATES (ft.):

N ______ E ______

GROUND ELEVATION (ft. MSL): ______

STATE: NEW MEXICO COUNTY: SAN JUAN

DRILLING METHOD: AIR CASING DRIVER ROTARY

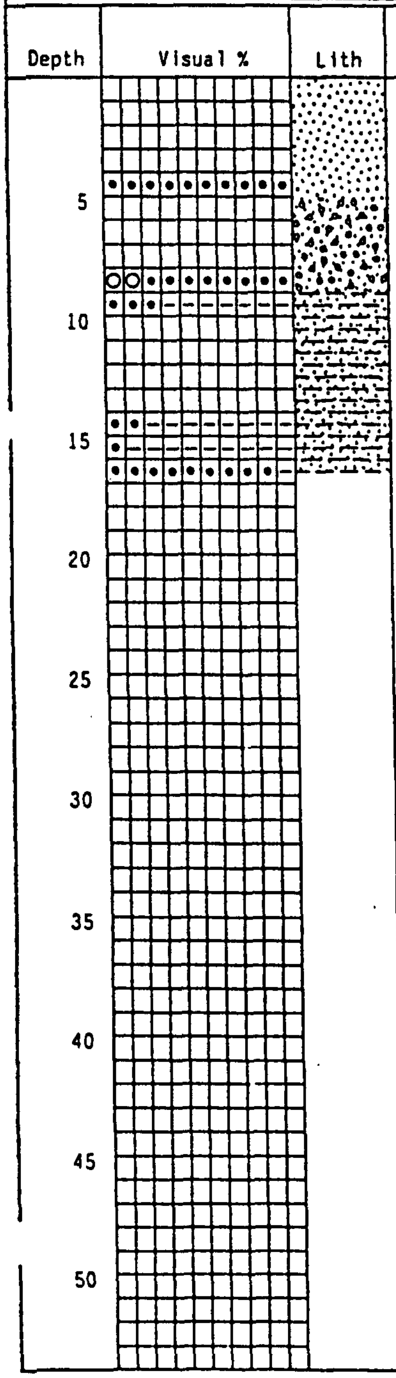
DRILLING CONTR.: BEEMAN BROTHERS

DATE STARTED: 8-1-87 DATE COMPLETED: 8-1-87

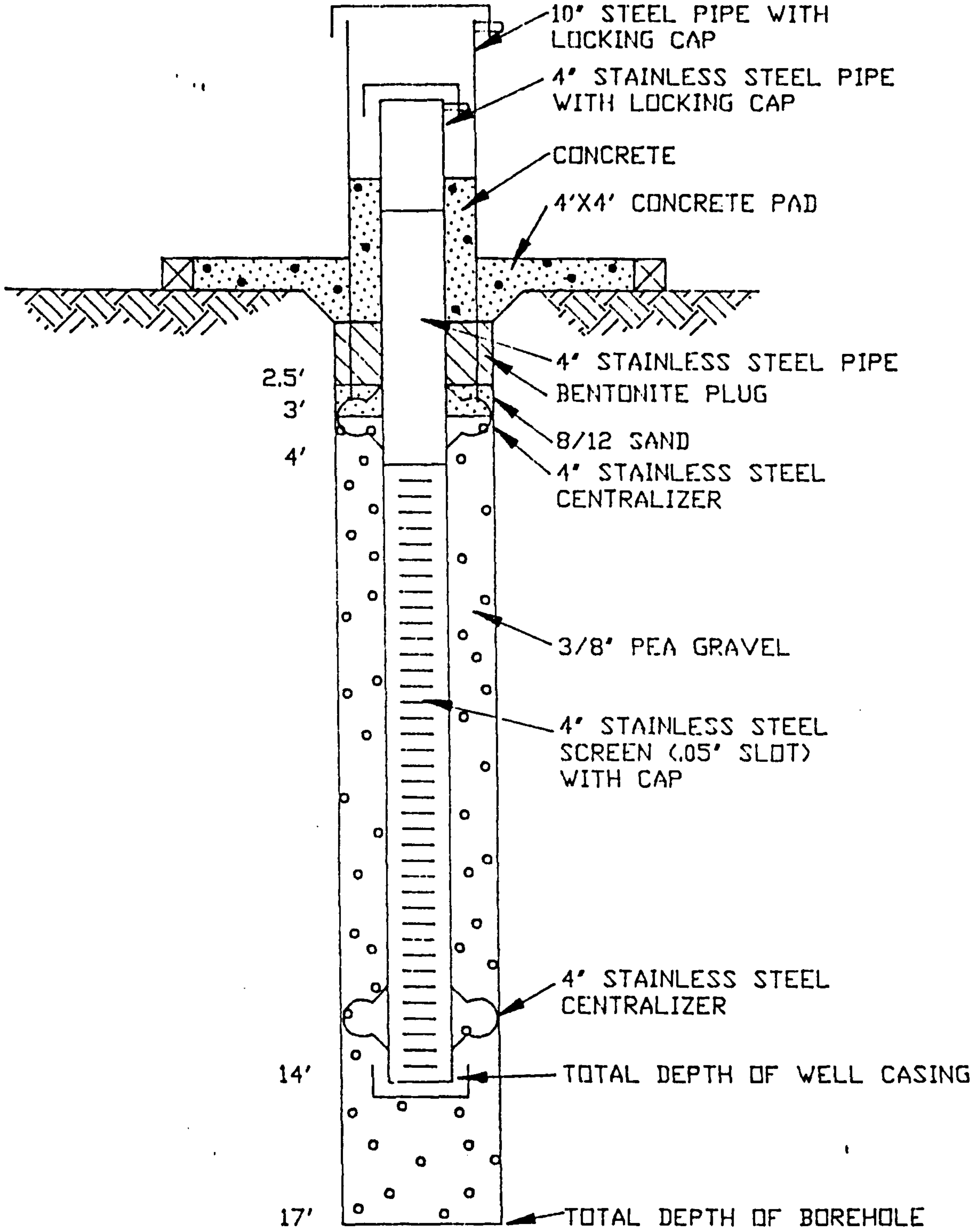
FIELD REP.: KASZUBA

COMMENTS: SATURATED FROM ~5'-~12'. TD=17'.
STEAM-CLEANED ALL TOOLS PRIOR TO DRILLING.

LOCATION DESCRIPTION: ______



Drilling Time Scale:	Sample Type and Interval		Lithologic Description
	0- 5'	0- 5'	SAND, mod yellowish brwn (10YR5/4), fine-to med-grained sand, unconsolidated, well-sorted, subrounded. No HC odor. Saturated @ ~5'.
	5- 9'	5- 9'	SAND, as above. Saturated. Gravelly sand @ 9'. Subrounded gravel, 2" dia.
	9-10'	9-10'	SANDY CLAY, dusky yellow (5Y6/4), fine-to med-gr sand in clay matrix. No HC odor. Saturated.
	10-15'	10-15'	SANDY CLAY, as above. Minor chips of clay (shale), ~10%. Saturated to ~12'.
	15-16'	15-16'	SANDY CLAY, as above. Clay chips up to ½" (moderately consolidated clay or weathered shale). Contains <10% gypsum. No HC odor.
	16-17'	16-17'	CLAYEY SAND, dusky yellow (5Y6/4), sand is fine-grained, well-sorted, No HC odor.

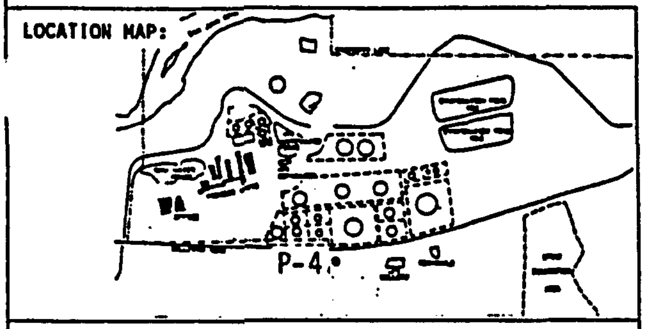


MONITOR WELL BRC-12

LITHOLOGIC LOG (SOIL)

Page 1 of 1

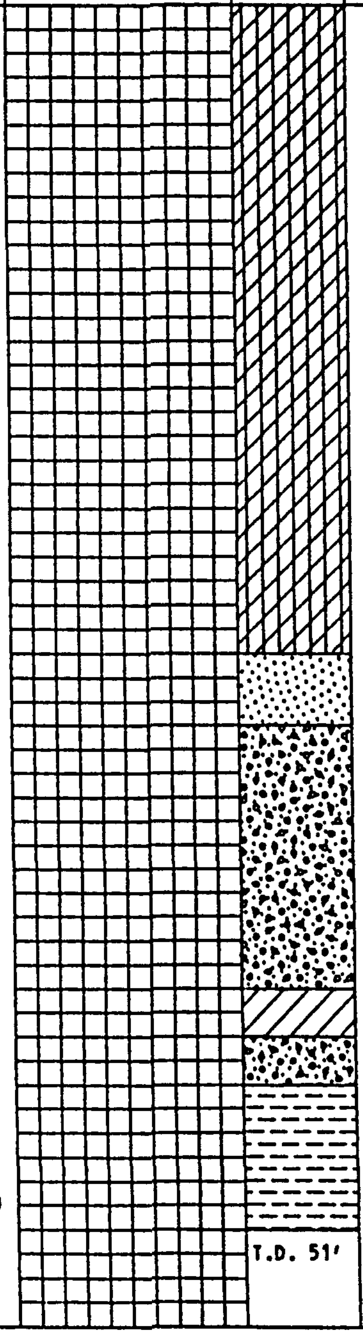
LOCATION MAP:



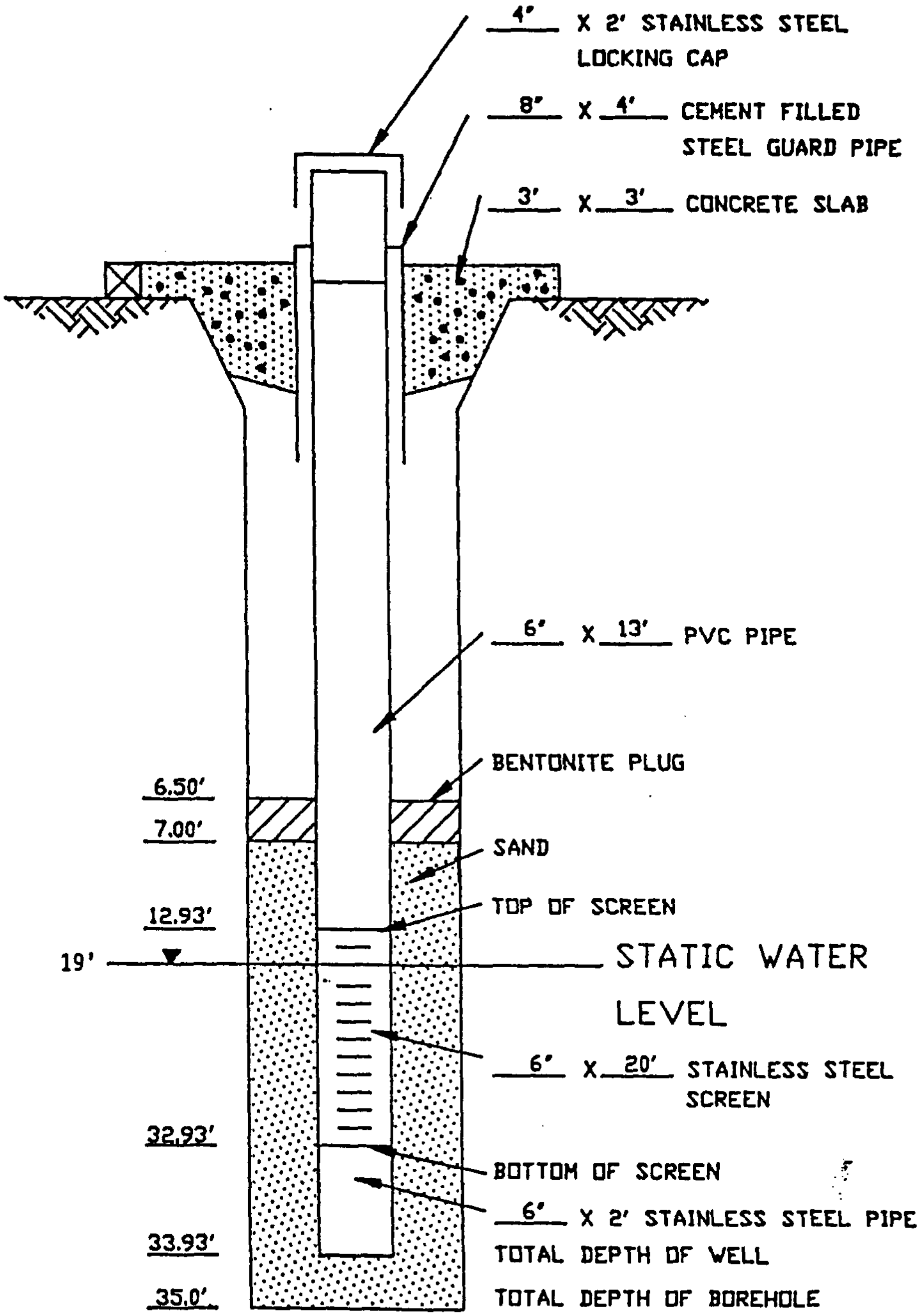
___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: P-4 (MW-13)
SITE COORDINATES (ft.):
N E
GROUND ELEVATION (ft. MSL): 5538.42
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Casing Driver
DRILLING CONTR.: Beeman Brothers
DATE STARTED: 2 September 1988 DATE COMPLETED: 3 September 1988
FIELD REP.: W.S. Dubyk
COMMENTS: Static on September 9, 1988: 37.91' from TOC.

LOCATION DESCRIPTION:



Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-27' <u>Silt and Clay</u> - Moderate brown (5 YR 4/4) to light brown (5 YR 5/6).
5					
10					
15					
20					
25			1233		
					27'-30' <u>Sand</u> - Very pale or (5 YR 8/2) fine to coarse grained, angular to subangular predominantly quartz.
30					30'-40' <u>Gravel and Sand</u> - Light gray (N7). Sand is medium to coarse grained, subrounded to rounded. Gravel is subangular to rounded, up to 3" diameter.
35					
40			1415		41'-43' <u>Clay</u> - Pale olive (10 Y 6/2), plastic.
					43'-45' <u>Gravel and Sand</u> - As above.
45			1420		45'-51' <u>Shale: Nacimiento Formation</u> - Dusky yellow (5 Y 6/4) to olive gray (5 Y 3/2).
50					
		T.D. 51'	1455		



COMPLETION DIAGRAM
RECOVERY WELL MW-13 (RW-3)
(RECONSTRUCTED FROM VERBAL DESCRIPTION
SUPPLIED BY ENGINEERING-SCIENCE, 1987)

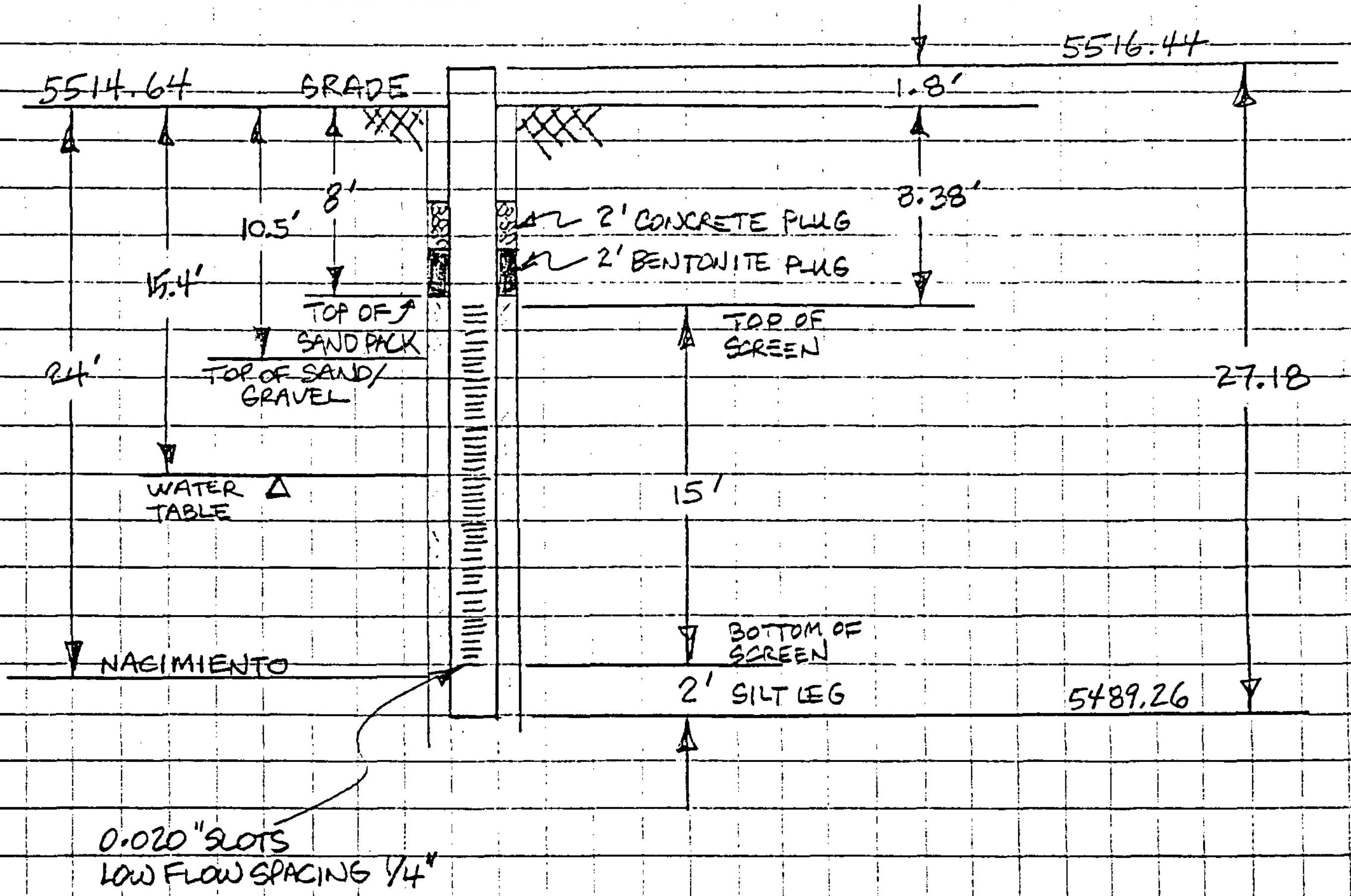
MW-20

CALCULATION SHEET

CONSTRUCTION COMMENTS: DRILLED BY CASING DRIVER, 8" BIT; 4.5" O.D. FIBERGLASS CASING SET TO DEPTH INSIDE DRIVEN CASING; ANNULAR SPACE FILLED WITH 30/40 SAND AS DRIVEN CASING REMOVED; 50 LBS. OF BENTONITE DRILLING MUD & 100 LBS OF CONCRETE PLACED ON TOP OF SAND PACK; BACKFILLED WITH DIRT TO SURFACE.

LOCATION: NORTH SIDE OF NOWP-CENTERED.

CONCRETE PAD SURFACE SEAL (NOT SHOWN)



INITIALS CA PROJECT No. GROUNDWATER MONITORING - SOWP & NOWP

DATE 9-16-91 SUBJECT MW-20

DATE OF INSTALLATION: 9-13-91 SHEET 1 OF 2

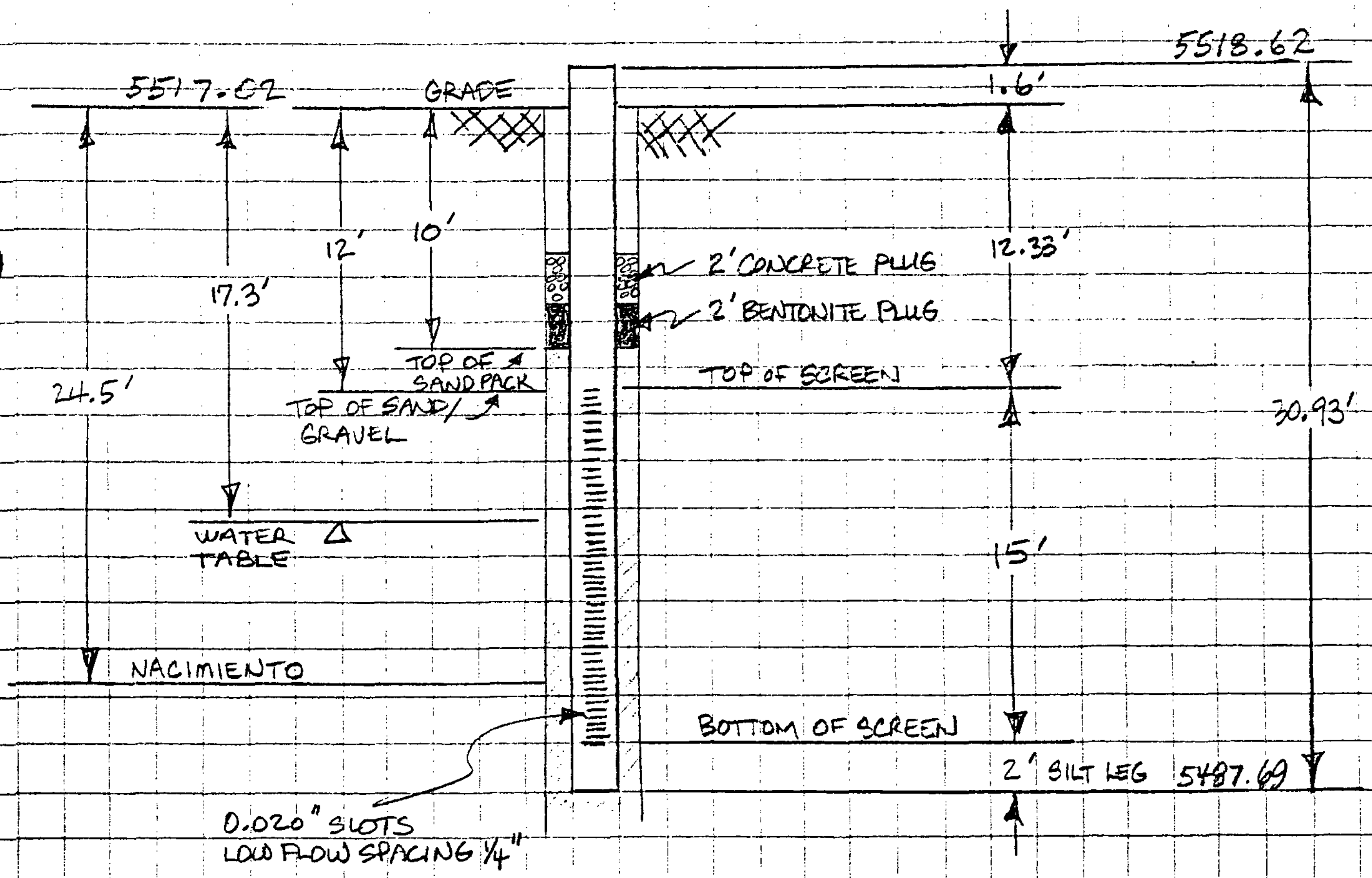
CALCULATION SHEET

MW-21

CONSTRUCTION COMMENTS: DRILLED BY CASING DRIVER, 8" BIT; 4.5" O.D. FIBERGLASS CASING SET TO DEPTH INSIDE DRIVEN CASING; ANNULAR SPACE FILLED WITH 30/40 SAND AS DRIVEN CASING REMOVED; 50 LBS OF BENTONITE DRILLING MUD & 100 LBS OF CONCRETE PLACED ON TOP OF SAND PACK; BACKFILLED WITH DIRT TO SURFACE.

LOCATION: ALONG PIPERACK SW FROM TK 11

CONCRETE PAD SURFACE SEAL (NOT SHOWN)



INITIALS CH

PROJECT No. GROUNDWATER MONITORING - SOWP & NOWP

DATE 9-16-91

SUBJECT MW-21, UPGRADIENT FROM SOWP & NOWP

DATE OF INSTALLATION: 9-16-91

SHEET 2 OF 2

GROUNDWATER
TECHNOLOGY

Drilling Log

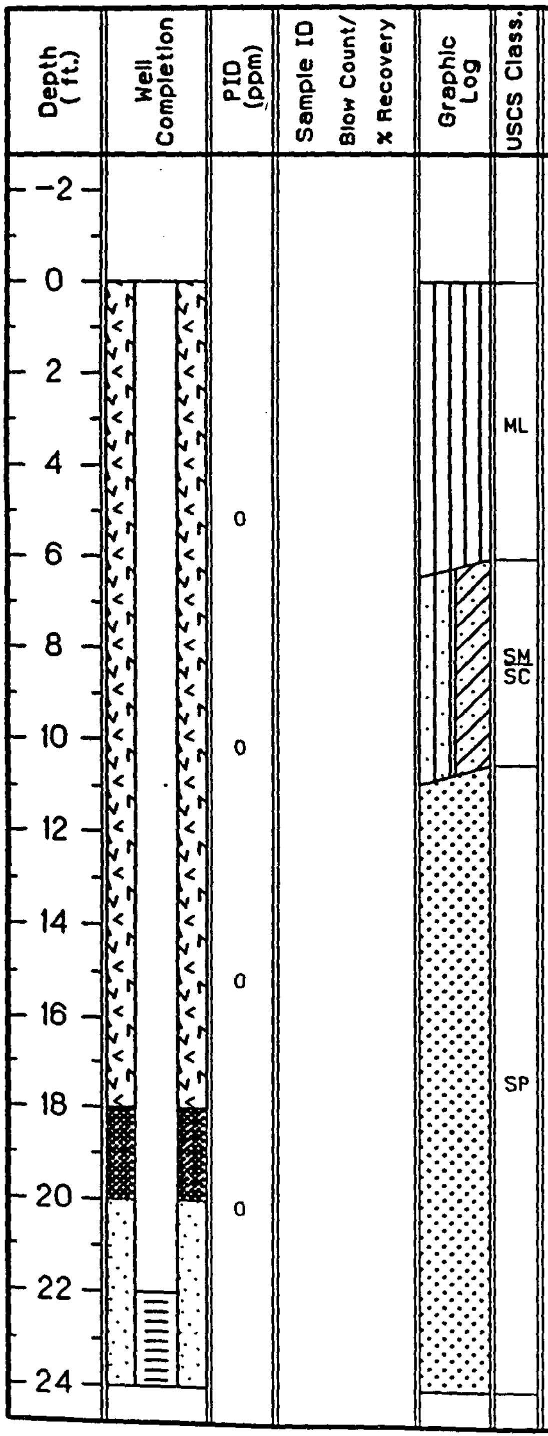
Monitoring Well **MW-25**

Project BRC Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. 5527.45 Total Hole Depth 38 ft. Diameter 11 in.
Top of Casing 5530.45 Water Level Initial 28 ft. Static
Screen: Dia 6 in. Length 14 ft. Type/Size FRE 0.020 in.
Casing: Dia 6 in. Length 24/2 ft. Type FRE
Fill Material 10/20 Co. Silica Rig/Core Drill Systems 180
Drill Co. Layne Method Air Percussion
Driller Gabby Rodriguez Log By Jerry May Date 05/11/94 Permit #
Checked By License No.

See Site Map
For Boring Location

COMMENTS:

Start @ 1000 hrs. 2 ft. silty leg installed from 36 feet to 38 feet.



Description
(Color, Texture, Structure)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%

Brown clayey SILT (dry-moist)

Brown fine poorly-graded silty/clayey SAND (moist)

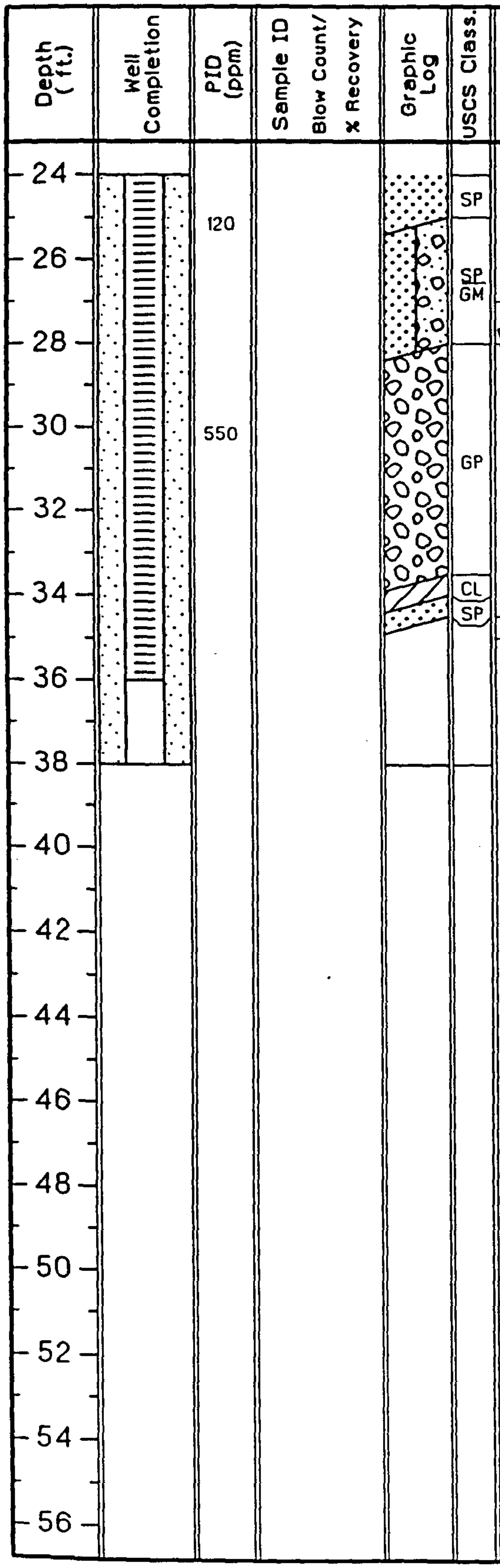
Tan fine poorly-graded SAND (moist)

GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Well MW-25

Project BRC Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014



Description

(Color, Texture, Structure)

Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%

Tan fine-coarse, poorly-graded SAND with gravel and cobbles (moist)

Dark gray-stained at 28 feet.

Groundwater encountered at 28 feet 5/11/94

Dark gray-stained cobbles (little fines)

Brown silty clay lens at 34 feet (moist)

Tan very fine poorly-graded SAND (dry)

Encountered weathered limestone at 35 feet (dry)

End of boring at 38 feet (1110 hrs.). Installed well screened from 22 to 36 feet on 5/11/94.

GROUNDWATER
TECHNOLOGY

Drilling Log

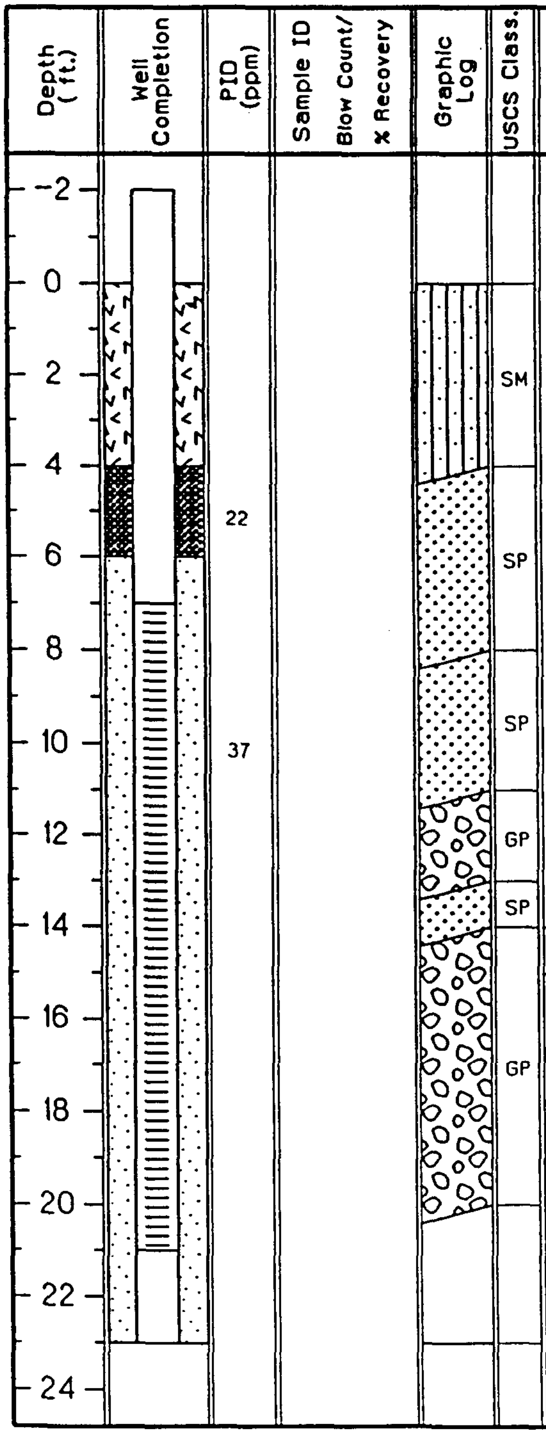
Monitoring Well MW-26

Project BRC Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. 5512.54 Total Hole Depth 23 ft. Diameter 15 in.
Top of Casing 5514.54 Water Level Initial 15 ft. Static
Screen: Dia 6 in. Length 14 ft. Type/Size FRE 0.020 in.
Casing: Dia 6 in. Length 9/2 ft. Type FRE
Fill Material 10/20 Co. Silica Rig/Core Drill Systems 180
Drill Co. Layne Method Air Percussion
Driller Gabby Rodriguez Log By Jerry May Date 05/12/94 Permit #
Checked By License No.

See Site Map For Boring Location

COMMENTS:

Start @ 0730 hrs. Silt leg installed from 21 feet to 23 feet.



Description
(Color, Texture, Structure)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%

Tan fine poorly-graded silty SAND (moist)

Tan fine poorly-graded SAND (moist)

Tan fine-coarse SAND with a little pea gravel and cobbles (dry)

Cobbles with some fines (dry)

Tan fine-coarse poorly-graded SAND (dry)

Gray-stained cobbles with some fines dry-wet

Groundwater encountered at 15 feet on 5/12/94

Dark gray-stained silty clay lens at 16 feet

Dark gray-stained silty clay lens at 19 feet

Encountered weathered limestone (moist)

Dry at 22 feet

End of boring at 23 feet (0820 hrs.). Installed well screened from 7 to 21 feet on 5/12/94.

Drilling Log

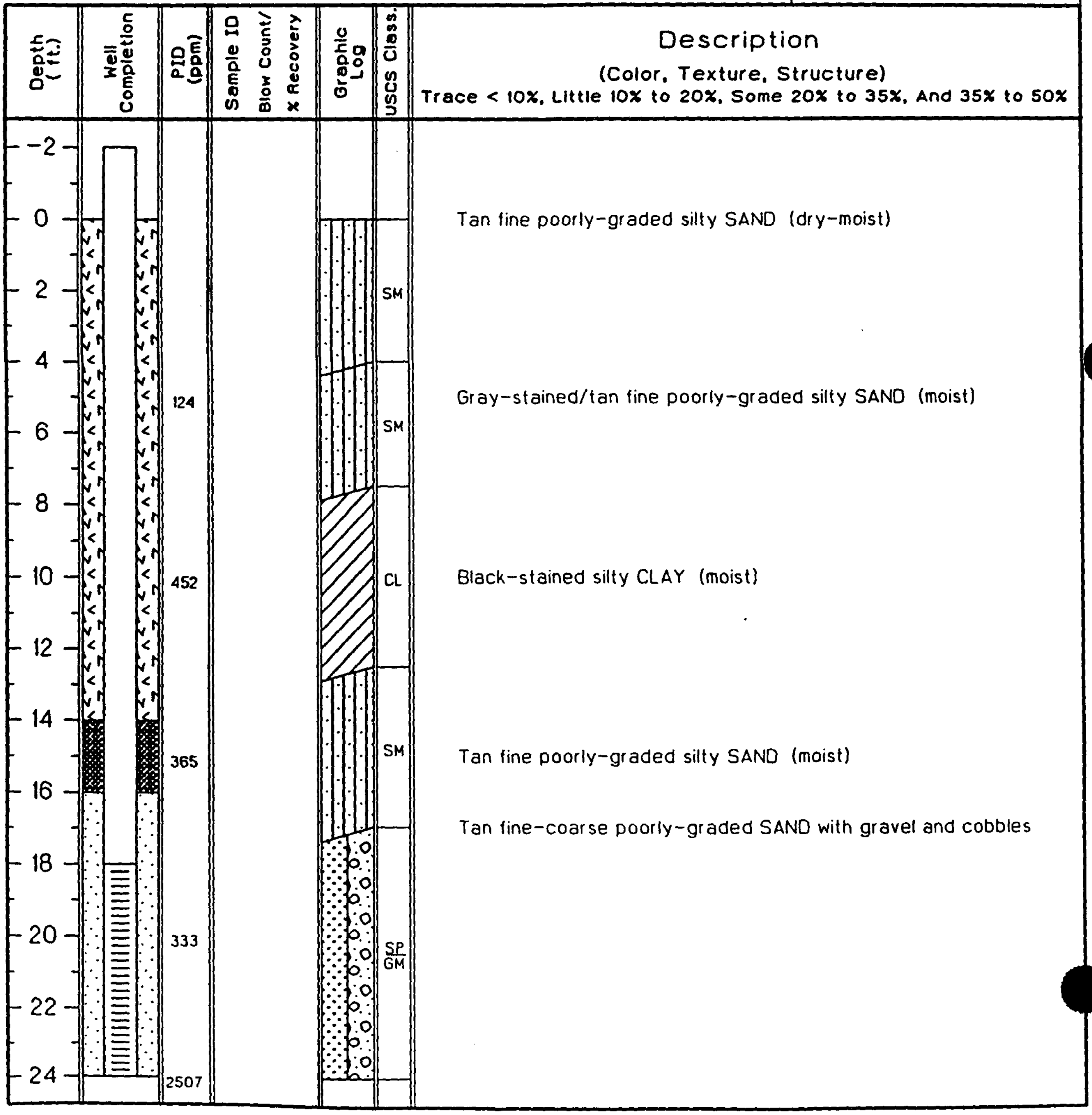
Monitoring Well MW-28

Project BRC Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. 5521.52 Total Hole Depth 33 ft. Diameter 10 in.
Top of Casing 5524.52 Water Level Initial 25 ft. Static
Screen: Dia 4 in. Length 15 ft. Type/Size FRE 0.020 in.
Casing: Dia 4 in. Length 20/2 ft. Type FRE
Fill Material 10/20 Co. Silica Rig/Core Drill Systems 180
Drill Co. Layne Method Air Percussion
Driller Gabby Rodriguez Log By Jerry May Date 05/13/94 Permit #
Checked By License No.

See Site Map
For Boring Location

COMMENTS:

Start @ 1020 hrs. Installed silt leg from 33 to 35 feet.



Description
(Color, Texture, Structure)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%

Tan fine poorly-graded silty SAND (dry-moist)

Gray-stained/tan fine poorly-graded silty SAND (moist)

Black-stained silty CLAY (moist)

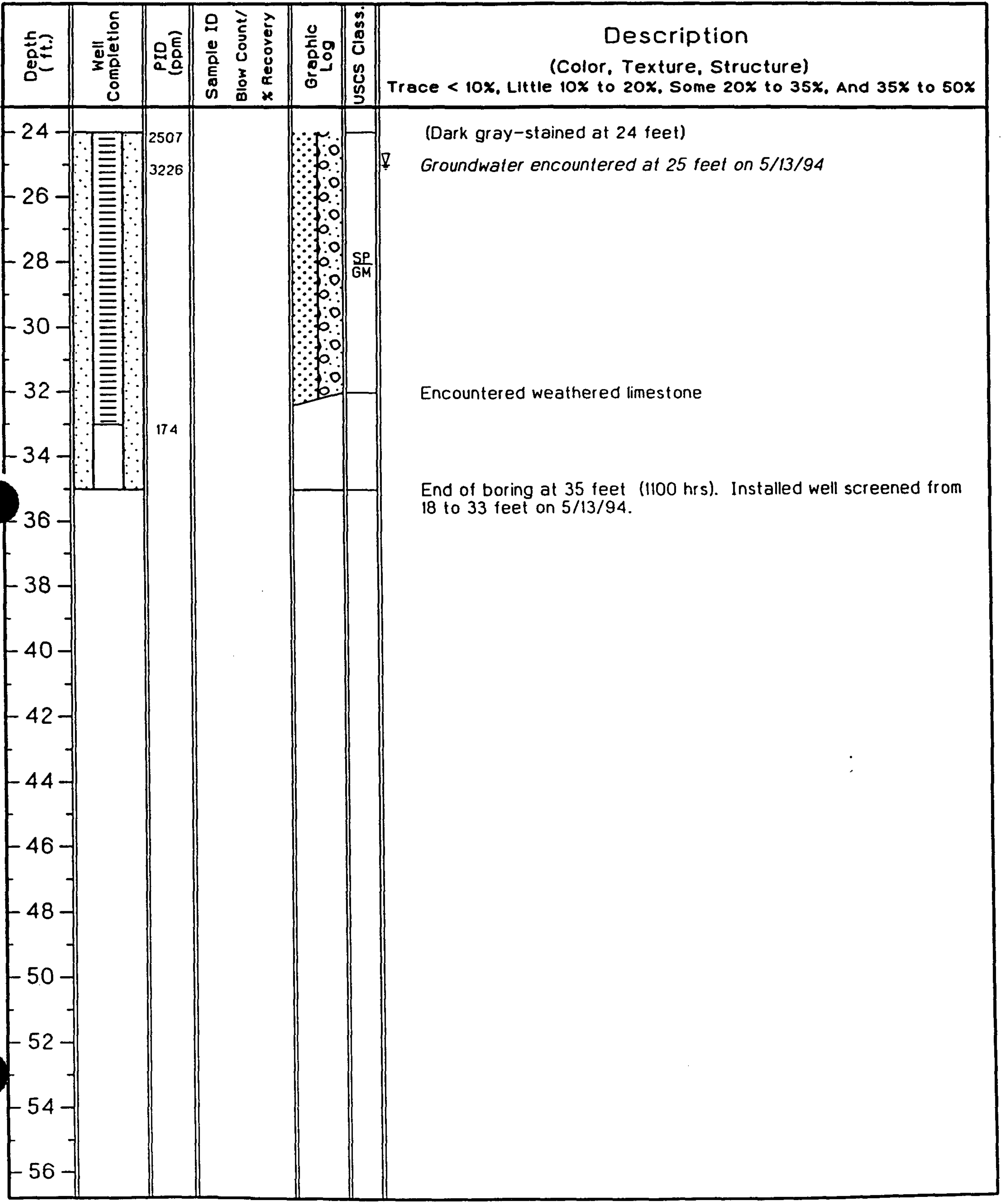
Tan fine poorly-graded silty SAND (moist)

Tan fine-coarse poorly-graded SAND with gravel and cobbles

Drilling Log

Monitoring Well MW-28

Project BRC Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014



Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24		2507					(Dark gray-stained at 24 feet)
25		3226					Groundwater encountered at 25 feet on 5/13/94
28						SP GM	
32							Encountered weathered limestone
33		174					
35							End of boring at 35 feet (1100 hrs). Installed well screened from 18 to 33 feet on 5/13/94.

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well MW-29

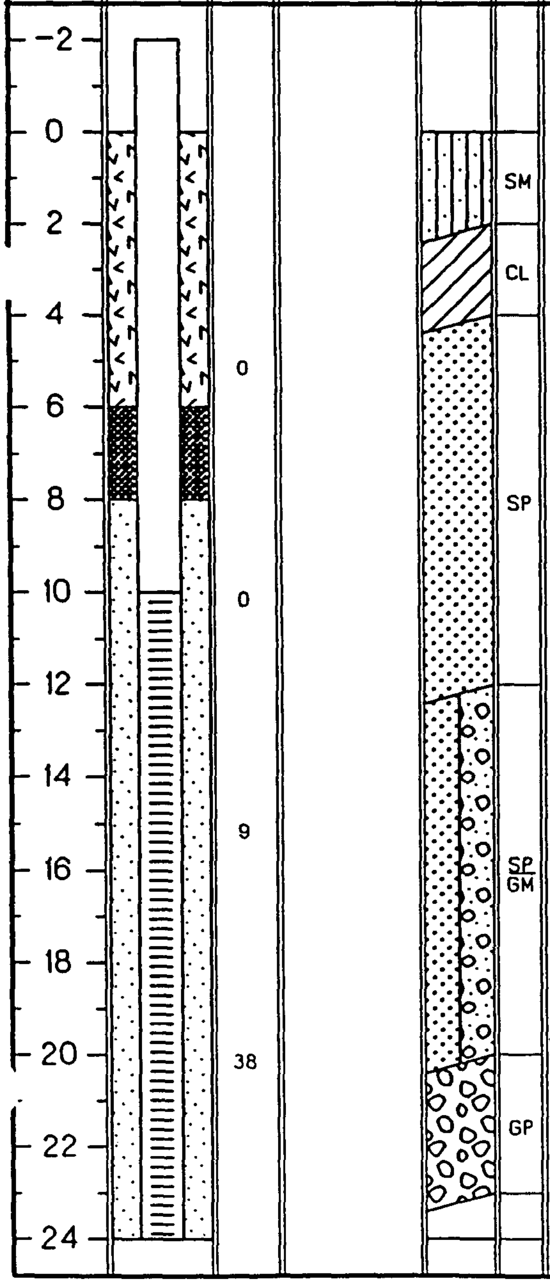
Project *BRC* Owner *Bloomfield Refining Co.*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*
Surface Elev. 5518.55 Total Hole Depth *26 ft.* Diameter *10 in.*
Top of Casing 5521.55 Water Level Initial *20 ft.* Static
Screen: Dia *4 in.* Length *14 ft.* Type/Size *FRE 0.020 in.*
Casing: Dia *4 in.* Length *12/2 ft.* Type *FRE*
Fill Material *10/20 Co. Silica* Rig/Core *Drill Systems 180*
Drill Co. *Layne* Method *Air Percussion*
Driller *Gabby Rodriguez* Log By *Jerry May* Date *05/12/94* Permit #
Checked By License No.

See Site Map For Boring Location

COMMENTS:

Start @ 1445 hrs. Installed silt leg 24 to 26 feet.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%



Tan fine poorly-graded silty SAND (moist)

Tan silty CLAY (moist)

Tan fine poorly-graded SAND (moist)

Tan fine-coarse poorly-graded SAND with gravel and cobbles

Groundwater encountered at 20 feet on 5/12/94

Cobbles with some fines (wet)

Encountered weathered limestone (dry)

GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Well **MW-29**

Project *BRC* Owner *Bloomfield Refining Co.*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							
26							End of boring at 26 feet (1510 hrs). Installed well screened from 10 to 24 feet.
28							
30							
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Well MW-30

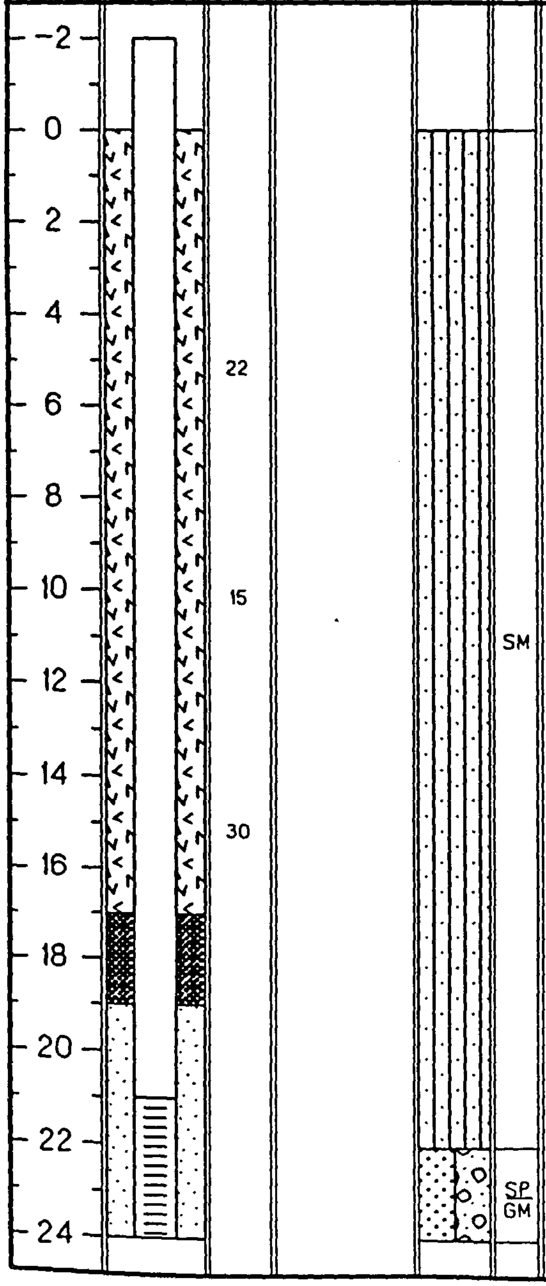
Project *BRC* Owner *Bloomfield Refining Co.*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*
Surface Elev. 5530.42 Total Hole Depth *38 ft.* Diameter *10 in.*
Top of Casing 5533.42 Water Level Initial *31 ft.* Static
Screen: Dia *4 in.* Length *15 ft.* Type/Size *FRE 0.020 in.*
Casing: Dia *4 in.* Length *23/2 ft.* Type *FRE*
Fill Material *10/20 Co. Silica* Rig/Core *Drill Systems 180*
Drill Co. *Layne* Method *Air Percussion*
Driller *Gabby Rodriguez* Log By *Jerry May* Date *05/13/94* Permit #
Checked By License No.

See Site Map For Boring Location

COMMENTS:

Start @ 0720 hrs. Installed silt leg from 36 to 38 feet.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%



Tan fine poorly-graded silty SAND (moist)

(Same as above)

(Same as above)

(Same as above)

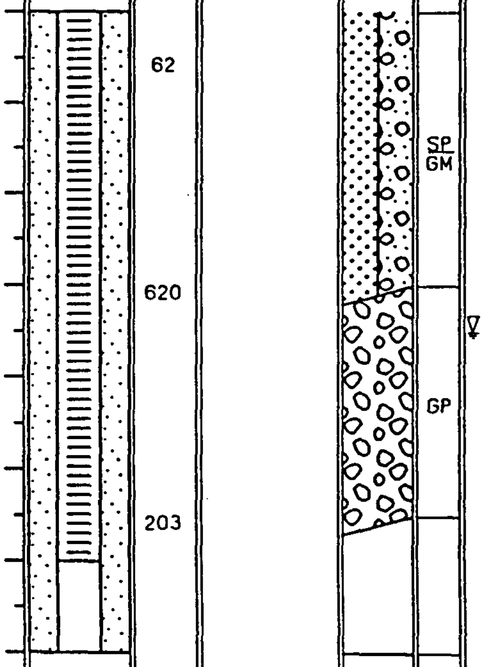
Tan fine-coarse poorly-graded SAND with pea gravel and cobbles

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Well **MW-30**

Project BRC **Owner** Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico **Proj. No.** 023353014



Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24					
25	62				(Same as above)
26					
27				SP GM	
28					
30	620				Dark gray-stained cobbles with some fines (moist-very moist)
31					∇ *Assume groundwater encountered at 31 feet on 5/13/94*
32					
33				GP	
34					(Some clay and silt at 34 feet)
35	203				Encountered weathered limestone (dry)
36					
38					End of boring at 38 feet (0800 hrs). Installed well screened from 21 to 36 feet.
40					
42					
44					
46					
48					
50					
52					
54					
56					

GROUNDWATER
TECHNOLOGY

Drilling Log

Monitoring Well MW-31

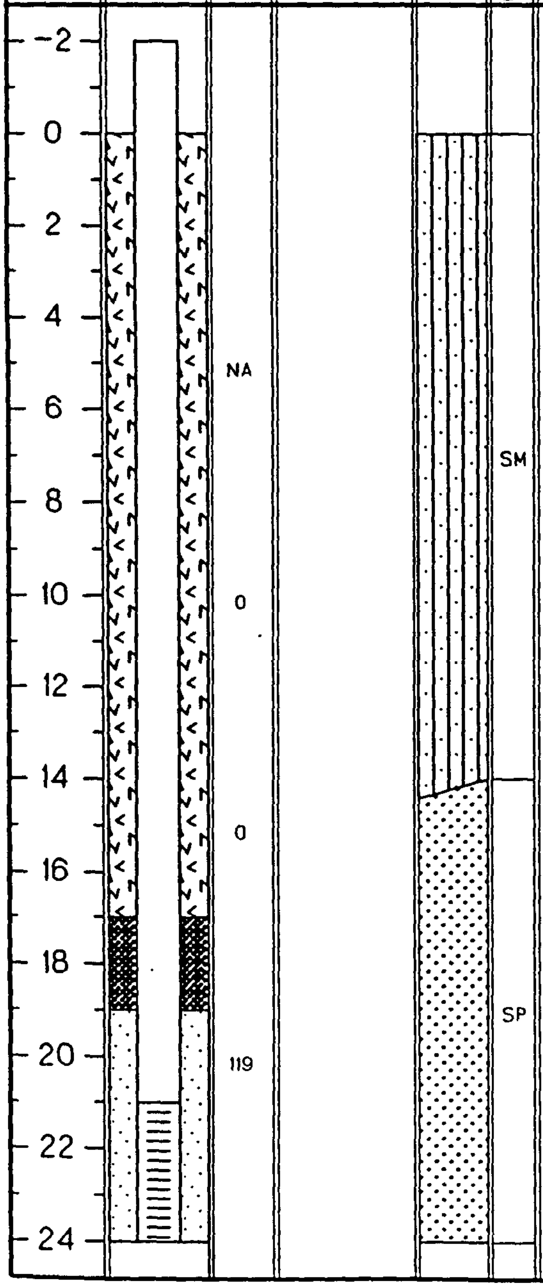
See Site Map
For Boring Location

COMMENTS:

Start @ 1200 hrs.

Project BRC Owner Bloomfield Refining Co.
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. 5530.17 Total Hole Depth 37 ft. Diameter 10 in.
Top of Casing 5532.17 Water Level Initial 30 ft. Static
Screen: Dia 4 in. Length 14 ft. Type/Size FRE 0.020 in.
Casing: Dia 4 in. Length 23/2 ft. Type FRE
Fill Material 10/20 Co. Silica Rig/Core Drill Systems 180
Drill Co. Layne Method Air Percussion
Driller Gabby Rodriguez Log By Jerry May Date 05/12/94 Permit #
Checked By License No.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
0						SM	Tan fine poorly-graded silty SAND (moist)
5		NA					
10		0					
14						SP	Tan fine poorly-graded SAND (moist)
15		0					
20		119					

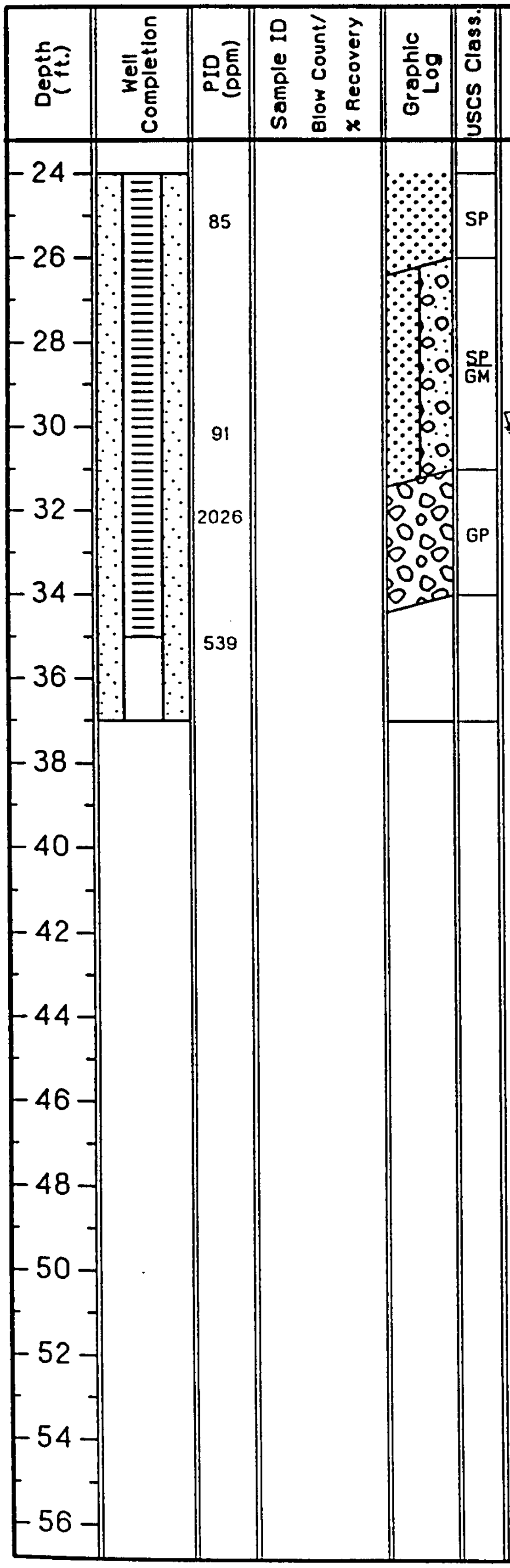


GROUNDWATER
TECHNOLOGY

Drilling Log

Monitoring Well **MW-31**

Project *BRC* Owner *Bloomfield Refining Co.*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*



Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
25	85			SP	
26					Fine-coarse poorly-graded SAND with gravel and cobbles (moist)
28.5				SP GM	
30	91				∇ *Groundwater encountered at 30 feet on 5/12/94*
31					Gray-stained cobbles with a little fines (wet)
32	2026			GP	(Dark gray-stained at 32 feet)
34					Encountered weathered limestone (moist-dry)
35	539				
37					End of boring at 37 feet (1225 hrs). Installed well screened from 21 to 35 feet on 5/12/94.

GROUNDWATER TECHNOLOGY

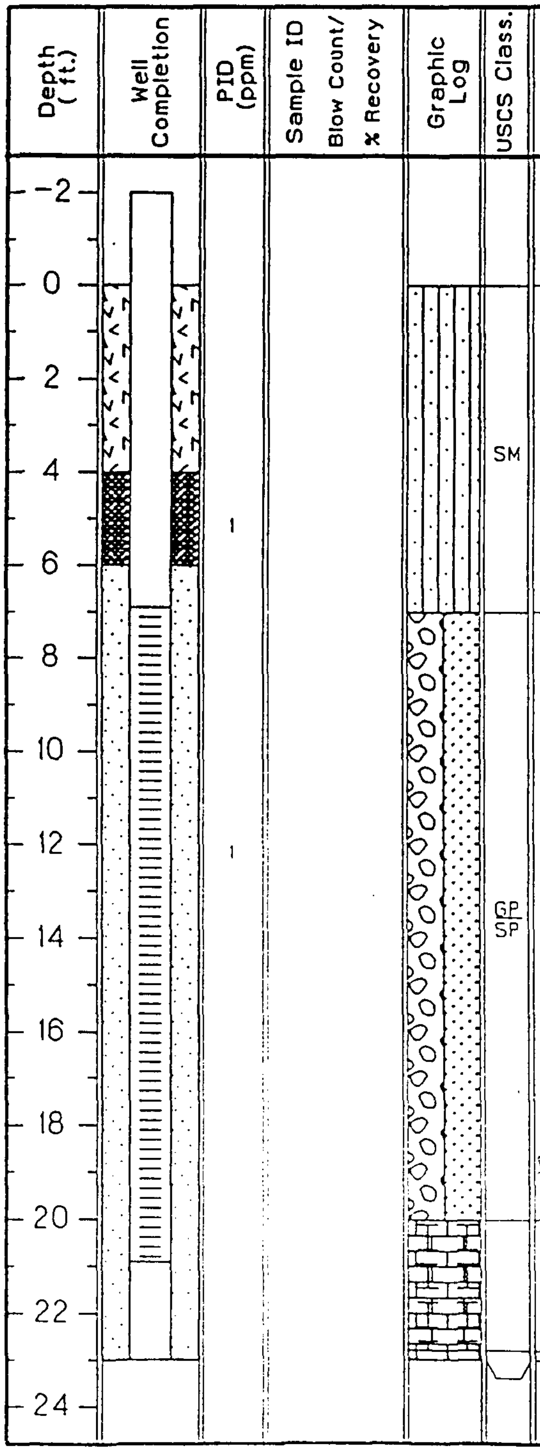
Drilling Log

Monitoring Well **MW-33**

See Site Map For Boring Location

COMMENTS:

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, NM* Proj. No. *023353014*
Surface Elev. 5515.86 Total Hole Depth *23 ft.* Diameter *9 in.*
Top of Casing 5518.46 Water Level Initial *19 ft.* Static *Dry ft.*
Screen: Dia *4 in.* Length *14 ft.* Type/Size *FRE/0.020 in.*
Casing: Dia *4 in.* Length *11.6 ft.* Type *FRE*
Fill Material *10/20 Silica Sand* Rig/Core *Drill Systems 180*
Drill Co. *Layne* Method *Air Hammer Percussion*
Driller *G. Rodriguez* Log By *E. Shannon* Date *02/23/95* Permit #
Checked By ELS 3-14-95 License No.



Description

(Color, Texture, Structure)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%

0-7 ft.: Brown medium to fine SAND, little silt, little coarse to fine gravel, occasional cobbles, dry.

7-20 ft.: Coarse to fine GRAVEL/COBBLES, some coarse to fine well graded sand, trace silty, dry.

▽ *Cuttings damp at 19'.*

20-22.8 ft.: Tanish brown SILT/weathered LIMESTONE, dry.

22.8-23 ft.: Gray LIMESTONE, weathered, dry.

End of boring at 23 feet. Set MW-33 with screened interval from 6.9-20.9 feet below grade.

GROUNDWATER TECHNOLOGY

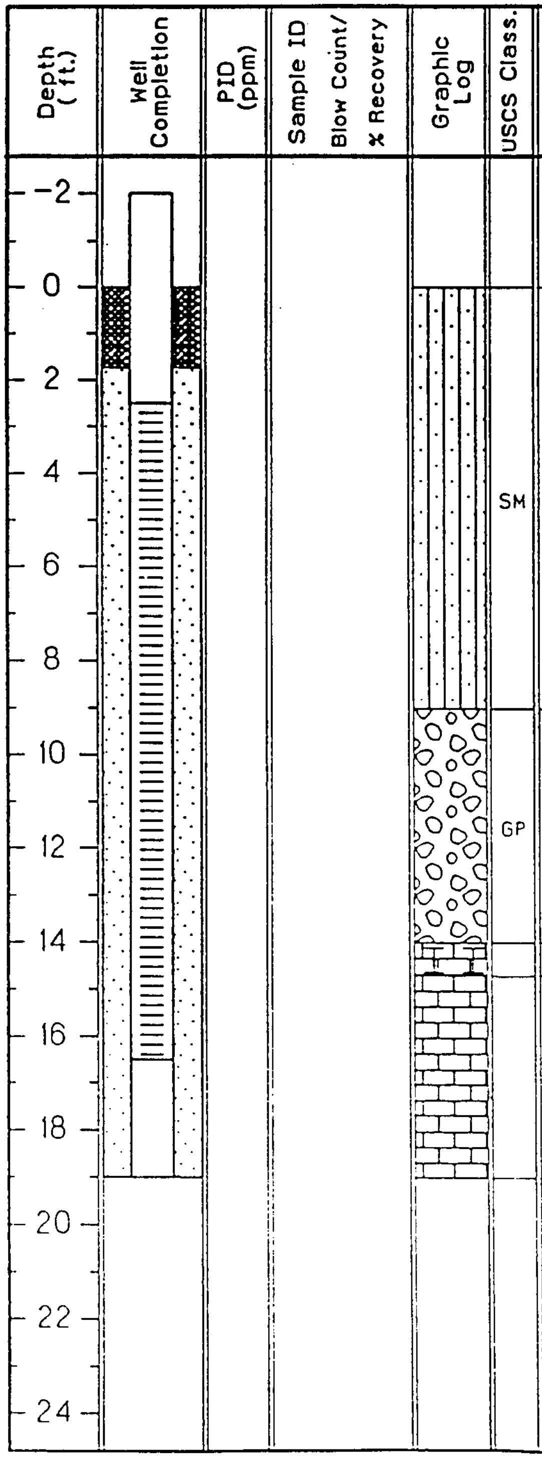
Drilling Log

Monitoring Well **MW-34**

See Site Map For Boring Location

COMMENTS:

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, NM* Proj. No. *023353014*
Surface Elev. 5505.53 Total Hole Depth *19 ft.* Diameter *10 in.*
Top of Casing 5508.23 Water Level Initial *12 ft.* Static
Screen: Dia *4 in.* Length *14 ft.* Type/Size *FRE/0.020 in.*
Casing: Dia *4 in.* Length *7.8 ft.* Type *FRE*
Fill Material *10/20 Silica Sand* Rig/Core *Drill Systems 180*
Drill Co. *Layne* Method *Air Hammer Percussion*
Driller *G. Rodriguez* Log By *E. Shannon* Date *02/23/95* Permit #
Checked By ES 3-14-95 License No.



Description

(Color, Texture, Structure)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%

0-9 ft.: Brown coarse to fine poorly graded SAND, little coarse to fine gravel, little silt, occasional cobbles.

9-14 ft.: Coarse to fine GRAVEL/COBBLES, some coarse to fine sand, trace silt, dry.

∇ *Wet at 12'*, gray-staining.

Yellowish brown SILT/weathered LIMESTONE, dry.

14.7-19 ft.: Gray LIMESTONE.

End of boring at 19 feet.

Set MW-34 with screened interval from 2.5-16.5 feet below grade

PRECISION ENGINEERING, INC.

LOCATION:BLOOMFIELD REFINERY
SEE BORING PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5512.39
TOTAL DEPTH: 23.1'
LOGGED BY: TM
DATE: 4-29-97
STATIC WATER: 20.5
BORING ID: MW-35
PAGE: 1

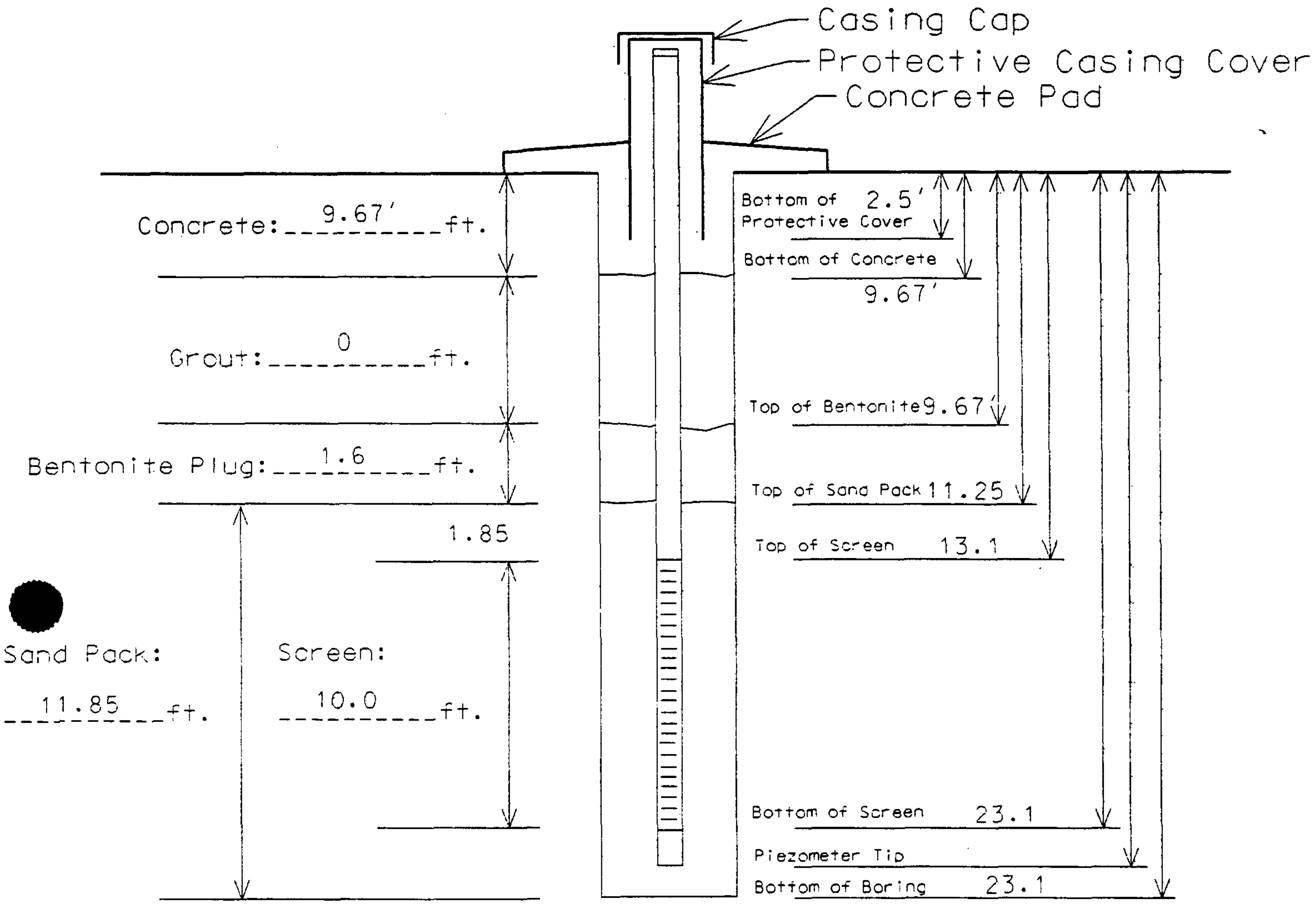
DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-6.5	****--***		C	**SAND**, VERY FINE TO FINE, SILTY, DAMP, LIGHT BROWN TO BROWN, LOOSE, NO ODOR,	0
	****--***		C	(MORE DAMP AT 2.0' TO 3.5')	
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***	5.0	C		
	****--***		C		
	****--***		C		
6.5-8.5	*********		C	**SAND**, FINE, SOME COARSE, TAN, DAMP, NO ODOR	0
	*********		C		
	*********		C		
8.5-13.5	***000***		C	**SAND**, FINE, FINE GRAVEL, SOME COARSE COMING UP FLIGHTS, DAMP, MODERATELY DENSE,	
	000		C	BROWN	
	000		C		
	000		C		
	000	10	C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
13.5-15.0	0000**000		C	**GRAVEL**, COARSE, SOME FINE, SOME COBBLES, SANDY, FINE, MORE COBBLY AT 15.0',	0
	0000**000		C	VERY DAMP	
	0000**000	15	C		
15.0-21.5	0000**000		C	**COBBLES**, GRAVELLY, COARSE, SOME FINE, SLIGHTLY SANDY, FINE, DAMP, VERY SLOW	
	0000**000		C	DRILLING, NO ODOR	
	0000**000		C		
	0000**000		C		
	0000**000		C		
	0000**000		C		
	0000**000		C		
	0000**000		C		
	0000**000		C		
	0000**000	20	C		
	0000**000		C		
	0000**000		C		
21.5	0000**000		C	**VERY WEAKLY WATER BEARING 20.5' TO 21.5'**	0
21.5-23.1	=========		C	**NACIMIENTO FORMATION**	0
	=========		C	**SHALE**, SANDY, GREEN, DAMP, DENSE, NO WATER IN SAMPLE OR ON SPLIT SPOON, NOT WATER	
TOTAL DEPTH	=========		C	BEARING	

LOGGED BY: TM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

Installation Diagram

Monitoring Well No. MW-35



Concrete: 9.67' ft.

Grout: 0 ft.

Bentonite Plug: 1.6 ft.

1.85

Sand Pack: 11.85 ft.

Screen: 10.0 ft.

Bottom of Protective Cover 2.5'

Bottom of Concrete 9.67'

Top of Bentonite 9.67'

Top of Sand Pack 11.25

Top of Screen 13.1

Bottom of Screen 23.1

Piezometer Tip

Bottom of Boring 23.1

Boring Diameter: 8-5/8"

Sand Type: 16-40

Bollards, Type/Size: 3" STEEL

Bentonite: 3/8 CHIPS

Screen Type/Size: 0.010

Cement/Grout: --------

Riser Type/Size: 2" SCH 40, PVC

PRECISION ENGINEERING, INC.

505-523-7674

Water: --------

Locking Expandable Casing Plug? YES

Site Northing: 4392.54

Other: --------

Bottom Cap Used? YES

Site Easting: 1723.01

Project #: 97-028

Project Name: BLOOMFIELD REFINING

Elevation: 5512.39

PRECISION ENGINEERING, INC.

LOCATION:BLOOMFIELD REFINERY
SEE BORING PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5510.56
TOTAL DEPTH: 21.0'
LOGGED BY: TM
DATE: 4-29-97
STATIC WATER: 19.5
BORING ID: MW-36
PAGE: 1

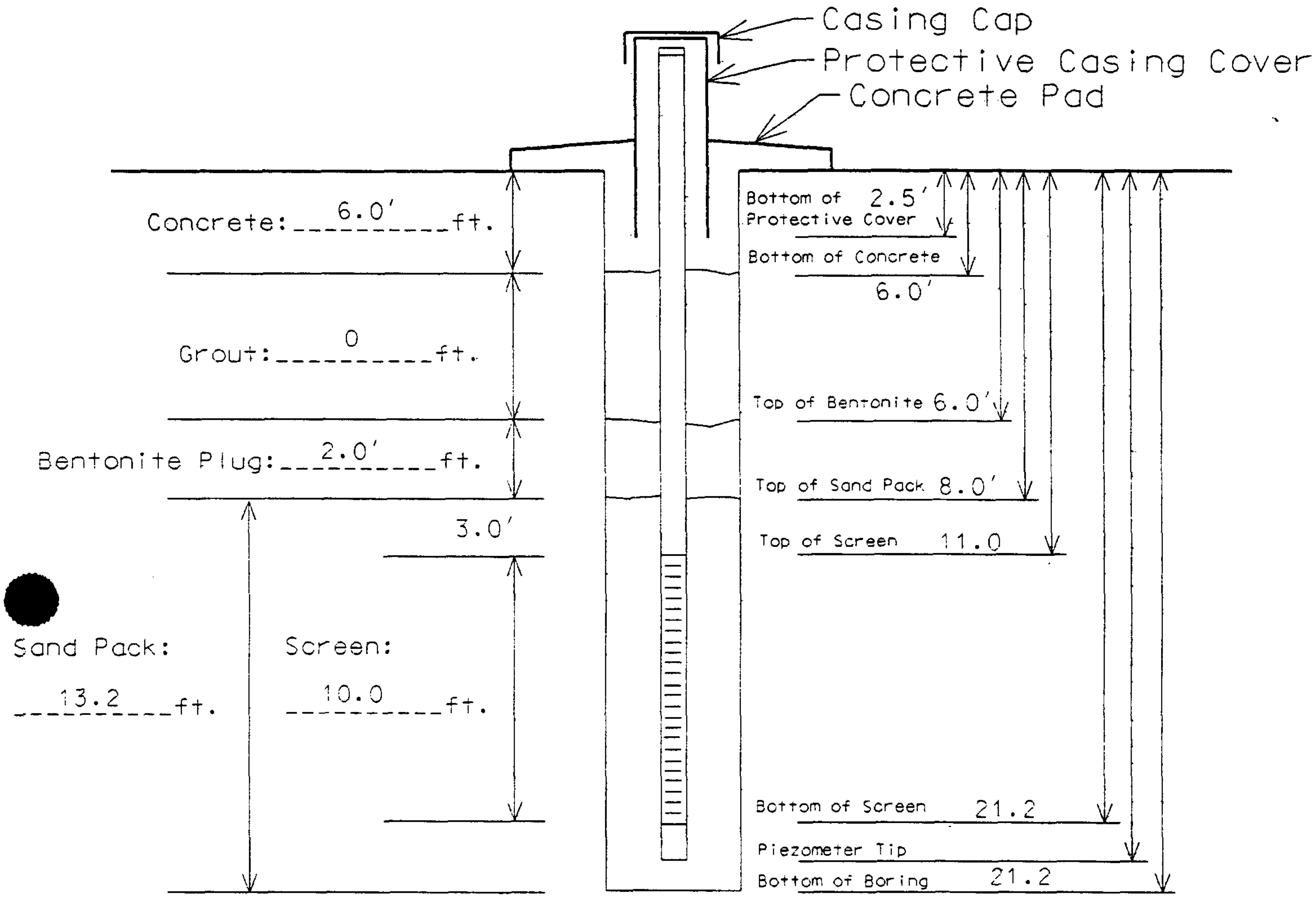
DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-7.5	****..***		C	**SAND**, FINE, SLIGHTLY SILTY, LOOSE, DAMP, LIGHT BROWN, NO ODOR	0
	****..***		C		
	****..***		C		
	****..***		C		
	****..***		C		
	****..***		C		
	****..***		C		
	****..***		C		
	****..***		C		
	****..***	5.0	C		
	****..***		C		
	****..***		C		
	****..***		C		
	****..***		C		
7.5	****..***		C		
7.5-12.0	ooo000ooo		C	**GRAVEL**, COARSE, SOME FINE, VERY COBBLY, VERY SLOW DRILLING, DAMP	0
	ooo000ooo		C		
	ooo000ooo		C		
	ooo000ooo		C		
	ooo000ooo	10	C		
	ooo000ooo		C		
	ooo000ooo		C		
	ooo000ooo		C		
	ooo000ooo		C		
12.0-19.5	000ooo000		C	**COBBLES**, GRAVELLY, COARSE, VERY HARD DRILLING, DAMP TO DRY	
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000	15	C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
19.5	000ooo000		C		
19.5-20.5	***000***	20	C	**SAND**, FINE, GRAVELLY, FINE TO COARSE, EASIER DRILLING, NO ODOR, WEAKLY WATER	0
20.5	***000***		C	BEARING	
20.5-21.5	=========		C	**NACIMIENTO FORMATION**	0
21.5	=========		C	**SHALE**, SANDY, GREEN, DAMP, DENSE, NOT WATER BEARING	
TOTAL DEPTH					

LOGGED BY: TM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

Installation Diagram

Monitoring Well No. MW-36



Concrete: 6.0' ft.

Grout: 0 ft.

Bentonite Plug: 2.0' ft.

3.0'

Sand Pack: 13.2 ft.

Screen: 10.0 ft.

Bottom of Protective Cover 2.5'

Bottom of Concrete 6.0'

Top of Bentonite 6.0'

Top of Sand Pack 8.0'

Top of Screen 11.0

Bottom of Screen 21.2

Piezometer Tip

Bottom of Boring 21.2

Boring Diameter: 8-5/8"

Sand Type: 16-40

Bollards, Type/Size: 3" STEEL

Bentonite: 3/8 CHIPS

Screen Type/Size: 0.010

Cement/Grout: --------

Riser Type/Size: 2" SCH 40, PVC

Water: --------

Locking Expandable Casing Plug? YES

Site Northing: 4652.99

Other: --------

Bottom Cap Used? YES

Site Easting: 1779.57

Project #: 97-028

Project Name: BLOOMFIELD REFINING

Elevation: 5510.56

PRECISION ENGINEERING, INC.

505-523-7674

PRECISION ENGINEERING, INC.

LOCATION:BLOOMFIELD REFINERY
SEE BORING PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5513.04
TOTAL DEPTH: 25.0'
LOGGED BY: TM
DATE: 5-1-97
STATIC WATER: 21.0
BORING ID: MW-37
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-7.0	****--***		C	**SAND**, FINE, SILTY, DAMP, LOOSE, RED BROWN	0
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***	5.0	C		
	****--***		C		
	****--***		C		
	****--***		C		
	****--***		C		
7.0-11.0	***--/***		C	**SAND**, VERY FINE, SILTY, SLIGHTLY CLAYEY, DAMP, MODERATELY DENSE, RED BROWN, SOME	0
	--/		C	FINE GRAVEL AT 10.0'	
	--/		C		
	--/		C		
	--/		C		
	--/	10	C		
	--/		C		
11.0	***--/***		C		
11.0-11.5	oooOoOooo		C	**GRAVEL**, COARSE, SOME FINE, SOME COBBLES, SLOW DRILLING, DAMP	0
11.5-12.5	***--//**		C	**SAND**, FINE, SILTY, CLAYEY, DAMP, RED BROWN, NO ODOR	0
12.5	***--//**		C		
12.5-17.0	oooOOOooo		C	**GRAVEL**, COARSE, COBBLES, SLOW DRILLING, DENSE, DAMP	0
	oooOOOooo		C		
	oooOOOooo		C		
	oooOOOooo		C		
	oooOOOooo	15	C		
	oooOOOooo		C		
	oooOOOooo		C		
	oooOOOooo		C		
	oooOOOooo		C		
17.0-22.0	OOOoooOOO		C	**COBBLES**, GRAVELLY, COARSE, VERY SLOW DRILLING, NO ODOR, DENSE, DAMP,	
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO	20	C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
22.0	OOOoooOOO		C	WEAKLY WATER BEARING 21.0-22.0	
22.0-25.0	==========		C	**NACIMIENTO FORMATION**	0
	==========		C	GREEN, FISSLE, DAMP, NO ODOR, NOT WATER BEARING	

LOGGED BY: TM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION:BLOOMFIELD REFINERY
SEE BORING PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5513.04
TOTAL DEPTH: 25.0'
LOGGED BY: TM
DATE: 5-1-97
STATIC WATER: 21.0
BORING ID: MW-37
PAGE: 2

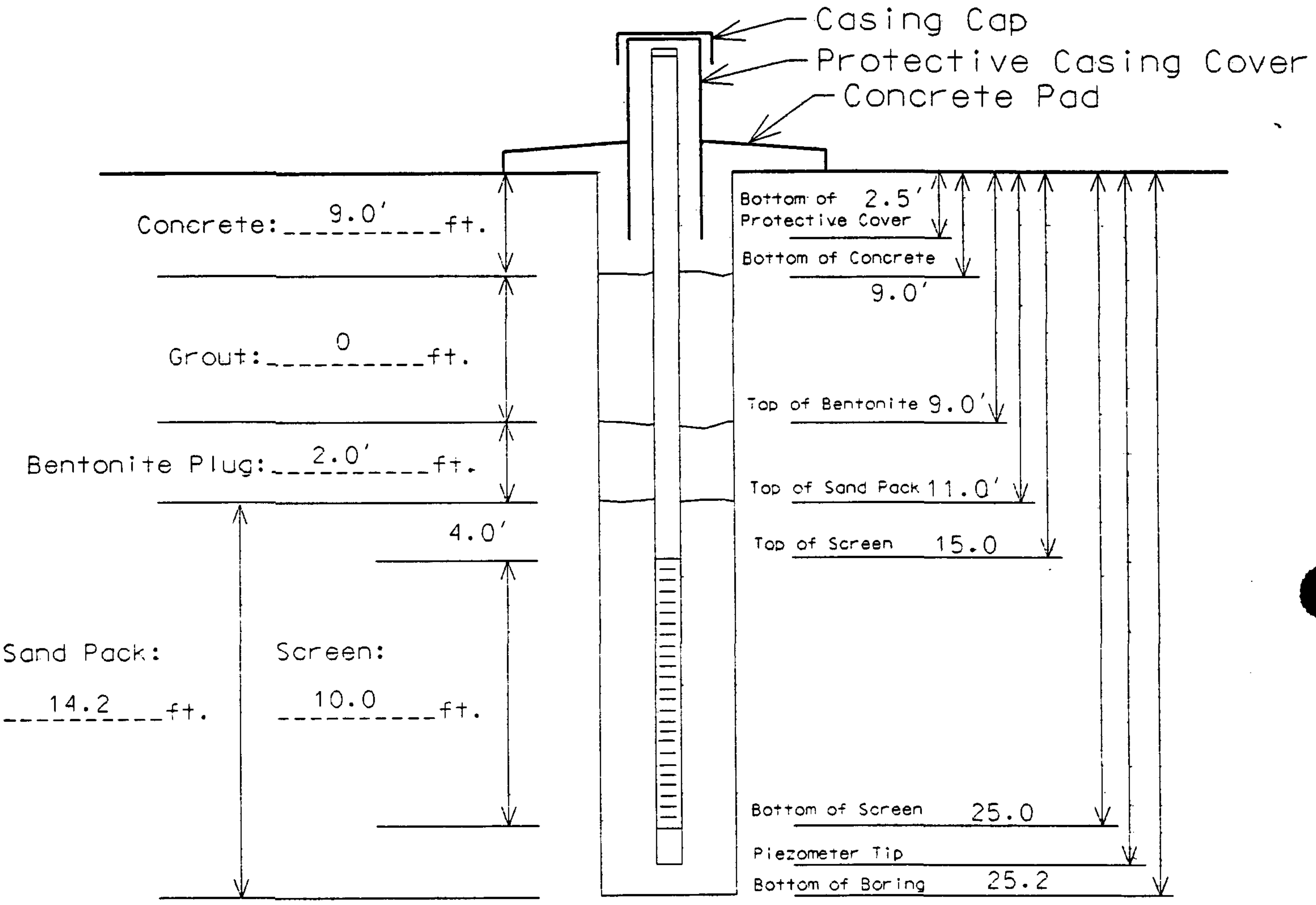
DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
22.0-25.0	=========		C	**NACIMIENTO FORMATION**	
	=========		C	GREEN, FISSLE, DAMP, NO ODOR, NOT WATER BEARING	
	=========		C		
25.0	=========	25	C		
TOTAL DEPTH					
		30			
		35			
		40			
		45			

LOGGED BY: TM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

Installation Diagram

Monitoring Well No. MW-37



Concrete: 9.0' ft.

Grout: 0 ft.

Bentonite Plug: 2.0' ft.

4.0'

Sand Pack: 14.2 ft.

Screen: 10.0 ft.

Bottom of Protective Cover 2.5'

Bottom of Concrete 9.0'

Top of Bentonite 9.0'

Top of Sand Pack 11.0'

Top of Screen 15.0

Bottom of Screen 25.0

Piezometer Tip

Bottom of Boring 25.2

Boring Diameter: 8-5/8"

Sand Type: 16-40

Bollards. Type/Size: 3" STEEL

Bentonite: 3/8 CHIPS

Screen Type/Size: 0.010

Cement/Grout: ---------------

Riser Type/Size: 2" SCH 40. PVC

PRECISION ENGINEERING, INC.

505-523-7674

Water: --------

Locking Expandable Casing Plug? YES

Site Northing: 4413.84

Other: -------

Bottom Cap Used? YES

Site Easting: 1496.01

Project #: 97-028

Project Name: BLOOMFIELD REFINING

Elevation: 5513.04

PRECISION ENGINEERING, INC.

LOCATION:BLOOMFIELD REFINERY
SEE BORING PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5512.87
TOTAL DEPTH: 23.5'
LOGGED BY: TM
DATE: 4-29-97
STATIC WATER: 21.0
BORING ID: MW-38
PAGE: 1

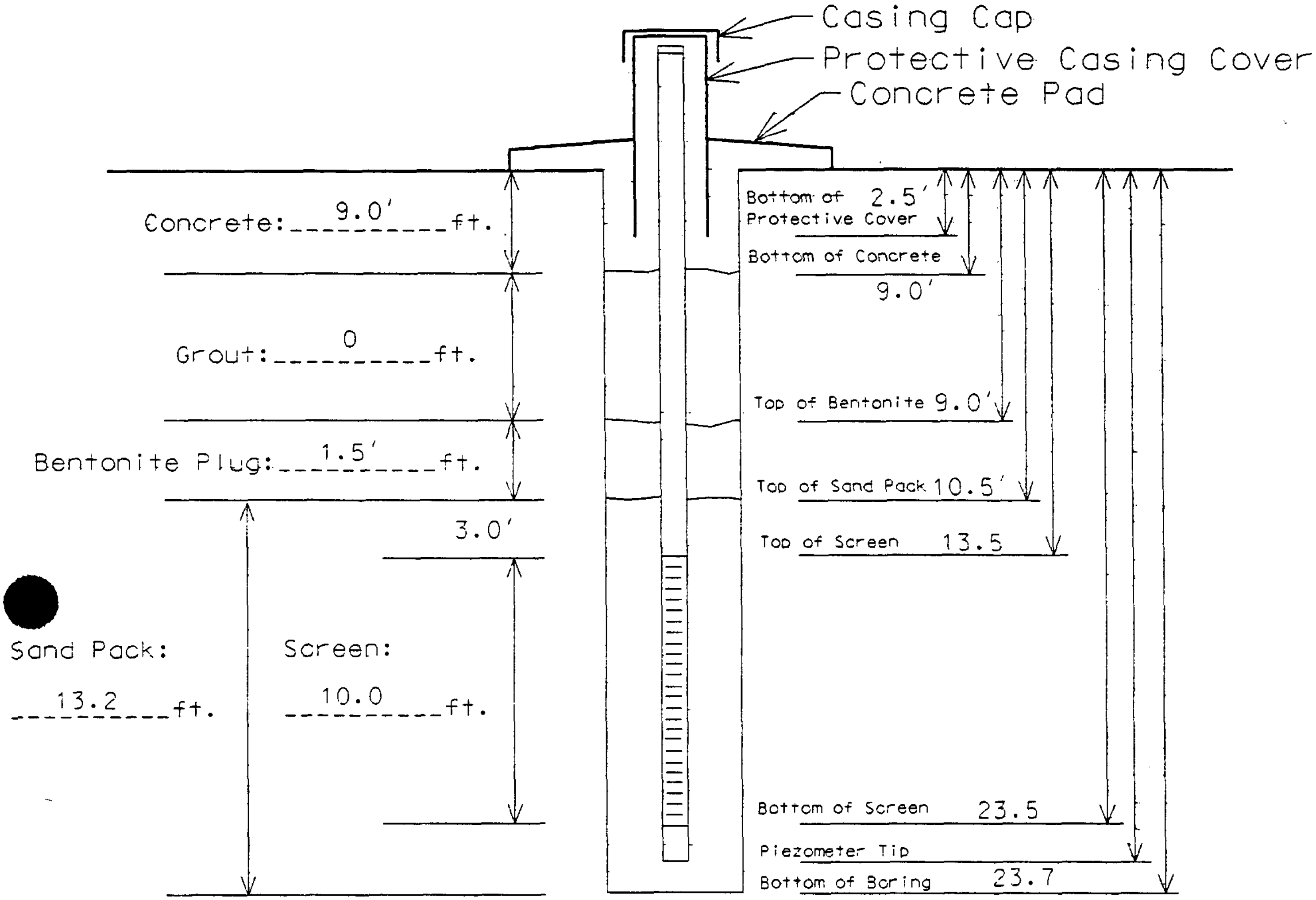
DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-7.5	***--oo**		C	**SAND**, FINE, SILTY, DAMP, BROWN, LOOSE, SOME FINE GRAVEL	0
	***--oo**		C		
	***--oo**		C		
	***--oo**		C		
	***--oo**		C		
	***--oo**		C		
	***--oo**		C		
	***--oo**		C		
	***--oo**		C		
	***--oo**	5.0	C		
	***--oo**		C		
	***--oo**		C		
	***--oo**		C		
	***--oo**		C		
	***--oo**		C		
7.5-11.5	***ooo***		C	**SAND**, FINE, GRAVELLY, COARSE, SOME FINE, LIGHT BROWN, DAMP, MODERATELY DENSE,	0
	ooo		C	NO ODOR	
	ooo		C		
	ooo		C		
	ooo	10	C		
	ooo		C		
	ooo		C		
11.5	***ooo***		C		
11.5-22.0	000ooo000		C	**COBBLES**, GRAVELLY, COARSE, VERY HARD, SLOW DRILLING, NO ODOR, DAMP	0
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000	15	C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
	000ooo000	20	C		
	000ooo000		C		
	000ooo000		C		
	000ooo000		C		
22.0	000ooo000		C	WEAKLY WATER BEARING 21.0	0
22.0-23.5	=========		C	**NACIMIENTO FORMATION**	0
TOTAL DEPTH	=========		C	**SHALE**, VERY SANDY, DAMP, NOT WATER BEARING, DENSE	

LOGGED BY: TM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

Installation Diagram

Monitoring Well No. MW-38



Concrete: 9.0' ft.

Grout: 0 ft.

Bentonite Plug: 1.5' ft.

3.0'

Sand Pack: 13.2 ft.

Screen: 10.0 ft.

Bottom of Protective Cover 2.5'

Bottom of Concrete 9.0'

Top of Bentonite 9.0'

Top of Sand Pack 10.5'

Top of Screen 13.5

Bottom of Screen 23.5

Piezometer Tip

Bottom of Boring 23.7

Boring Diameter: 8-5/8"

Sand Type: 16-40

Bollards. Type/Size: 3" STEEL

Bentonite: 3/8 CHIPS

Screen Type/Size: 0.010

Cement/Grout: ------------

Riser Type/Size: **2" SCH 40. PVC**

Water: --------

Locking Expandable Casing Plug? YES

Other: --------

Bottom Cap Used? YES

PRECISION ENGINEERING, INC.

505-523-7674

Site Northing: 4674.24

Site Easting: 1587.4

Project #: 97-028

Project Name: BLOOMFIELD REFINING

Elevation: 5512.87

PRECISION ENGINEERING, INC.

PROJECT: Bloomfield Refinery
CMS Wells & Borings

LOG OF TEST BORINGS

FILE #: 98-149
ELEVATION: 5522 ft
TOTAL DEPTH: 36 ft
LOGGED BY: WHK
DATE: 9-28-98
STATIC WATER: 18 ft
BORING ID: MW-39
PAGE: 1 of 5

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0 - 1.5	*-**-**-*			**Sand**, fine, silty, EOLIAN	
1.5 - 3.0	0*00*00*0			**Gravel**, sandy	
	0*00*00*0				
3.0 - 4.5	*-**/**-*			**Sand**, silty, clayey, moist, loose, brown	
	*-**/**-*	5.0		more clayey, soft, wet, black	
	*-**/**-*				
7.0	*-**/**-*				
	0*00*00*0			**Gravel**, sandy, moist, moderately dense, grey-black, JACKSON LAKE	
	0*00*00*0				
	0*00*00*0	10			
	0*00*00*0				
	0*00*00*0				
	0*00*00*0				
	0*00*00*0				
	0*00*00*0	15		more cobbly at 14'	
	0*00*00*0				
	0*00*00*0				
	0*00*00*0				
	0*0*0*0*0			water bearing at 18', sandier from 18-20'	
	0*0*0*0*0	20			
	0*00*00*0			gravel & cobbles, moist, very dense, black	
22.0	0*00*00*0				
	SSS*S*SSS			Sandstone, slightly sandy, moist, dense, NACIMIENTO	
	SSS*S*SSS				
	SSS*S*SSS	25			
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS	30			
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS				
	SSS*S*SSS	35			
36.0	SSS*S*SSS				
total depth					
		40			
		45			

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4.25" ID HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5526.21
TOTAL DEPTH: 34.5'
LOGGED BY: TM
DATE: 3-11-97
STATIC WATER: NOT FOUND
BORING ID: MW-40
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-17.0	//**-0///		C	CLAY, SANDY, FINE, SILTY, FIRM, SOME FINE GRAVEL, DARK BROWN TO BLACK, DAMP, SLIGHT	
	//**-0///		C	ODOR	
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///	5.0	C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C	GRAB SAMPLE-NO CHANGE	
	//**-0///		C	CLAY, SILTY, SANDY, MOIST, DARK BROWN, FIRM, NO ODOR	
	//**-0///		C		
	//**-0///	10	C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
	//**-0///	15	C		
	//**-0///		C		
	//**-0///		C		
	//**-0///		C		
17.0	//**-0///		C		
17.0-17.5	***00/***		C	SAND, FINE, SOME COARSE, RED-BROWN, VERY DAMP TO MOIST, MODERATELY DENSE, SLIGHTLY	
17.5	***00/***		C	CLAYEY, NO ODOR	
17.5-19.5	---//*---		C	SILT, CLAYEY, SANDY, FINE, DARK BROWN, MOIST, NO ODOR	
	---//*---		C		
19.5	---//*---		C		
19.5-31.5	000000000	20	C	COBBLES, GRAVELLY, (FINE TO COARSE), SOME SMALL BOULDERS, NO ODOR, VERY SLOW	
	000000000		C	DRILLING	
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		

LOGGED BY: TM

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5526.21
TOTAL DEPTH: 34.5'
LOGGED BY: TM
DATE: 3-11-97
STATIC WATER: NOT FOUND
BORING ID: MW-40
PAGE: 2

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
	000000000		C	COBBLES, GRAVELLY, (FINE TO COARSE), SOME SMALL BOULDERS, NO ODOR, VERY SLOW	
	000000000		C	DRILLING	
	000000000		C		
	000000000	25	C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C	EASIER DRILLING, LESS AUGER SCRAPING	
	000000000		C		
	000000000		C		
31.5	000000000	30	C		
31.5-33.5	SSSSSSSSS		C	NACIMIENTO FORMATION	
	SSSSSSSSS		C	DENSE, AUGER NOT SCRAPING	
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
33.5-34.5	SSSSSSSSS		S	NACIMIENTO FORMATION	
	SSSSSSSSS		S	BLACKISH COLOR, TURNING MORE WHITE 36.0 FEET, NO WATER IN HOLE OR SAMPLE AS OF	
34.5	SSSSSSSSS	35	S	4:40 PM, SLIGHT ODOR IN SAMPLE	
TOTAL DEPTH				10-12-97	
				DISCOVERED 2.5 FEET OF WATER IN HOLE AFTER PULLING AUGER	

LOGGED BY: TM

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5525.13
TOTAL DEPTH: 33.0'
LOGGED BY: TM
DATE: 3-12-97
STATIC WATER: NOT FOUND
BORING ID: MW-41
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-7.0	///--*///		C	CLAY, SILTY, SANDY, FINE, MOIST, SOFT	
	///--*///		C	0.0-0.5 FEET MORE BLACK	
	///--*///		C	0.5-5.0 FEET DARK GREY, FAINT ODOR, ODOR SEEMS OLD, SOME FINE GRAVEL	
	///--*///		C		
	///--*///		C		
	///--*///		C		
	///--*///		C		
	///--*///		C		
	///--*///		C		
	///--*///	5.0	C		
	///--*///		C		
	///--*///		C		
	///--*///		C		
7.0	///--*///		C		
7.0-12.0	***--/***		C	SAND, FINE, SILTY, SLIGHTLY CLAYEY, LOOSE, VERY DAMP, GREY BROWN, NO ODOR	
	--/		C		
	--/		C		
	--/		C		
	--/		C		
	--/	10	C		
	--/		C		
	--/		C		
	--/		C		
12.0	***--/***		C		
12.0-16.0	///--////		C	CLAY, SLIGHTLY SILTY, MOIST, GREY BROWN, NO ODOR	
	///--////		C		
	///--////		C		
	///--////		C		
	///--////		C		
	///--////	15	C		
	///--////		C		
16.0	///--////		C		
16.0-16.5	***0/****		C	SAND, FINE, SOME COARSE, SLIGHTLY CLAYEY, GREY BROWN, VERY DAMP, NO ODOR	
16.5-17.5	000000000		C	COBBLES, VERY SLOW DRILLING, AUGER SCRAPING	
17.5	000000000		C		
17.5-18.5	*********		C	SAND, FINE, DAMP, GREY BROWN, NO ODOR, EASY DRILLING	
18.5	*********		C		
18.5-30.0	000000000		C	COBBLES, VERY SLOW DRILLING, SOME SMALL BOULDERS	
	000000000		C		
	000000000	20	C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		

LOGGED BY: TM

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5525.13
TOTAL DEPTH: 33.0'
LOGGED BY: TM
DATE: 3-12-97
STATIC WATER: NOT FOUND
BORING ID: MW-41
PAGE: 2

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
	000000000		C	COBBLES, VERY SLOW DRILLING, SOME SMALL BOULDERS	
	000000000		C		
	000000000		C		
	000000000	25	C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
	000000000		C		
30.0	000000000	30	C		
30.0-33.0	SSSSSSSSS		C	NACIMIENTO, GREYISH BROWN, DAMP, VERY SLIGHT ODOR	
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
33.0	SSSSSSSSS		C		
[illegible]TAL DEPTH					

LOGGED BY: TM

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

PROJECT: Bloomfield Refinery
CMS Wells & Borings

LOG OF TEST BORINGS

FILE #: 98-149
ELEVATION: 5536 ft
TOTAL DEPTH: 47.5 ft
LOGGED BY: WHK
DATE: 10-01-98
STATIC WATER: 34 ft
BORING ID: MW-44
PAGE: 3 of 5

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0 - 5.0	*-/**-/**			**Sand**, fine, silty, slightly clayey, moist-wet, loose, light brown, Qe	
	*-/**-/**				
	*-/**-/**				
	*-/**-/**				
	*-/**-/**	5.0			
	*-/**-/**				
	*-/**-/**				
	*-/**-/**				
9.0	*-/**-/**				
9.0-10.0	/-//-//-/	10		**Clay**, silty, sandy(fine), wet, soft, brown	
10.0-15.0	*-*****-*			**Sand**, fine, slightly silty, damp, loose, brown	
	*-*****-*				
	*-*****-*				
	*-*****-*				
	*-*****-*	15			
	*-*****-*				
	*-*****-*				
	*-*****-*				
	*-*****-*				
20.2	*-**/**-*	20		some clay at 19'	
	0*00*00*0			**Gravel**(up to 3"), sandy, damp, moderately dense, interbeds of sand(medium-coarse) brown to grey no odor appears to be natural color	
	0*00*00*0				
	0*00*00*0				
	0*00*00*0				
	0*00*00*0	25			
	0*00*00*0			some cobble or boulder material	
	0*00*00*0				
	0*00*00*0				
	0*00*00*0				
	0*00*00*0	30			
	0*00*00*0				
	0*00*00*0				
	0*00*00*0				
33.5	0*00*00*0				
	SSSSSSSSS	35		Sandstone, argillaceous, liesgaing banded, dense, yellow brown orange banded in random patern, fine to medium, NACIMIENTO	
	SSSSSSSSS			water bearing at 34'	
	SSSSSSSSS				
	SSSSSSSSS				
	SSSSSSSSS				
	SSSSSSSSS	40			
	SSSSSSSSS				
	SSSSSSSSS				
	SSSSSSSSS				
	SSSSSSSSS				
	SSSSSSSSS	45			
47.5	SSSSSSSSS				

total depth

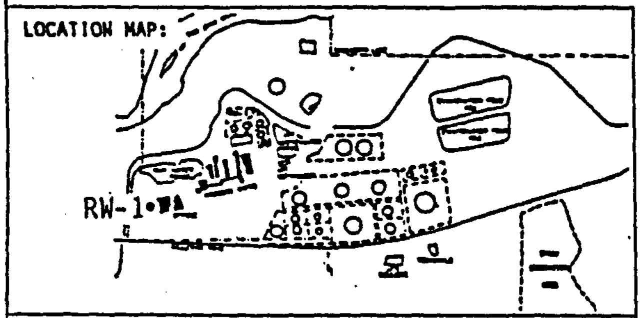
LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4.25" HSA

LITHOLOGIC LOG (SOIL)

Page 1 of 1

LOCATION MAP:

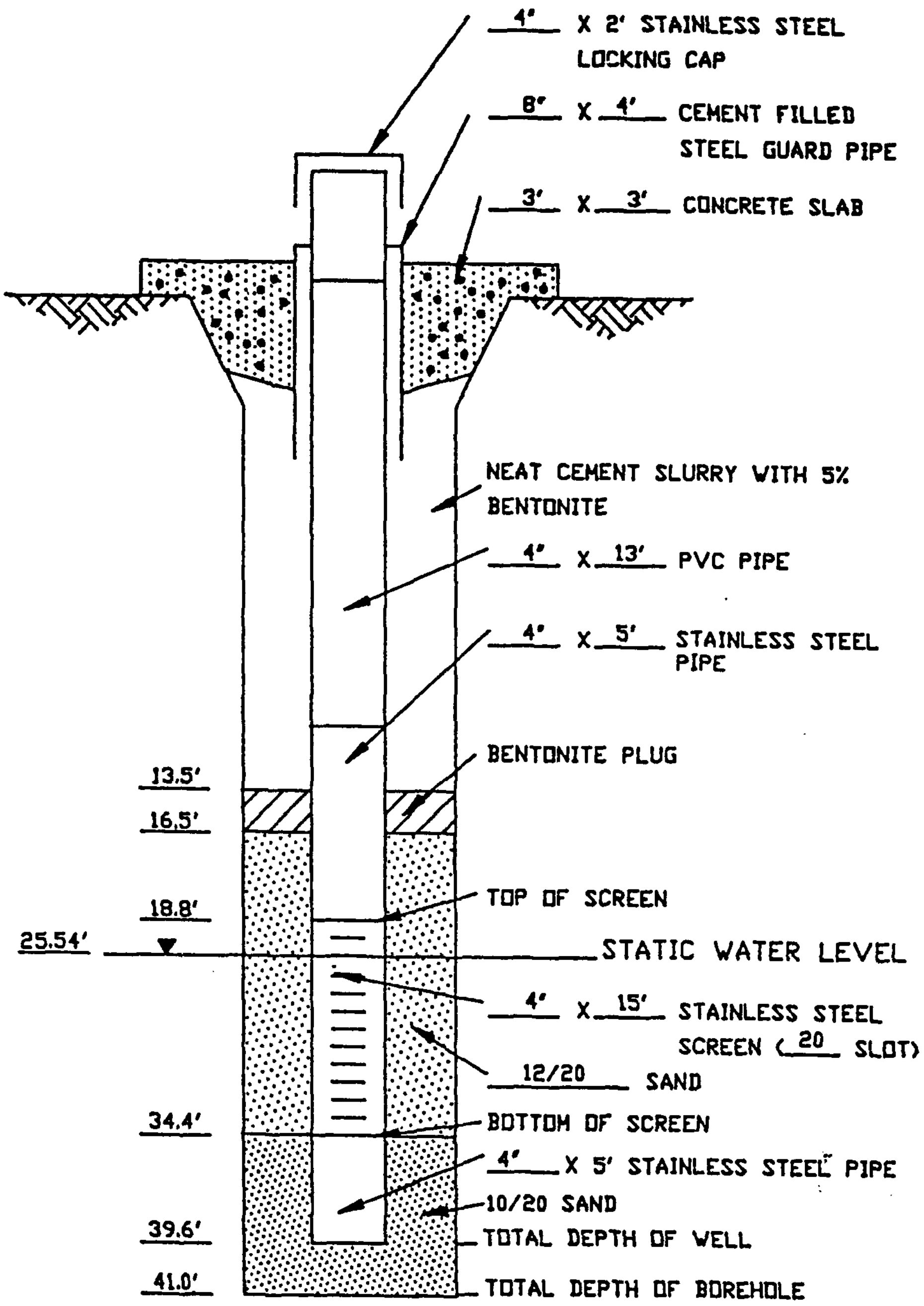


____1/4 ____1/4 ____1/4 ____1/4 S____ T____ R____

SITE ID: BRC LOCATION ID: RW-1
SITE COORDINATES (ft.):
N ____ E ____
GROUND ELEVATION (ft. MSL): 5525.92
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Casing Driver
DRILLING CONTR.: Beeman Brothers
DATE STARTED: 30 August 1988 DATE COMPLETED: 31 August 1988
FIELD REP.: W.S. Dubyk
COMMENTS: Static on September 2, 1988: 26.65 from TOC.

LOCATION DESCRIPTION: ____

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-18' Silt and Sand - Dark yellowish brown (10 YR 4/2) to grayish brown (5 YR 3/2). Minor to strong hydrocarbon odor.
5			1642		
10			1646		
15			1710		
20			1720		18'-34' Sand and Gravel - Medium dark gray (N4). Sand is medium to very coarse grained, subangular to subrounded. Gravel is subrounded to well rounded, to 2" diameter. Strong hydrocarbon odor.
25			1725		
30			1730		
35			1738		34'-41' Shale - Nacimiento Formation - Dusky yellow (5 YR 6/4) to light olive gray (5 Y 6/1) shale.
40		T.D. 41'	1758		
45					

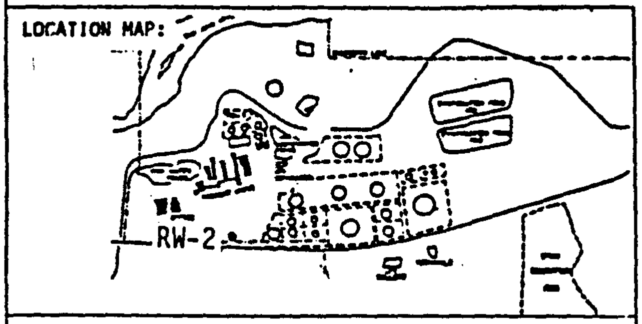


COMPLETION DIAGRAM
RECOVERY WELL RV-1

LITHOLOGIC LOG (SOIL)

Page 1 of 1

LOCATION MAP:

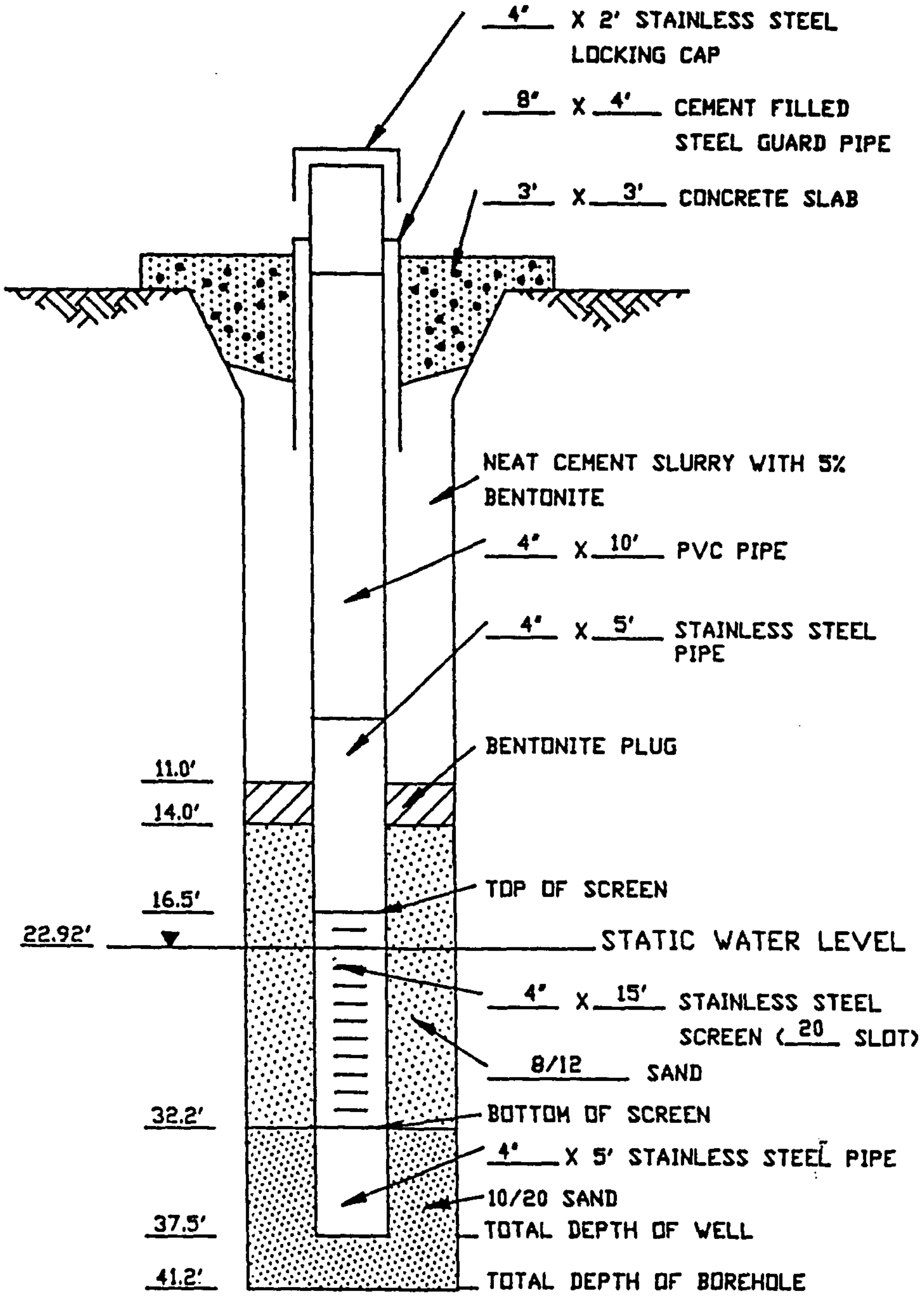


___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: RW-2
SITE COORDINATES (ft.):
N ___ E ___
GROUND ELEVATION (ft. MSL): 5523.48
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Casing Driver
DRILLING CONTR.: Beeman Brothers
DATE STARTED: 29 August 1988 DATE COMPLETED: 29 August 1988
FIELD REP.: W.S. Dubyk
COMMENTS: Static on September 2, 1988: 23.42 from TOC.

LOCATION DESCRIPTION:

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-10' Silt and Clay - Medium dark gray (N4) to brownish gray (5 YR 4/1). Slightly effervescent in HCl. Faint hydrocarbon odor.
5			0948		
10			0953		10'-15' Sand and Silt - Moderate brown (5 YR 4/4), very fine grained and well sorted.
			0958		15'-32' Sand and Gravel - Olive gray (5 Y 4/1) to brownish gry (5 YR 4/1). Sand is medium to very coarse grained, subangular to subrounded. Gravel is subangular to well rounded, to 2" diameter. Noticeable hydrocarbon odor below 25'.
20			1024		
25			1029		
30			1033		32'-41.2' Shale - Nacimiento Formation - Dusky yellow (5 Y 6/4) to olive gray (5 Y 3/2).
35			1050		
40					
			1100		
		T.D. 41.2'			
45					



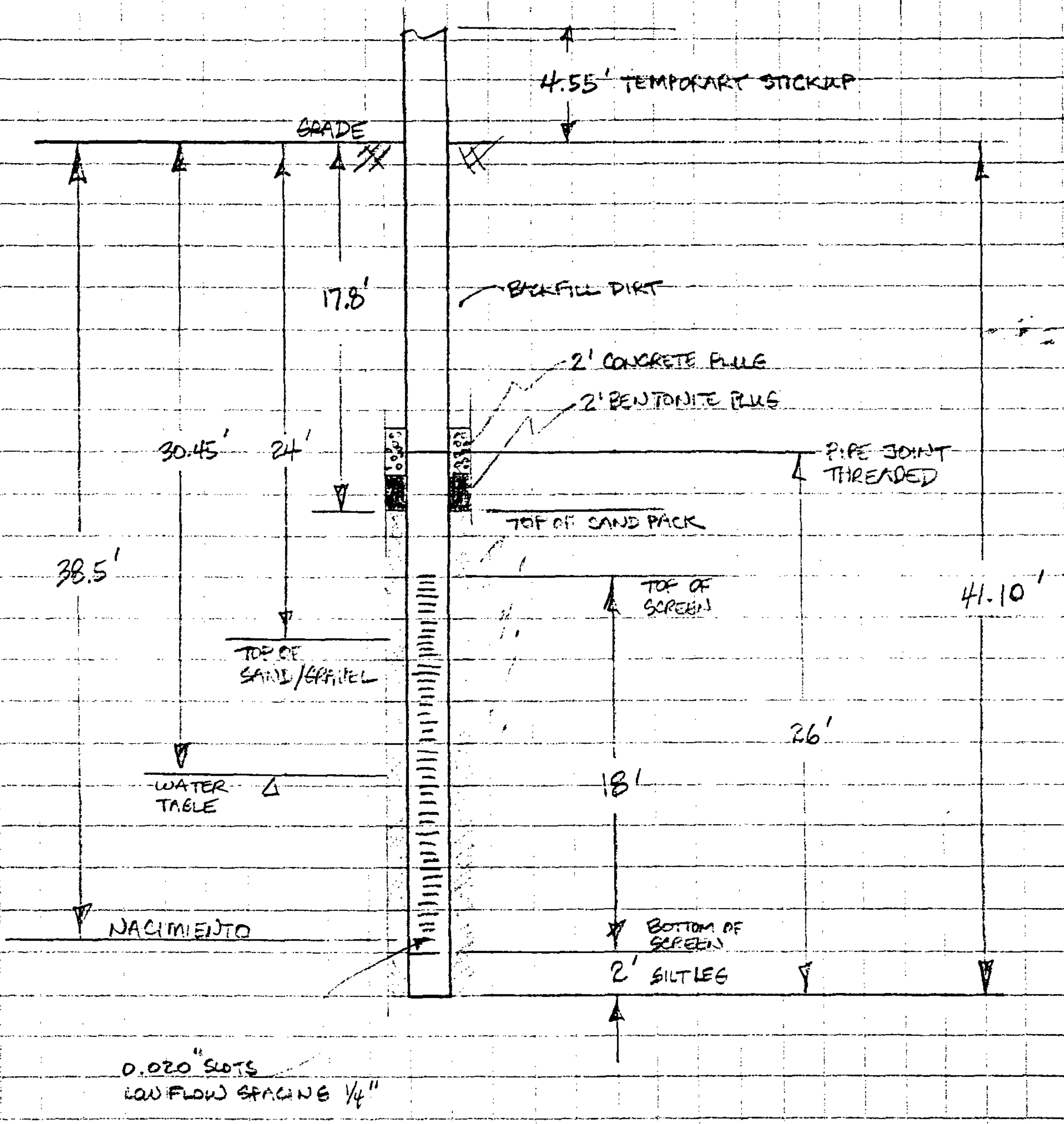
COMPLETION DIAGRAM
RECOVERY WELL RW-2

RW-14

CALCULATION SHEET

CONSTRUCTION COMMENTS: DRILLED BY CASING DRIVER, 8" BIT; 4.5" O.D. FIBERGLASS CASING SET TO DEPTH INSIDE DRIVEN CASING.; ANNULAR SPACE FILLED WITH 10/20 SAND AS DRIVEN CASING REMOVED; 50 LBS. OF BENTONITE DRILLING MUD & 100 LBS OF CONCRETE PLACED ON TOP OF SAND PACK; BACKFILLED WITH DIRT TO SURFACE.

LOCATION: END OF ROAD BETWEEN TANKS 19 & 29.



INITIALS CH

PROJECT NO. GROUNDWATER RECOVERY - PHASE II, AE 9146

DATE 8-9-90

SUBJECT RECOVERY WELL 14

DATE OF INSTALLATION: 8-6-90

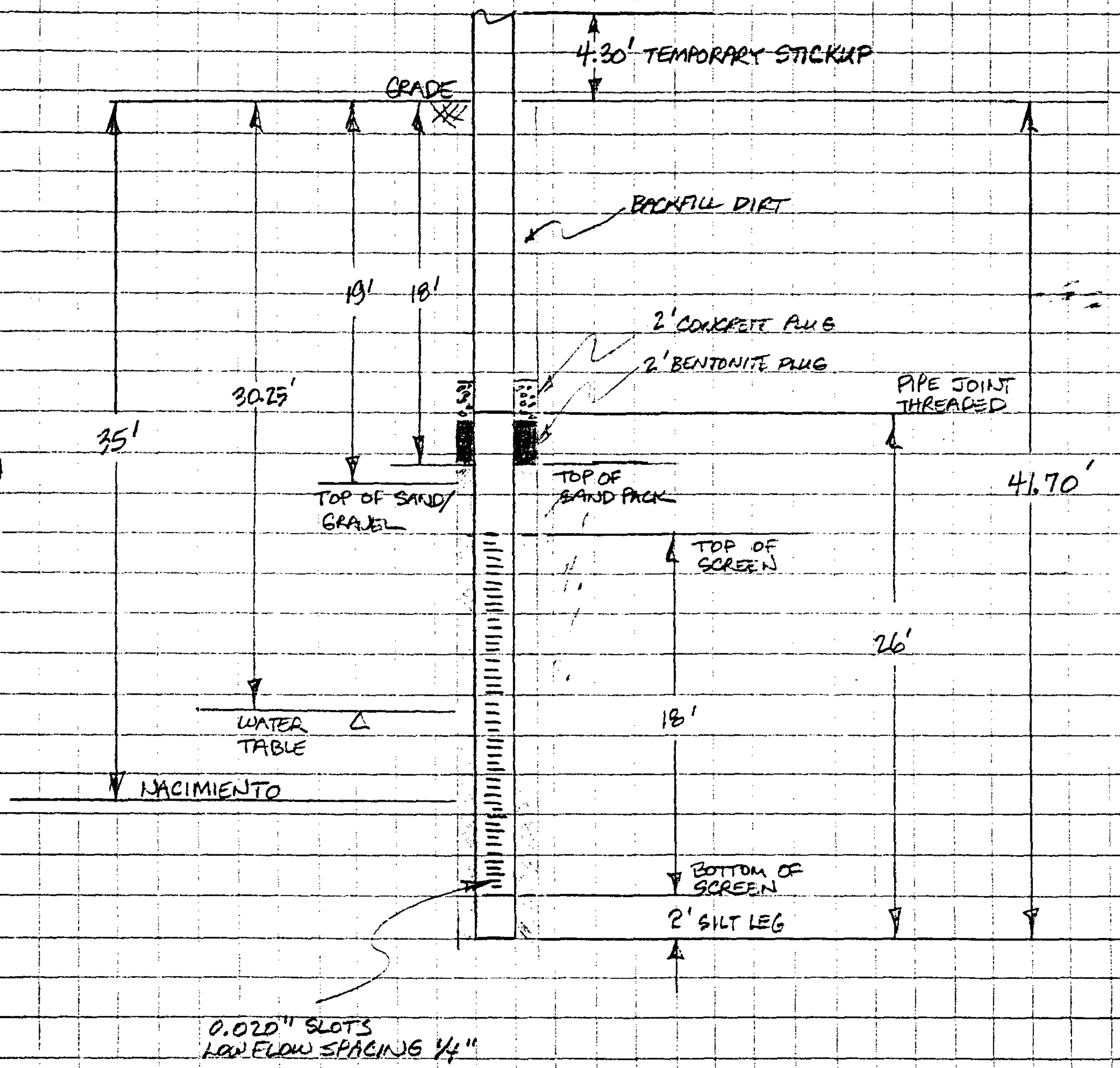
SHEET 1 OF 6

RW-15

CALCULATION SHEET

CONSTRUCTION COMMENTS: SAME AS RW-14

LOCATION: ROADWAY BETWEEN TANKS 18 & 28



INITIALS CH PROJECT No. GROUNDWATER RECOVERY - PHASE II, AFE 9146

DATE 8-9-90 SUBJECT RECOVERY WELL 15

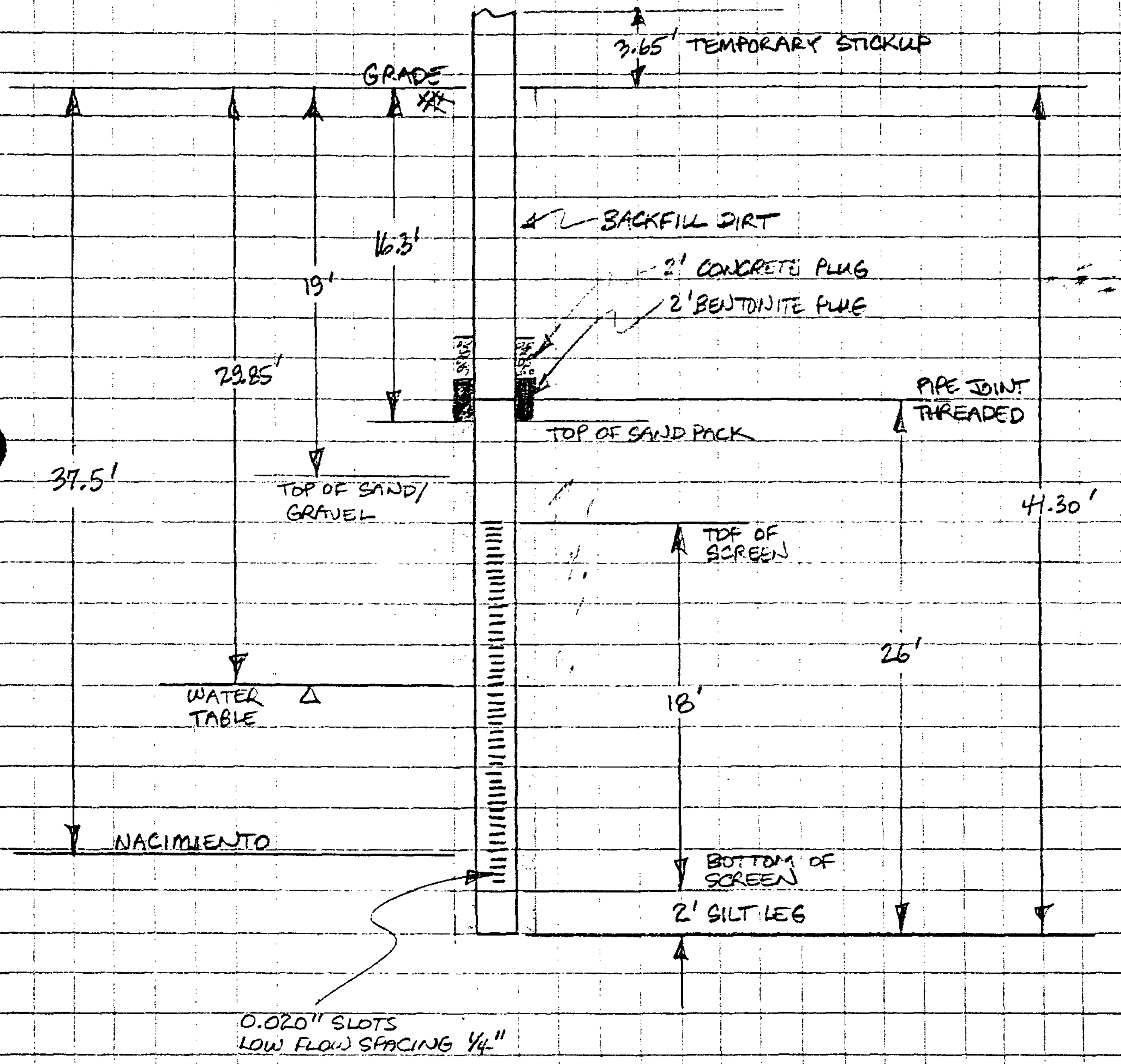
DATE OF INSTALLATION: 8-7-90 SHEET 2 OF 6

RW-16

CALCULATION SHEET

CONSTRUCTION COMMENTS: SAME AS RW-14

LOCATION: ROADWAY BETWEEN TANKS 26 & 18



INITIALS GH PROJECT No. GROUNDWATER RECOVERY - PHASE II, AFE 9146

DATE 8-9-90 SUBJECT RECOVERY WELL 16

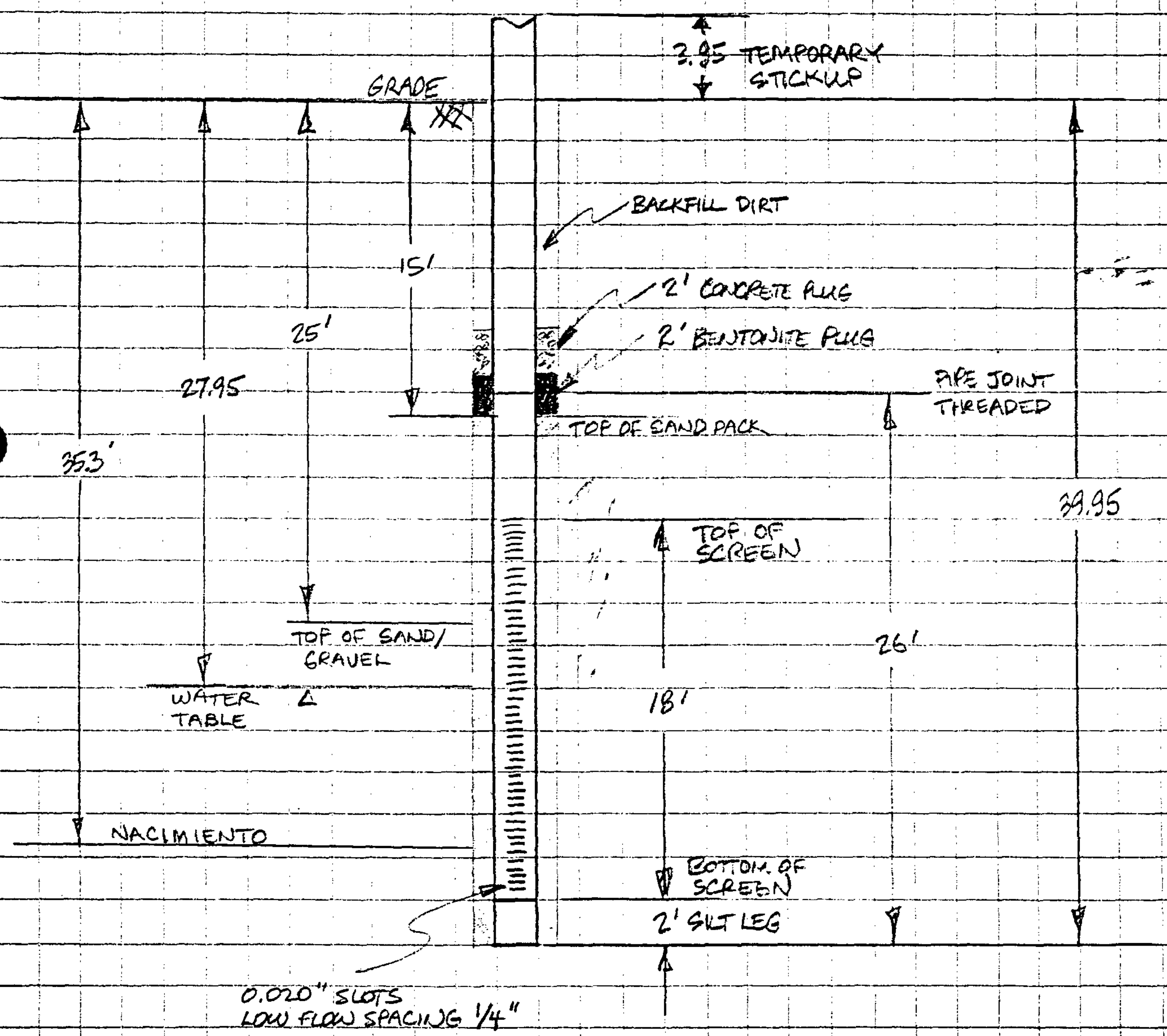
DATE OF INSTALLATION: 8-7-90 SHEET 3 OF 6

RW-17

CALCULATION SHEET

CONSTRUCTION COMMENTS: SAME AS RW-14

LOCATION: ROAD BETWEEN TANK 17 & 24



INITIALS CH PROJECT No. GROUNDWATER RECOVERY-PHASE II, AFE 9146

DATE 8-9-90 SUBJECT RECOVERY WELL 17

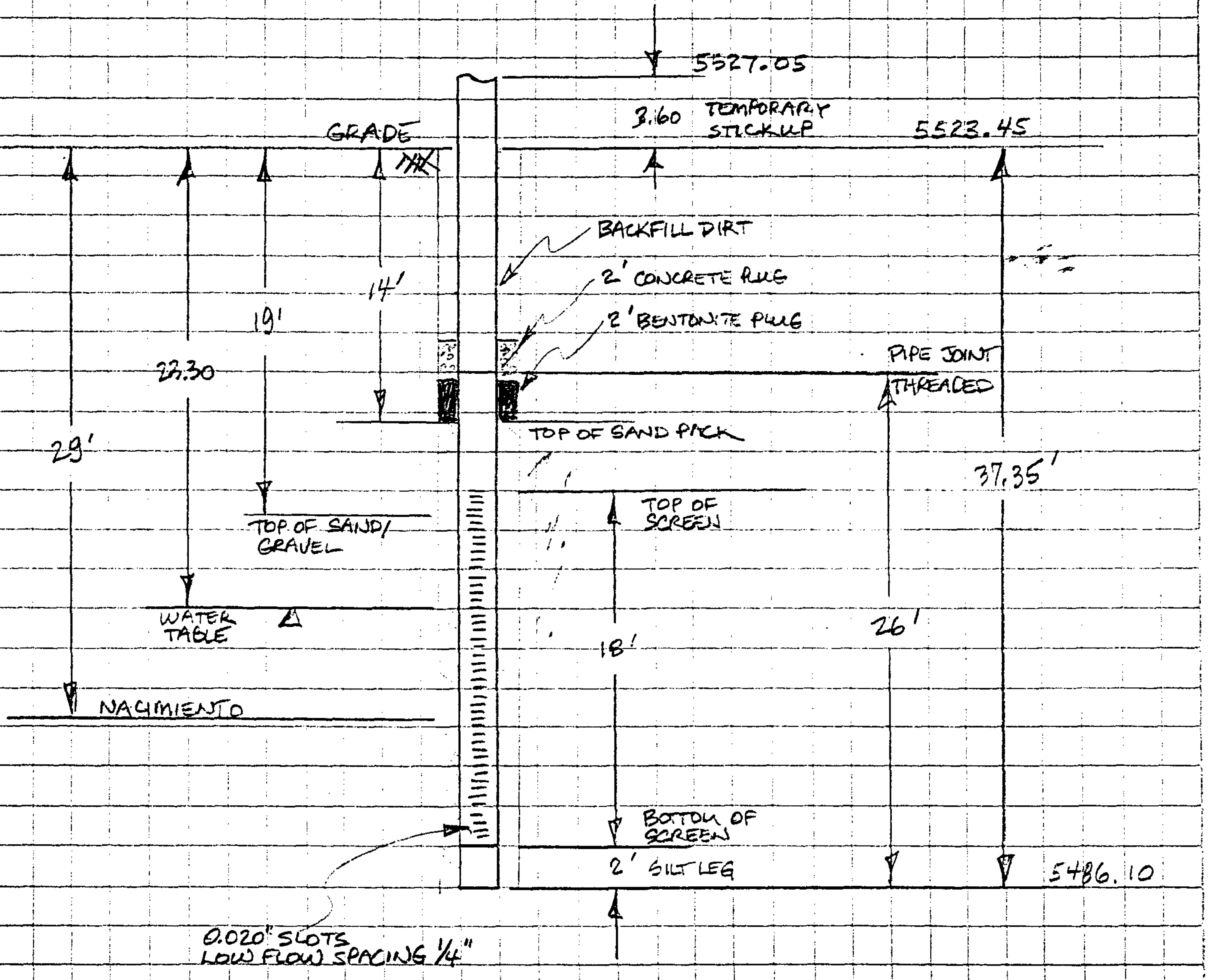
DATE OF INSTALLATION: 8-7-90 SHEET 4 OF 6

RW-18

CALCULATION SHEET

CONSTRUCTION COMMENTS: DRILLED BY CASING DRIVER, 8" BIT; 4.5" O.D. FIBERGLASS CASING SET TO DEPTH INSIDE DRIVEN CASING.; ANNULAR SPACE FILLED WITH 10/20 SAND AS DRIVEN CASING REMOVED; 50 LBS OF BENTONITE DRILLING MUD & 100 LBS OF CONCRETE PLACED ON TOP OF SAND PACK; BACKFILLED WITH DIRT TO SURFACE CONCRETE PAD SURFACE SEAL (NOT SHOWN).

LOCATION: WEST OF SOWP & NOWP, NORTH OF CAT/POLY



INITIALS CH

PROJECT No. GROUNDWATER MONITORING - SOWP & NOWP GROUNDWATER RECOVERY - OVERALL FACILITY

DATE 8-9-90

SUBJECT RECOVERY WELL 18

DATE OF INSTALLATION: 8-8-90

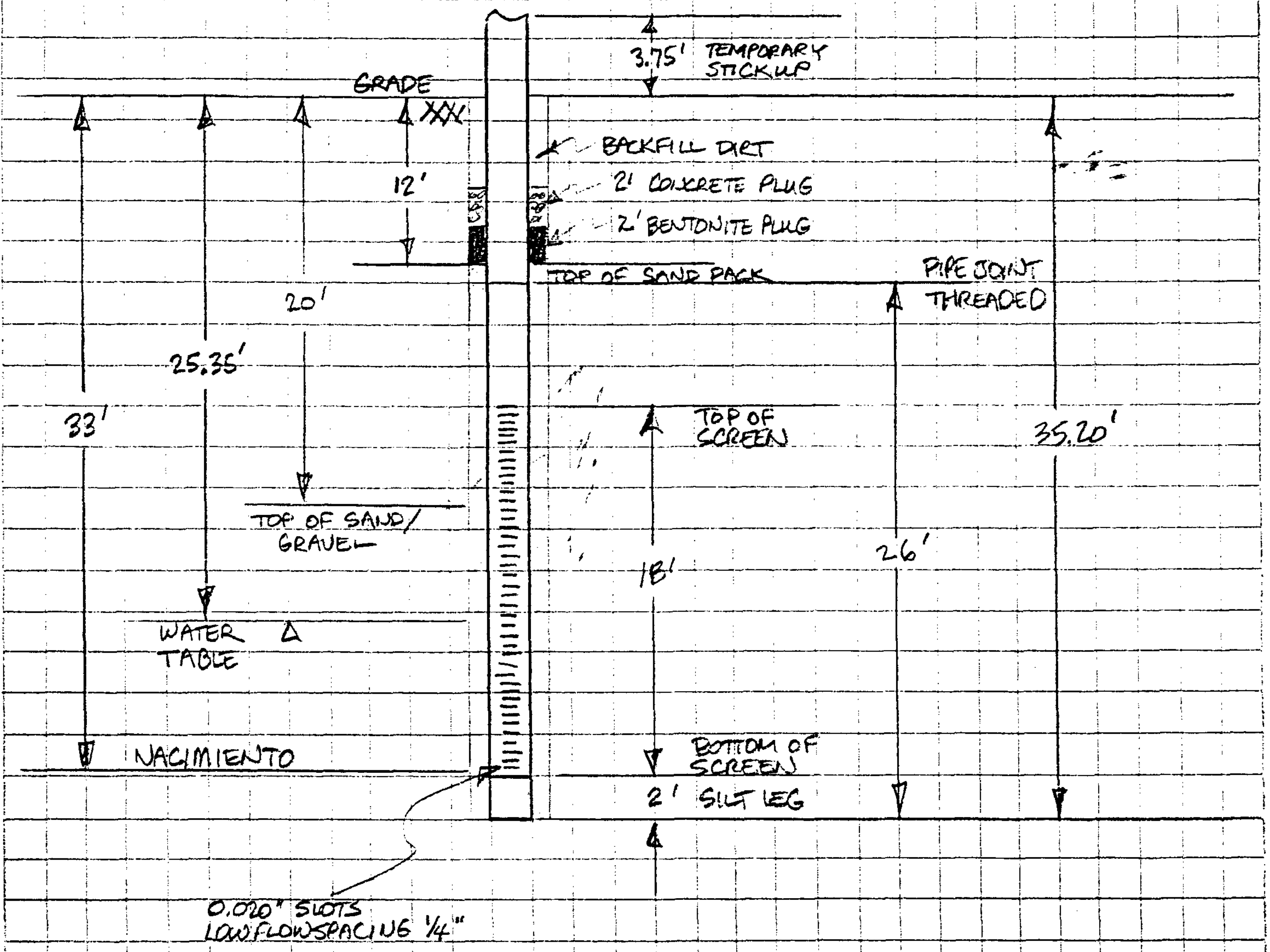
SHEET 5 OF 6

RW-19

CALCULATION SHEET

CONSTRUCTION COMMENTS: SAME AS RW-14

LOCATION: NEAR NE CORNER FIRE EQUIP. BLDG.



INITIALS CA PROJECT No. GROUNDWATER RECOVERY - PHASE II, AFE 9146

DATE 8-9-90 SUBJECT RECOVERY WELL 19

DATE OF INSTALLATION: 8-8-90 SHEET 6 OF 6

GROUNDWATER
TECHNOLOGY

Drilling Log

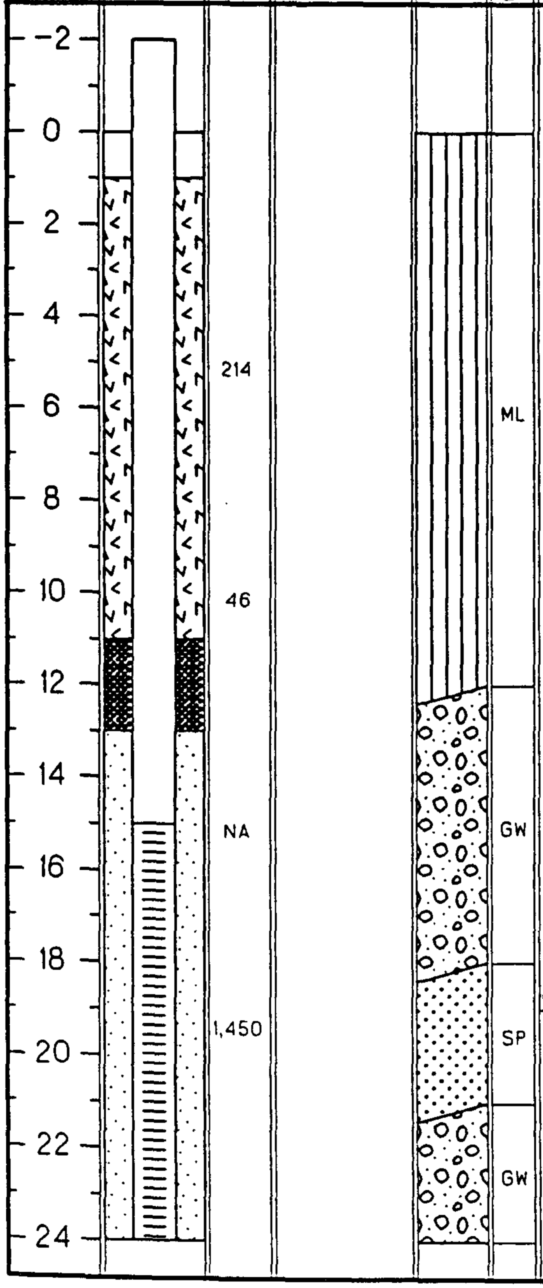
Recovery Well RW-22

Project Bloomfield/50 CR4990 Owner Bloomfield Refining Co.
Location Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. 5518.05 ft. Total Hole Depth 34 ft. Diameter 10 in.
Top of Casing 5521.05 ft. Water Level Initial 19 ft. Static
Screen: Dia 6 in. Length 16 ft. Type/Size FRE/0.020 in.
Casing: Dia 6 in. Length 17/2 ft. Type FRE
Fill Material 12/20 Co. Silica Rig/Core Speedstar 15-THH
Drill Co. Beeman Bros. Method Air Percussion
Driller Leo Beeman Log By Jerry May Date 07/19/93 Permit #
Checked By License No.

See Site Map
For Boring Location

COMMENTS:

Start @ 1230 hrs. 2 ft silt leg installed from 31 to 33 feet



Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
1					Tan SILT (moist)
4					Same as above
5	214				
6				ML	
10	46				Same as above
12					Gray COBBLES (trace or no fines)
15	NA			GW	
18					Light gray-stained poorly-graded fine SAND with trace of gravel (moist-wet)
19					▽ Groundwater encountered at 19' on 7/19/93
20	1,450			SP	
21					Dark-gray-stained COBBLES with trace fines (moist)
22				GW	

GROUNDWATER
TECHNOLOGY

Drilling Log

Recovery Well **RW-23**

Project *Bloomfield/50 CR4990* Owner *Bloomfield Refining Co.*
Location *Bloomfield, New Mexico* Proj. No. *023353014*
Surface Elev. *5515.74 ft.* Total Hole Depth *33 ft.* Diameter *10 in.*
Top of Casing *5517.74 ft.* Water Level Initial *19 ft.* Static
Screen: Dia *6 in.* Length *16 ft.* Type/Size *FRE/0.020 in.*
Casing: Dia *6 in.* Length *15/2 ft.* Type *FRE*
Fill Material *12/20 Co. Silica* Rig/Core *Speedstar 15-THH*
Drill Co. *Beeman Bros.* Method *Air Percussion*
Driller *Leo Beeman* Log By *Jerry May* Date *07/19/93* Permit #
Checked By License No.

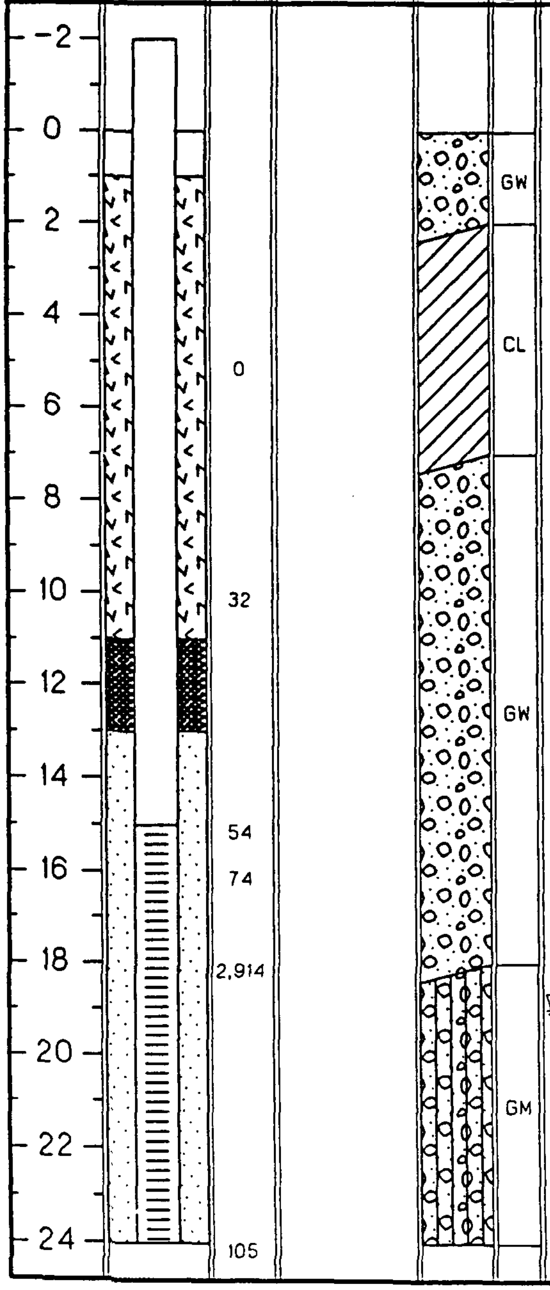
See Site Map For Boring Location

COMMENTS:

Start @ 1630 hrs. 2 ft. silt leg installed from 31 to 33 feet

Depth (ft.) | Well Completion | PID (ppm) | Sample ID | Blow Count/ % Recovery | Graphic Log | USCS Class.

Description
(Color, Texture, Structure)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%



Gravel with fines (dry)

Brown silty CLAY (moist, medium plasticity)

Gravel and COBBLES (no fines)

Same as above with little fines

Gravel and COBBLES with trace of fines (dry)

Gray-stained, same as above

Black-stained GRAVEL with some fines (moist)

▽ *Groundwater encountered at 19 feet on 7/19/93*

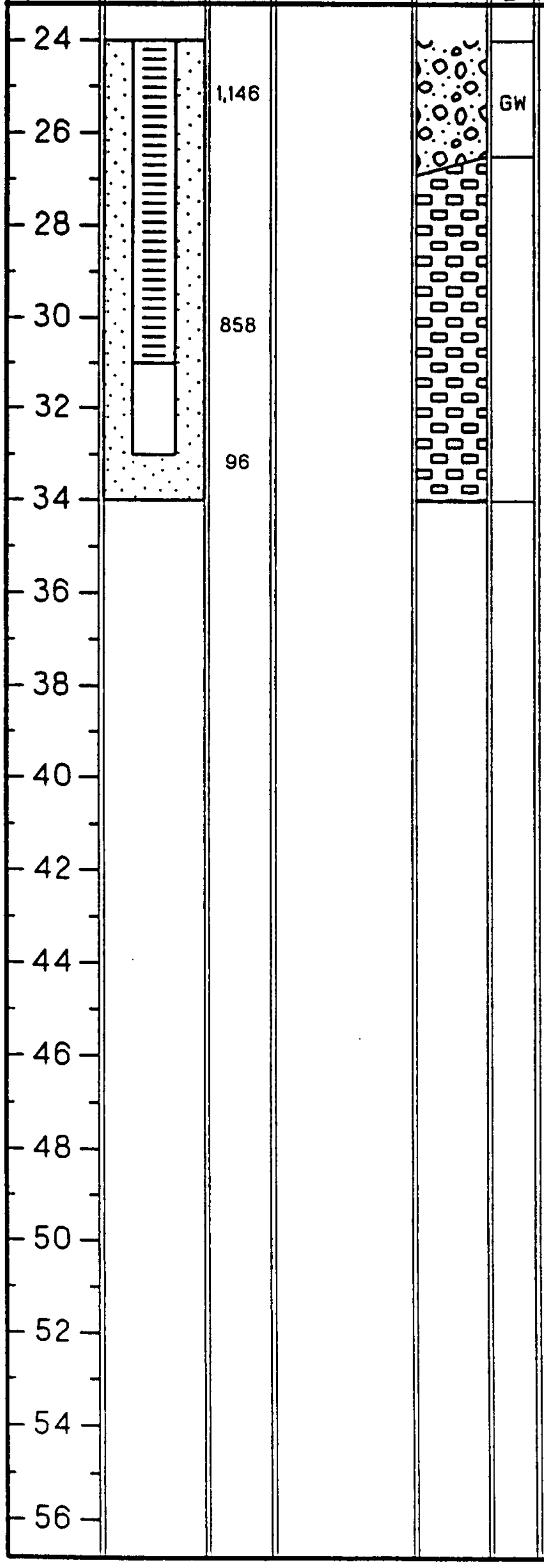
GROUNDWATER TECHNOLOGY

Drilling Log

Recovery Well **RW-22**

Project *Bloomfield/50 CR4990* Owner *Bloomfield Refining Co.*
Location *Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%



Encountered weathered limestone (moist)

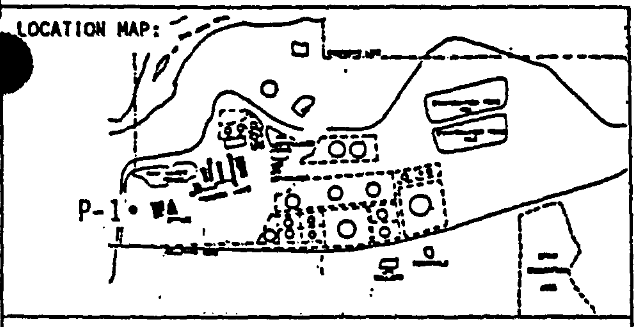
(Dry at 28 feet)

End of boring at 34 feet (1355 hrs.). Installed recovery well screened from 15 to 31 feet on 7/19/93.

LITHOLOGIC LOG (SOIL)

Page 1 of 1

LOCATION MAP:



___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: P-1

SITE COORDINATES (ft.):

N ______ E ______

GROUND ELEVATION (ft. MSL): 5524.62

STATE: New Mexico COUNTY: San Juan

DRILLING METHOD: Casing Driver

DRILLING CONTR.: Beeman Brothers

DATE STARTED: 30 August 1988 DATE COMPLETED: 30 August 1988

FIELD REP.: W.S. Dubyk

COMMENTS: This well replaced by P-1a on August 31, 1988.

LOCATION DESCRIPTION:

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-20' Silt and Clay - Dark yellowish brown (10 YR 4/2) to grayish brown (5 YR 3/2). Weak hydrocarbon odor.
5			1135		
10			1140		
15			1145		
20			1200		20'-36.5' Sand and Gravel - Dark gray (N3) to grayish black (N2). Sand is fine to very coarse grained, subangular to rounded. Gravel is subangular to well rounded, to 2" diameter. Very strong to intense hydrocarbon odor.
25			1205		
30			1210		
35			1220		
					36.5'-42.0' Shale - Nacimiento Formation - Dusky yellow (5 Y 6/4) to olive gray (5 Y 3/2) shale.
40					
			1225 1240		
		T.D. 42'			
45					
50					

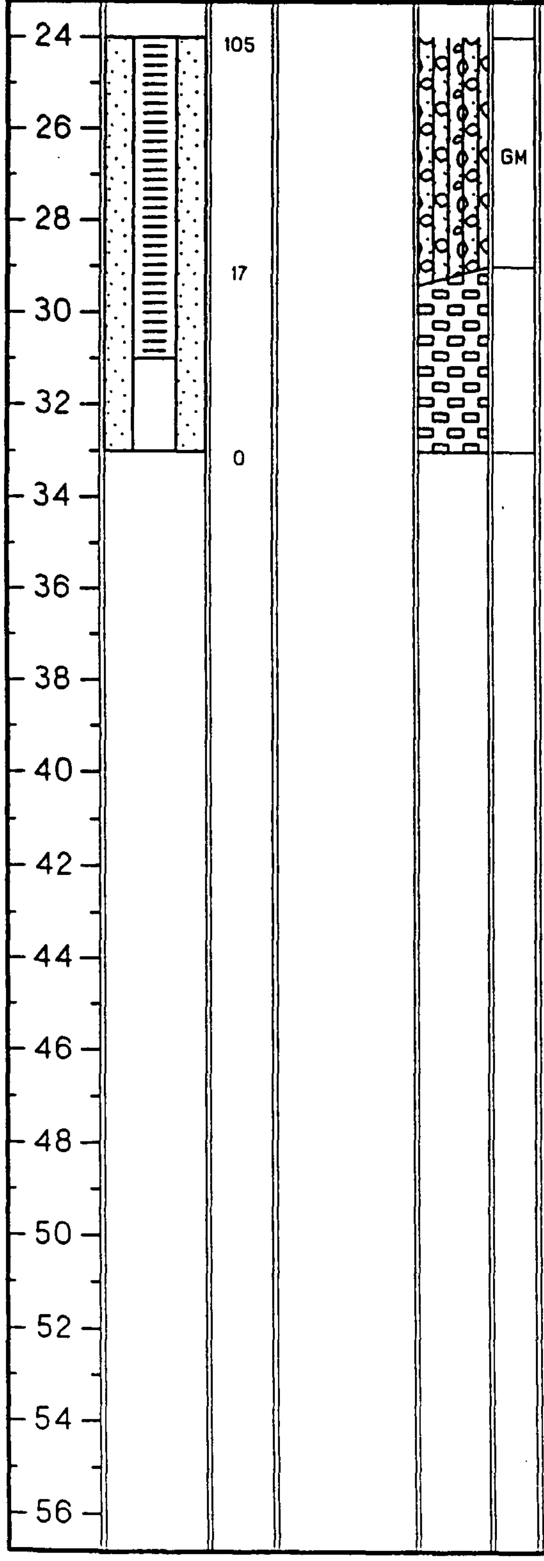
GROUNDWATER TECHNOLOGY

Drilling Log

Recovery Well **RW-23**

Project *Bloomfield/50 CR4990* Owner *Bloomfield Refining Co.*
Location *Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%



Gravel and some tan fines (moist)

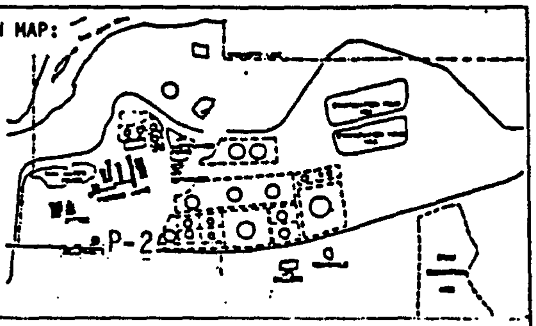
Light gray weathered limestone (dry)

End of boring at 33 feet (1750 hrs). Installed recovery well screened from 15 to 31 feet on 7/19/93.

LITHOLOGIC LOG (SOIL)

Page 1 of 1

LOCATION MAP:



___1/4 ___1/4 ___1/4 ___1/4 S___ T___ R___

SITE ID: BRC LOCATION ID: P-2

SITE COORDINATES (ft.):

N ________ E ________

GROUND ELEVATION (ft. MSL): 5523.73

STATE: New Mexico COUNTY: San Juan

DRILLING METHOD: Casing Driver

DRILLING CONTR.: Beeman Brothers

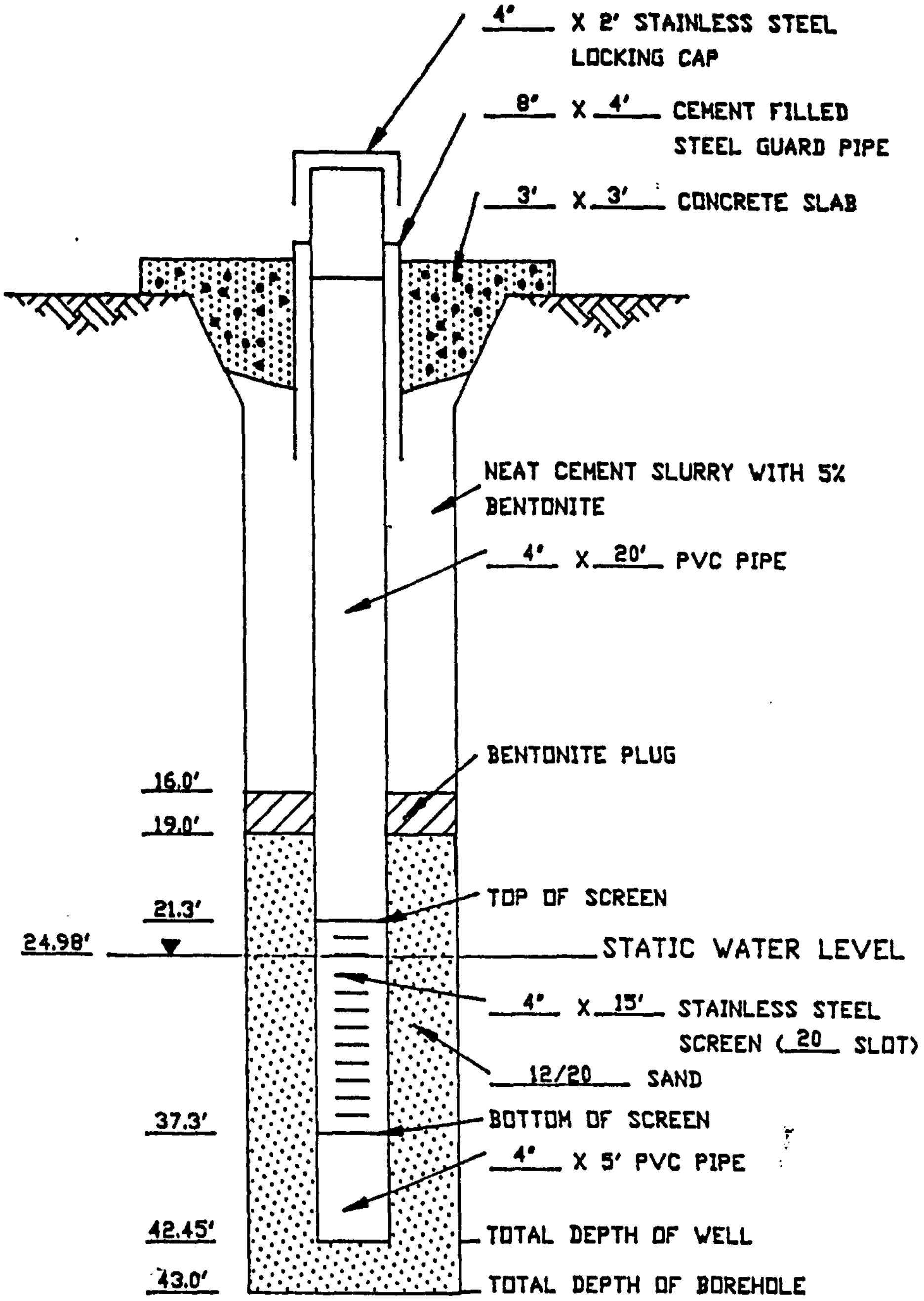
DATE STARTED: 29 August 1988 DATE COMPLETED: 29 August 1988

FIELD REP.: W.S. Dubyk

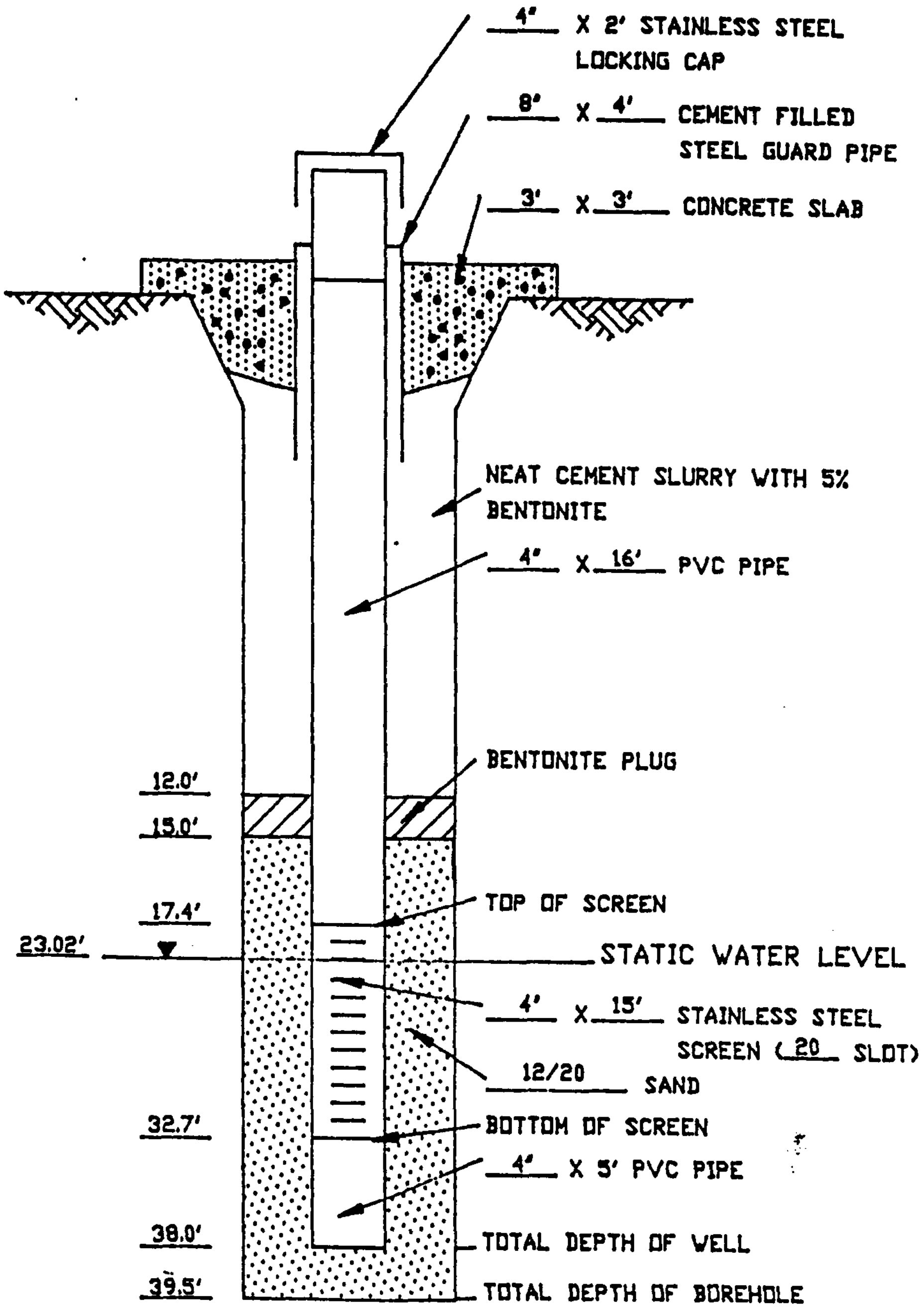
COMMENTS: This well replaced by P-2a. Static on September 2, 1988: 23.75 from TOC.

LOCATION DESCRIPTION: ________

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-13' Silty and Clay - Dark gray (N3) to grayish black (N2) to dark yellowish brown (10 YR 4/2). Intense hydrocarbon odor.
5			1650		
10			1656		
15			1710		13'-31.5' Sand and Gravel - Moderate yellowish brown (10 YR 5/4) to medium gray (N5). Sand is medium to very coarse grained, subangular to subrounded. Gravel is subangular to well rounded, to 2" diameter. Strong hydrocarbon odor below 25'.
20			1720		
25			1730		
30			1734		31.5'-39.5' Shale - Nacimiento Formation - Dusky yellow (5 Y 6/4) to olive gray (5 Y 3/2).
35			1752		
40		T.D. 39.5'	1808		
45					
50					



COMPLETION DIAGRAM
PIEZOMETER P-1

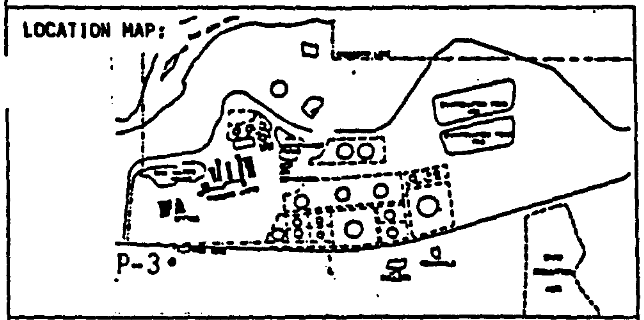


COMPLETION DIAGRAM
PIEZOMETER P-2

LITHOLOGIC LOG (SOIL)

Page 1 of 1

LOCATION MAP:

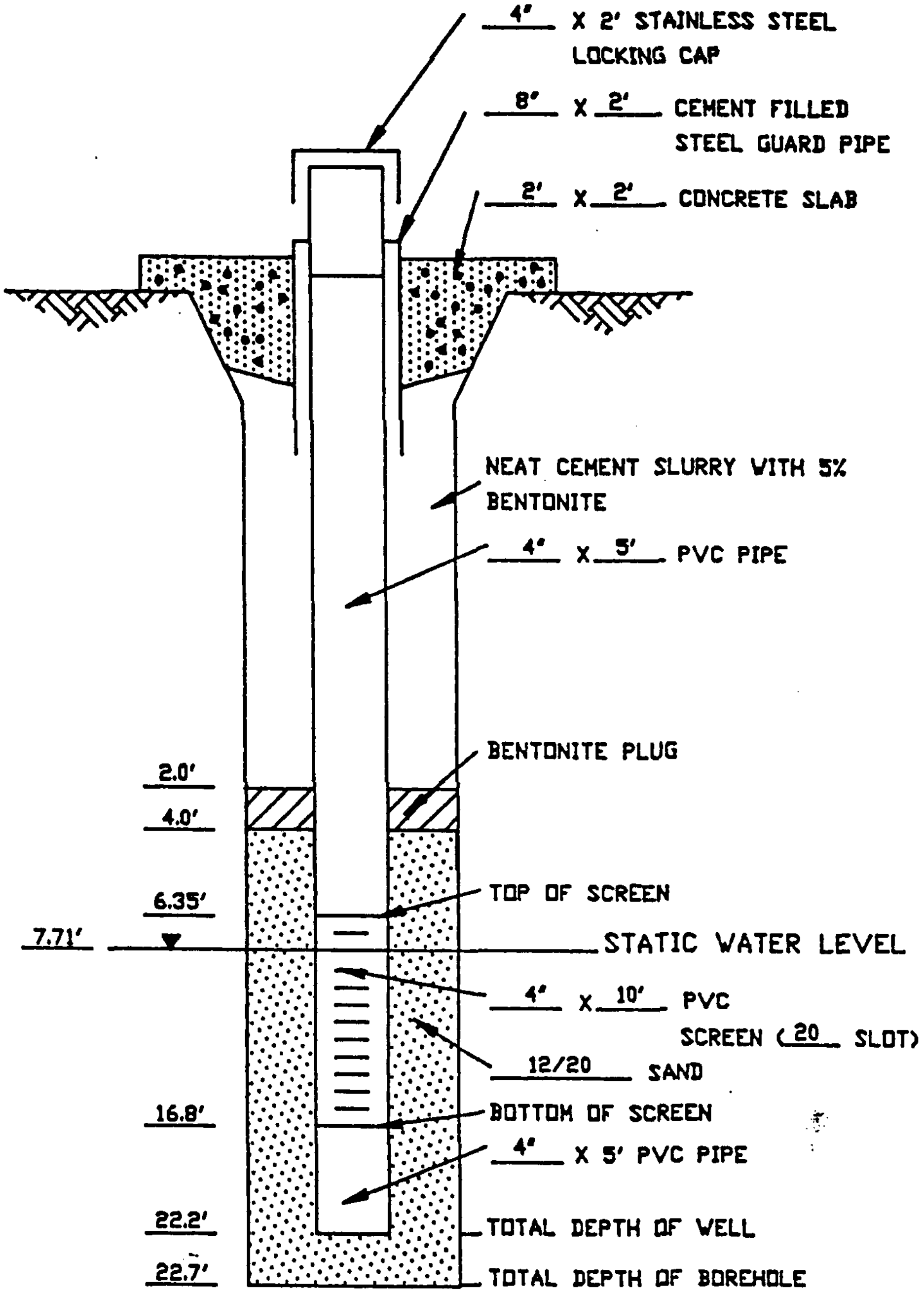


____1/4 ____1/4 ____1/4 ____1/4 S____ T____ R____

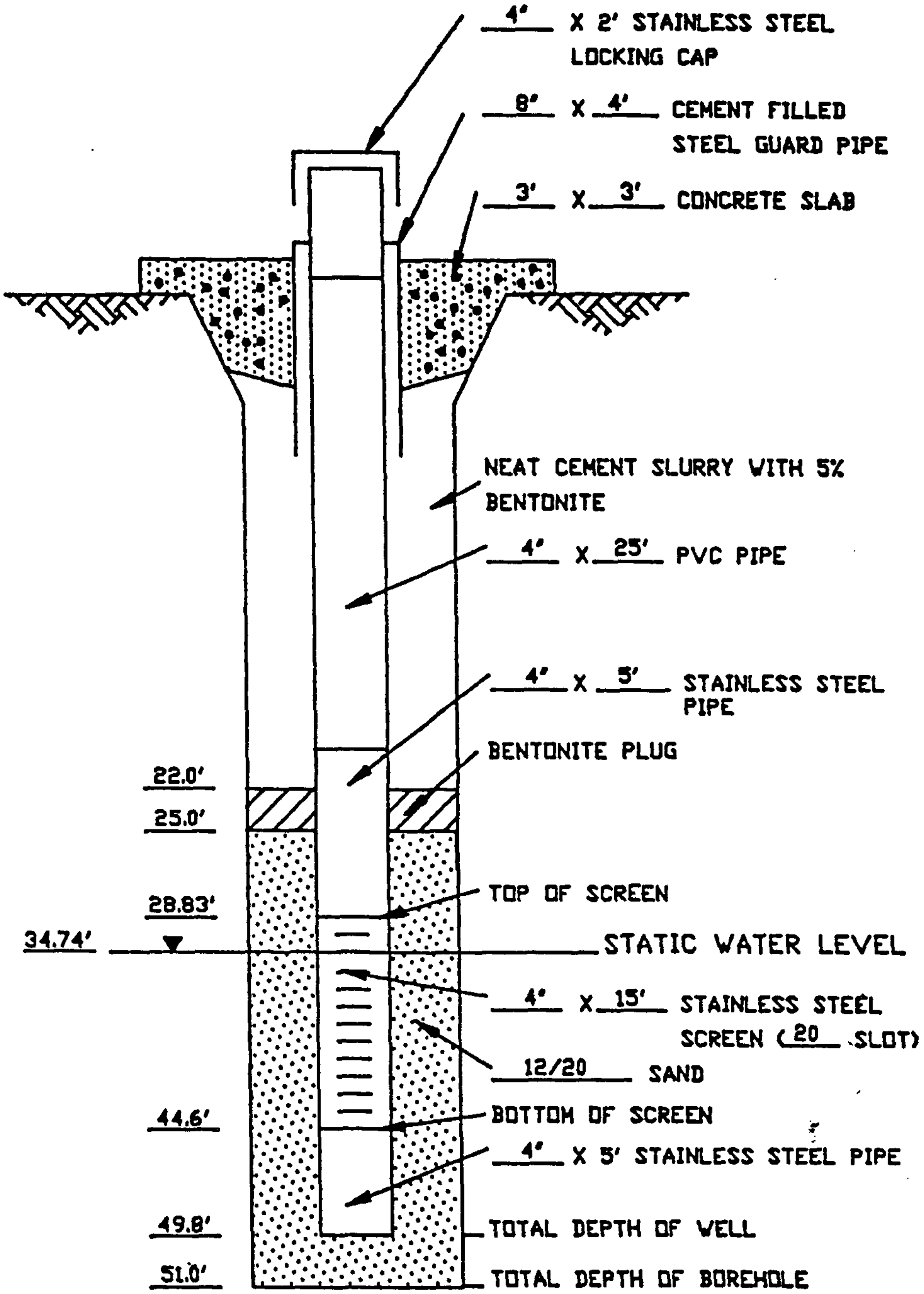
SITE ID: BRC LOCATION ID: P-3
SITE COORDINATES (ft.):
N ____ E ____
GROUND ELEVATION (ft. MSL): 5507.20
STATE: New Mexico COUNTY: San Juan
DRILLING METHOD: Casing Driver
DRILLING CONTR.: Beeman Brothers
DATE STARTED: 1 September 1988 DATE COMPLETED: 1 September 1988
FIELD REP.: W.S. Dubyk
COMMENTS: Static on September 2, 1988: 8.30' from TOC.

LOCATION DESCRIPTION: ____

Depth	Visual %	Lith	Drilling Time Scale:	Sample Type and Interval	Lithologic Description
					0'-14' Sand and Gravel - Medium gray (N5) to dark gray (N3). Sand is medium to coarse grained, subangular to subrounded. Gravel is subrounded to rounded, to 2" diameter. Strong hydrocarbon odor.
5			0902		
10			0913		
15			0920		14'-22.7' Shale: Nacimiento Formation - Dusky yellow (5 YR 6/4) to light olive gray (5 Y 6/1) shale.
20			0925		
			1000		
25					
		T.D.22.7'			
30					
35					
40					
45					
50					



COMPLETION DIAGRAM
PIEZOMETER P-3



COMPLETION DIAGRAM
PIEZOMETER P-4

GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Point **MP-1**

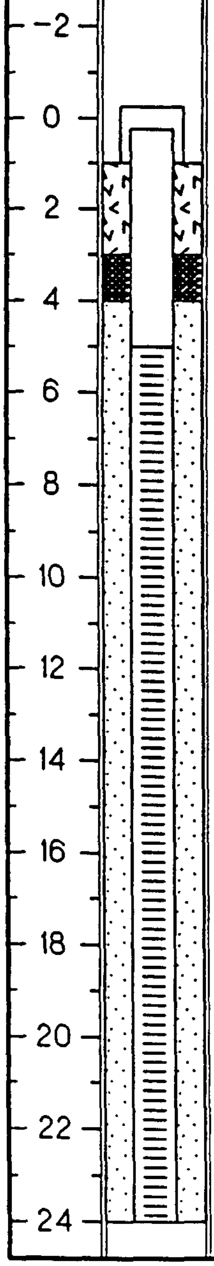
Project *BRC* Owner *Bloomfield Refining Co.*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *30 ft.* Diameter *10 in.*
Top of Casing ______ Water Level Initial *25 ft.* Static ______
Screen: Dia *2 in.* Length *25 ft.* Type/Size *PVC 0.020 in.*
Casing: Dia *2 in.* Length *5 ft.* Type *PVC*
Fill Material *10/20 Co. Silica* Rig/Core *Drill Systems 180*
Drill Co. *Layne* Method *Air Percussion*
Driller *Gabby Rodriguez* Log By *Jerry May* Date *05/13/94* Permit # ______
Checked By JAM License No. ______

See Site Map For Boring Location

COMMENTS:

Start @ 1315 hrs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
0							See drilling log VEW-1 for lithology

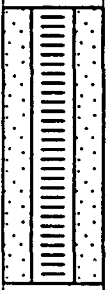


GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Point **MP-1**

Project *BRC* Owner *Bloomfield Refining Co.*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24						∇	*Groundwater encountered at 25 feet on 5/13/94*
26							
28							
30							End of boring at 30 feet (1335 hrs). Installed well screened from 5 to 30 feet on 5/13/94.
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

GROUNDWATER TECHNOLOGY

Drilling Log

Monitoring Point MP-2

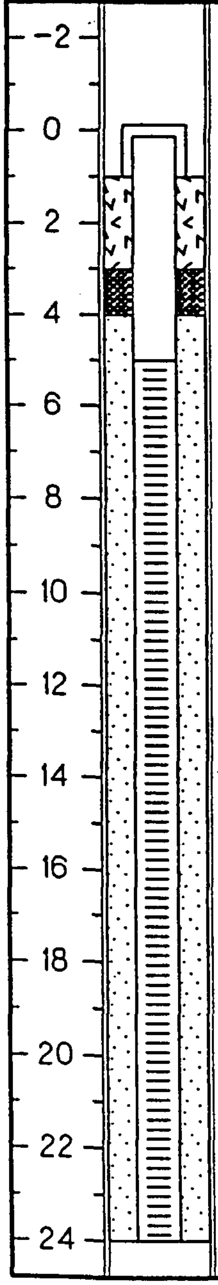
Project BRC Owner Bloomfield Refining Company
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014
Surface Elev. ______ Total Hole Depth 30 ft. Diameter 10 in.
Top of Casing ______ Water Level Initial 24 ft. Static ______
Screen: Dia 2 in. Length 25 ft. Type/Size PVC .020 in.
Casing: Dia 2 in. Length 5 ft. Type PVC
Fill Material 10/20 Co. Silica Rig/Core Drill Systems 180
Drill Co. Layne Method Air Percussion
Driller Gabby Rodriguez Log By Jerry May Date 05/16/94 Permit # ______
Checked By JAM License No. ______

See Site Map
For Boring Location

COMMENTS:

Start at 1615 hrs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
0							See well VEW-1 for lithology

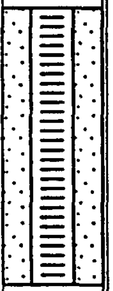


GROUNDWATER
TECHNOLOGY

Drilling Log

Monitoring Point **MP-2**

Project *BRC* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							▽ *Groundwater encountered at 24 feet on 5/16/94*
26							
28							
30							End of boring at 30 feet (1640 hrs). Installed well screened from 5 to 30 feet on 5/16/94.
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

GROUNDWATER TECHNOLOGY

Drilling Log

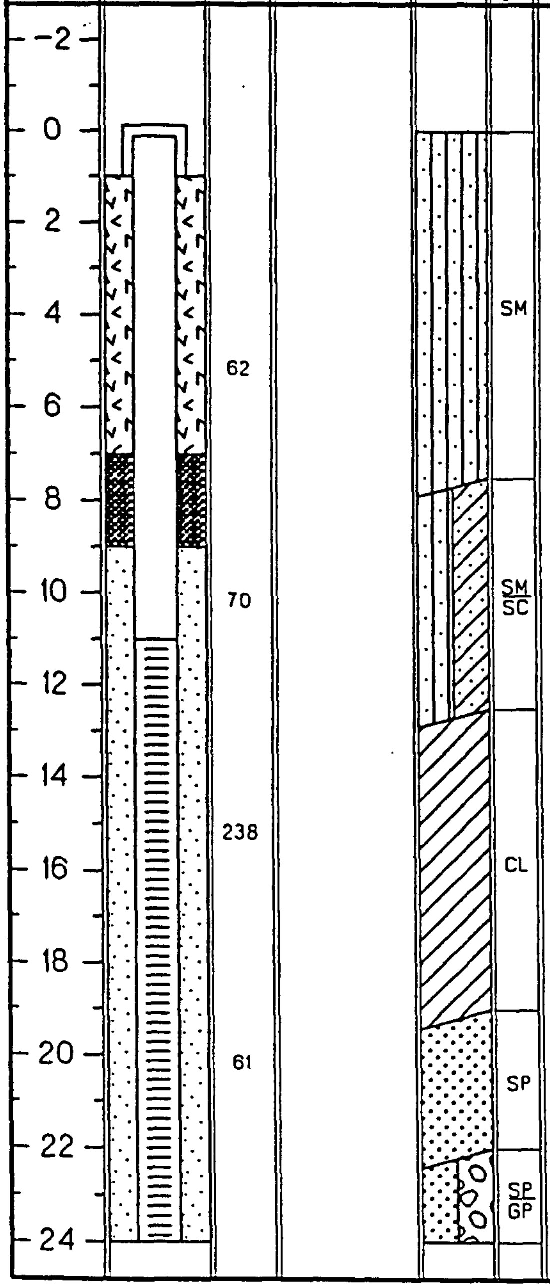
Monitoring Point MP-

Project *BRC* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *31 ft.* Diameter *10 in.*
Top of Casing ______ Water Level Initial *28 ft.* Static ______
Screen: Dia *2 in.* Length *20 ft.* Type/Size *PVC .020 in.*
Casing: Dia *2 in.* Length *11 ft.* Type *PVC*
Fill Material *10/20 Co. Silica* Rig/Core *Drill Systems 180*
Drill Co. *Layne* Method *Air Percussion*
Driller *Gabby Rodriguez* Log By *Jerry May* Date *05/17/94* Permit # ______
Checked By JAM License No. ______

See Site Map For Boring Location

COMMENTS:

Start at 0950 hrs.



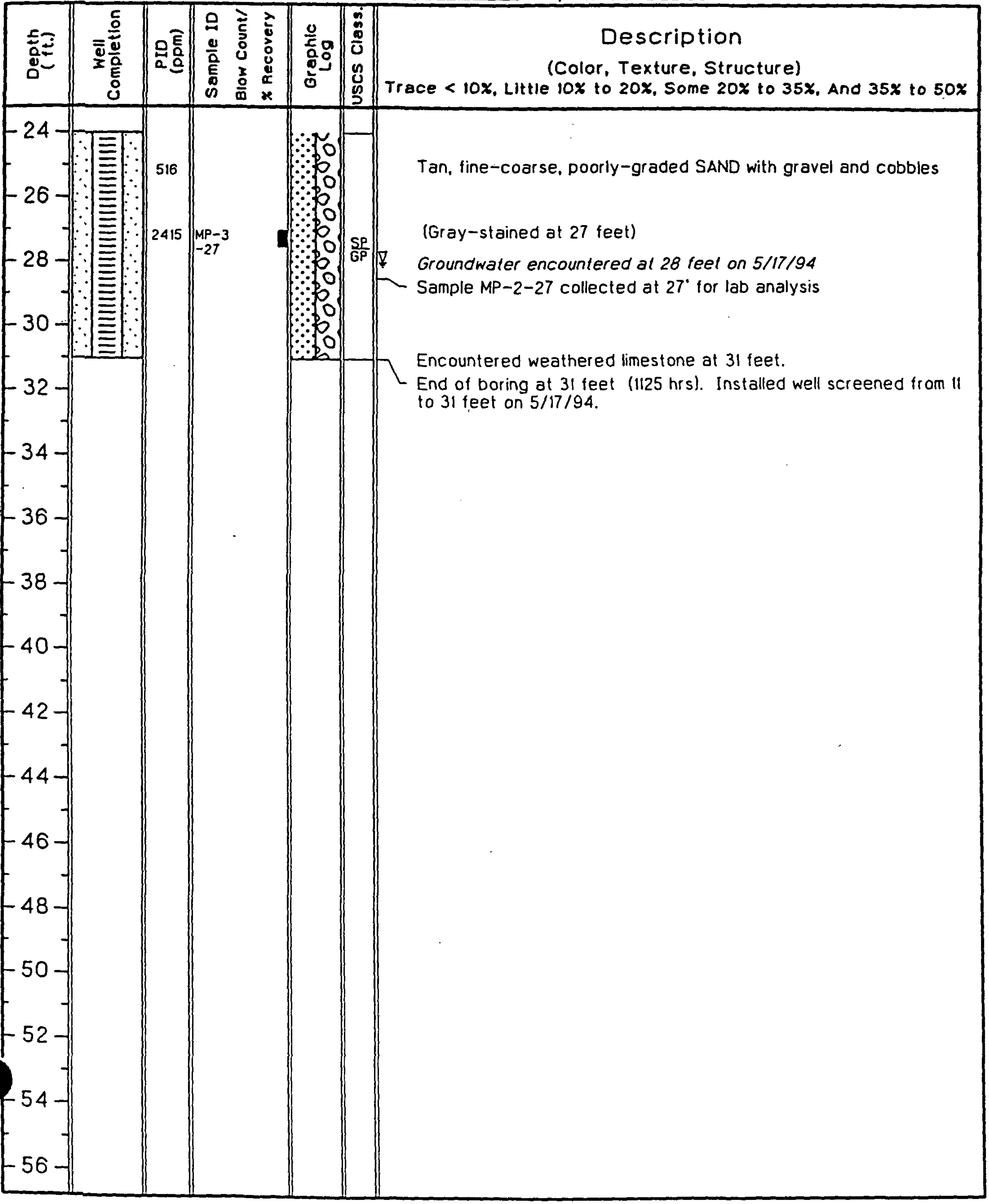
Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
0							Tan, fine, poorly-graded silty SAND (dry)
4						SM	
		62					(Same as above)
10		70				SM/SC	Tan, fine, poorly-graded silty/clayey SAND (moist)
		238					Brown/gray-stained, silty CLAY (moist, low-medium plasticity)
16						CL	
20		61					Tan, fine-coarse, poorly-graded SAND (moist)
						SP	
22							(Same with gravel and cobbles at 22 +/- feet)
						SP/GP	

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Point **MP-3**

Project BRC
Owner Bloomfield Refining Company
Location 50 County Road 4990, Bloomfield, New Mexico
Proj. No. 023353014



Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24–25	516				Tan, fine-coarse, poorly-graded SAND with gravel and cobbles
27	2415	MP-3 -27	▮	SP GP	(Gray-stained at 27 feet)
28				▽	*Groundwater encountered at 28 feet on 5/17/94* Sample MP-2-27 collected at 27' for lab analysis
31					Encountered weathered limestone at 31 feet. End of boring at 31 feet (1125 hrs). Installed well screened from 11 to 31 feet on 5/17/94.

Drilling Log

GROUNDWATER TECHNOLOGY

Monitoring Point MP-4

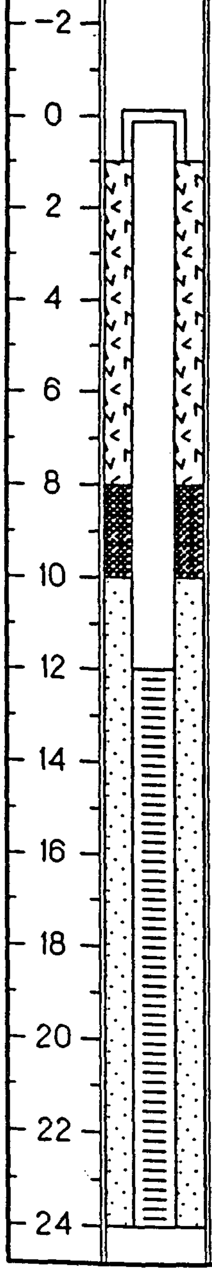
Project *BRC* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *32 ft.* Diameter *10 in.*
Top of Casing ______ Water Level Initial *28 ft.* Static ______
Screen: Dia *2 in.* Length *20 ft.* Type/Size *PVC 0.020 in.*
Casing: Dia *2 in.* Length *12 ft.* Type *PVC*
Fill Material *10/20 Co. Silica* Rig/Core *Drill Systems 180*
Drill Co. *Layne* Method *Air Percussion*
Driller *Gabby Rodriguez* Log By *Jerry May* Date *05/17/94* Permit # ______
Checked By JAM License No. ______

See Site Map For Boring Location

COMMENTS:

Start at 0845 hrs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
0							See well MP-3 for lithology

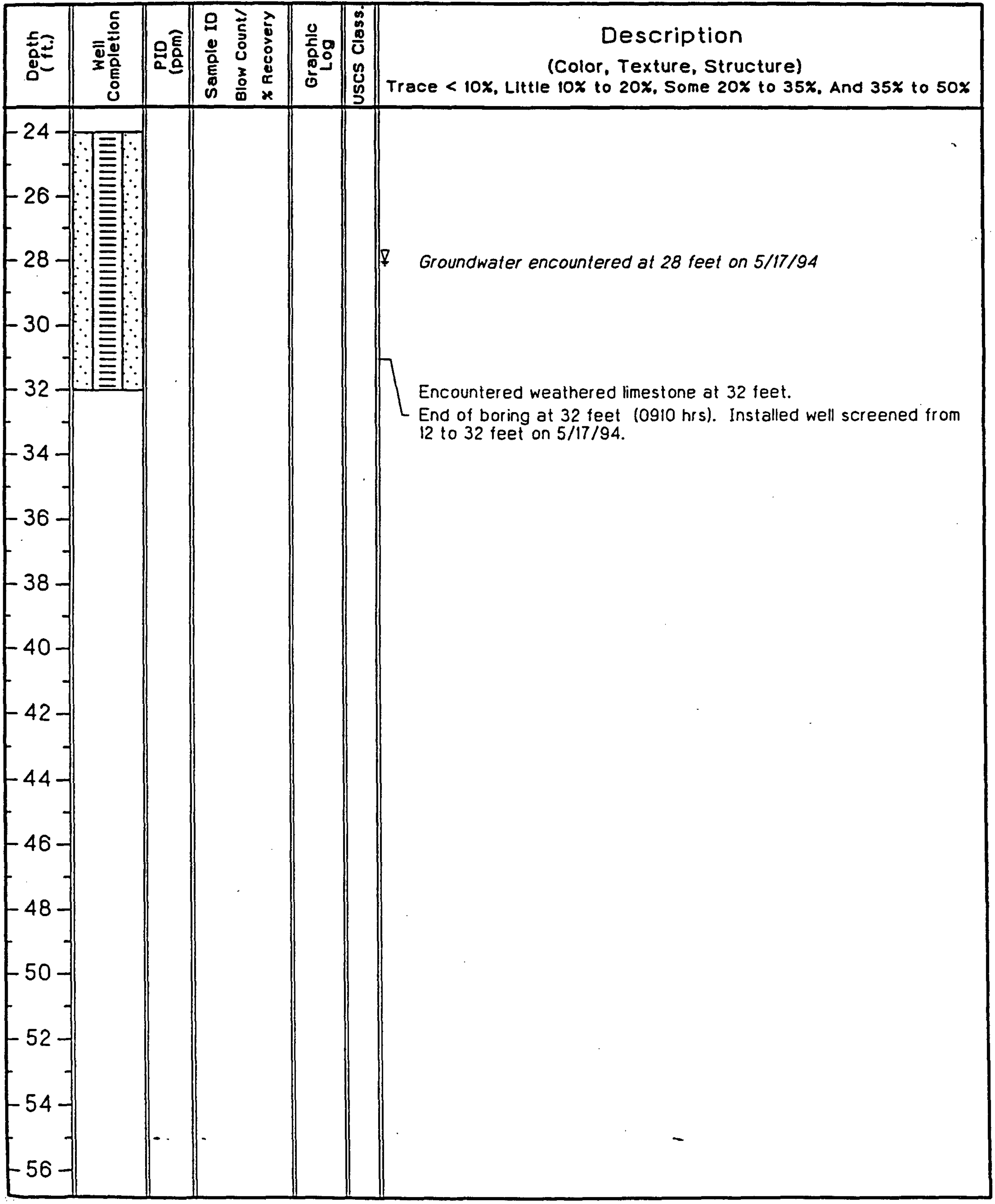


GROUNDWATER
TECHNOLOGY

Drilling Log

Monitoring Point **MP-4**

Project *BRC* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*



Groundwater encountered at 28 feet on 5/17/94

Encountered weathered limestone at 32 feet.
End of boring at 32 feet (0910 hrs). Installed well screened from 12 to 32 feet on 5/17/94.

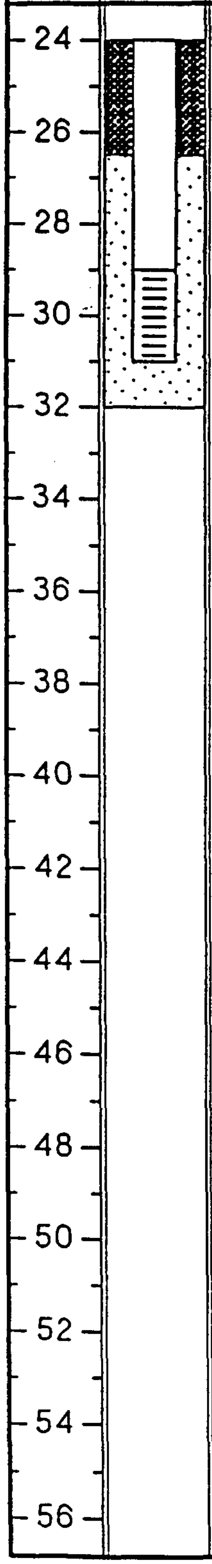
Drilling Log

GROUNDWATER TECHNOLOGY

Air Sparge Well **AS-1**

Project *BRC* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24							⊽ *Groundwater encountered at 24 feet on 5/16/94*
							Encountered weathered limestone at 31 feet
32							End of boring at 32 feet (1225 hrs). Installed well screened from 29 to 31 feet on 5/16/94.



GROUNDWATER
TECHNOLOGY

Drilling Log

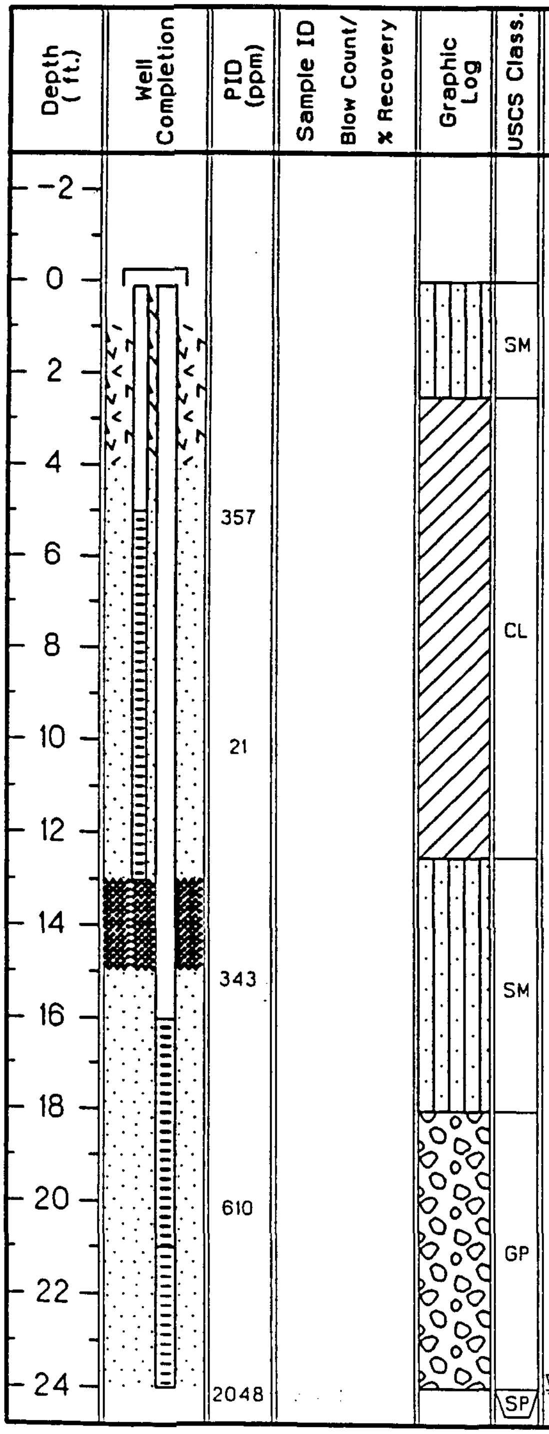
Vapor Extraction Well **VEW-1**

Project *BRC* Owner *Bloomfield Refining Company*
Location *50 County Road 4990, Bloomfield, New Mexico* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *26 ft.* Diameter *10 in.*
Top of Casing ______ Water Level Initial *24 ft.* Static ______
Screen: Dia *2 in.* Length *See comments* Type/Size *PVC 0.020" & 0.040 in.*
Casing: Dia *2 in.* Length *See comments* Type *PVC*
Fill Material *10/20 & 6/16 Co. Silica* Rig/Core *Drill Systems 180*
Drill Co. *Layne* Method *Air Percussion*
Driller *Gabby Rodriguez* Log By *Jerry May* Date *05/16/94* Permit # ______
Checked By JMM License No. ______

See Site Map
For Boring Location

COMMENTS:

Start at 1410 hrs. Set nested well. Deep well screened from 21 to 26 feet (0.020 in. slot, 10/20 sand) and 16 to 21 feet (0.040 in. slot, 6/16 sand). Shallow well screened from 5 to 13 feet (0.040 in. slot, 6/16/ sand)



PID (ppm)	Sample ID	Blow Count/ % Recovery	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
			SM	Tan, fine, poorly-graded, silty SAND (dry-moist)
357			CL	Brown, silty CLAY (moist, low plasticity)
21				(Tan, same as above)
343			SM	Gray-stained, fine poorly-graded, silty SAND (moist)
				(Cobbles at 17 feet)
610			GP	Gravel and cobbles with some fines (moist)
2048			SP	

GROUNDWATER TECHNOLOGY

Drilling Log

Vapor Extraction Well **VEW-1**

Project BRC Owner Bloomfield Refining Company
Location 50 County Road 4990, Bloomfield, New Mexico Proj. No. 023353014

Depth (ft.)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
24		2048	VEW-1 -24			SP	Gray-stained, fine-coarse, poorly-graded SAND with gravel and cobbles (moist-wet)
						GM	*Groundwater encountered at 24 feet on 5/16/94* Sample VEW-1-24 collected at 24' End of boring at 26 feet (1500 hrs). Installed nested wells screened from 5 to 13 feet and from 16 to 26 feet (see comments) on 5/16/94.
26							
28							
30							
32							
34							
36							
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							

Drilling Log

GROUNDWATER
TECHNOLOGY

Soil Boring B-01

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *North of Transportation Terminal Sump* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *12 ft.* Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/22/94* Permit # ______
Checked By ______ License No. ______

See Site Map
For Boring Location

COMMENTS:

Posthole to 2.5'. No groundwater encountered. Boring backfilled with cement-bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-12': Silty Sand, medium stiff, light brown to brown, moist, no odor, trace clay
2						
	3.5		2/2/3			
4						
			2/2/2			
6	3.1		2/4/4		ML	
8	0		2/3/3			
10	0		4/3/3			
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

GROUNDWATER
TECHNOLOGY

Drilling Log

Soil Boring B-02

See Site Map
For Boring Location

COMMENTS:

Posthole to 2'. No groundwater encountered. Boring backfilled with cement-bentonite.

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *West of Transportation Terminal Sump* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *12 ft.* Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/22/94* Permit # ______
Checked By ______ License No. ______

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ x Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-12': Silty Sand, medium stiff, light brown to brown, moist, no odor, trace clay
2	0					
4	0		1/3/3			
6	0		3/4/4		ML	
8	0					
10	0		3/3/3			
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

GROUNDWATER
TECHNOLOGY

Drilling Log

Soil Boring B-03

See Site Map
For Boring Location

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *Adjacent to Crude/Product Loading Area* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *12 ft.* Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/23/94* Permit # ______
Checked By ______ License No. ______

COMMENTS:

Posthole to 2'. No groundwater encountered. Boring backfilled with cement-bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-12': Light brown to brown Sandy Silt, little clay, moist, no odor
2	0		3/5/2			
4	0		3/4/3			
6	0		3/3/2		ML	
8	0		3/4/4			
10	0		3/3/4			
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

Drilling Log

GROUNDWATER
TECHNOLOGY

Soil Boring B-04

See Site Map
For Boring Location

COMMENTS:

Posthole to 2'. No groundwater encountered. Boring backfilled with cement-bentonite.

Project Bloomfield Refining Company Owner Bloomfield Refining Company
Location by Tank 44, Adjacent to Crude/Product Loading Area Proj. No. 023353014
Surface Elev. Total Hole Depth 12 ft. Diameter
Top of Casing Water Level Initial Static
Screen: Dia Length Type/Size
Casing: Dia Length Type
Fill Material Rig/Core B55
Drill Co. Western Technology Method Split Spoon/Hollow Stem Auger (7")
Driller Rob Log By Tim Busby Date 02/23/94 Permit #
Checked By License No.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-12': Light brown to brown Sandy Silt, moist, no odor
2	5.2		3/3/4			
4	15.7		3/2/1			Light brown to brown Sandy Silt, little clay
6	22		3/5/6		ML	Light brown to brown sandy silt, moist, no odor
8	45					
10	18.8		3/4/5			Light brown to brown Sandy Silt, little clay
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

GROUNDWATER
TECHNOLOGY

Drilling Log

Soil Boring **B-05**

See Site Map
For Boring Location

COMMENTS:

Posthole to 2'. Hit cobble layer @ 5'. Poor recovery @ 6': No sample collected at 6'. Terminated boring. No groundwater encountered. Boring backfilled with cement-bentonite.

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *West of Evaporation Pond #2* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *8 ft.* Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/23/94* Permit # ______
Checked By ______ License No. ______

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0				▥		0-5': Light brown to brown Silty Sand, some clay, moist, no odor
2	0		2/2/5	▥	ML	
4	0		26/34/31	▥		
				⁘		Light brown to gray Sand and gravel and cobbles, moist, no odor
6	0		40/37/39	⁘	GW	
8						Total Depth @ 8 feet.
10						
12						
14						
16						
18						
20						
22						
24						

GROUNDWATER TECHNOLOGY

Drilling Log

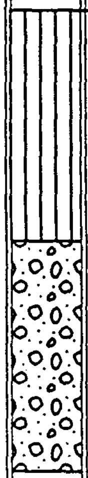
Soil Boring B-06

See Site Map
For Boring Location

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *West of Evaporation Pond #1* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *10 ft.* Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/23/94* Permit # ______
Checked By ______ License No. ______

COMMENTS:

Shelby sample collected @ 4-5'; Cobble layer @ ~ 5.5'. Cuttings collected @ 6'. Try to sample @ 8 because driller thinks we're thru layer. 9" into sample blow count=27, bouncing on cobble. No groundwater encountered. Boring filled with cement/bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-5.5': Light brown to brown Silty Sand, trace clay, moist, no odor
2	0		12/8/8		ML	
4	4		10/11			
6	2					5.5-10': Light brown to tan, Sand and gravel and cobbles, very coarse, poorly graded, moist, no odor
8	0				GW	
10	0					Total Depth @ 10 feet.
12						
14						
16						
18						
20						
22						
24						

GROUNDWATER
TECHNOLOGY

Drilling Log

Soil Boring **B-07**

Project *Bloomfield Refining Company* Owner *Bloomfield Refining Company*
Location *Southwestern section of Fire Training Area* Proj. No. *023353014*
Surface Elev. ______ Total Hole Depth *12 ft.* Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core *B55*
Drill Co. *Western Technology* Method *Split Spoon/Hollow Stem Auger (7")*
Driller *Rob* Log By *Tim Busby* Date *02/23/94* Permit # ______
Checked By ______ License No. ______

See Site Map
For Boring Location

COMMENTS:

Post hole to 2'. No groundwater encountered. Boring backfilled with cement/bentonite.

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-7': Light brown to brown Sandy Silt, moist, no odor
2	0		2/2/1			
4	0		6/5/4		ML	
6	0		12/13/12			
						7-12': Light brown to brown Silty Sand, trace silt, moist, no odor
8	0					
10	0		5/6/7		SM	
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

GROUNDWATER
TECHNOLOGY

Drilling Log

Soil Boring B-08

See Site Map
For Boring Location

COMMENTS:

Post hole to 2'. No groundwater encountered. Boring backfilled with cement/bentonite.

Project Bloomfield Refining Company Owner Bloomfield Refining Company
Location Southeastern section of Fire Training Area Proj. No. 023353014
Surface Elev. ______ Total Hole Depth 12 ft. Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core B55
Drill Co. Western Technology Method Split Spoon/Hollow Stem Auger (7")
Driller Rob Log By Tim Busby Date 02/23/94 Permit # ______
Checked By ______ License No. ______

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0						0-7.5': Light brown to brown Sandy Silt, moist, no odor
2	0		3/3/4			
4	0		6/5/7		ML	
6	1		8/13/16			
					CL	7.5-8': Clay, trace sand, brown, moist, no odor
8	0		6/8/9			8-12': Silty Sand, light brown to brown, moist, no odor
10	0		6/10/13		SM	
12						Total Depth @ 12 feet.
14						
16						
18						
20						
22						
24						

03/15/1994 lithlog-mar83

Drilling Log

GROUNDWATER
TECHNOLOGY

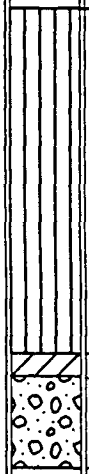
Soil Boring B-09

See Site Map
For Boring Location

Project Bloomfield Refining Company
Owner Bloomfield Refining Company
Location Northeastern section of Fire Training Area
Proj. No. 023353014
Surface Elev.
Total Hole Depth 10 ft.
Diameter
Top of Casing
Water Level Initial
Static
Screen: Dia
Length
Type/Size
Casing: Dia
Length
Type
Fill Material
Rig/Core B55
Drill Co. Western Technology
Method Split Spoon/Hollow Stem Auger (7")
Driller Rob
Log By Tim Busby
Date 02/23/94
Permit #
Checked By
License No.

COMMENTS:

Post hole to 2'. No groundwater encountered. Bag samples only @ 8 & 10'. No odor. Boring backfilled with cement/bentonite.



Depth (ft.)	PID (ppm)	Sample ID Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2					
0					0-7.5': Silty Sand, light brown to brown, moist, no odor
2	0	4/3/3			
4	0	4/6/5		ML	
6	0	5/4/12			
				CL	7.5-8': Clay, brown, moist, no odor, cobbles from 8-10'
8	0				
				GW	8-10': Cobbles
10	0				Total Depth @ 10 feet.
12					
14					
16					
18					
20					
22					
24					

GROUNDWATER
TECHNOLOGY

Drilling Log

Soil Boring **B-10**

See Site Map
For Boring Location

COMMENTS:

Post hole to 2'. No groundwater encountered. Boring backfilled with cement/bentonite.

Project Bloomfield Refining Company Owner Bloomfield Refining Company
Location Northwestern section of Fire Training Area Proj. No. 023353014
Surface Elev. ______ Total Hole Depth 12 ft. Diameter ______
Top of Casing ______ Water Level Initial ______ Static ______
Screen: Dia ______ Length ______ Type/Size ______
Casing: Dia ______ Length ______ Type ______
Fill Material ______ Rig/Core B55
Drill Co. Western Technology Method Split Spoon/Hollow Stem Auger (7")
Driller Rob Log By Tim Busby Date 02/23/94 Permit # ______
Checked By ______ License No. ______

Depth (ft.)	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
-2						
0				▥	ML	0-11': Silty Sand, light brown to brown, moist, no odor
2	0			▥		
4	0		6/7/7	▥		
6	0		4/5/7	▥		
8	0		5/7/4	▥		
10	0		6/6/23	▥		
				▨	CL	11-12': Clay and cobbles, brown, moist, no odor Total Depth @ 12 feet.
12						
14						
16						
18						
20						
22						
24						

PRECISION ENGINEERING, INC.

PROJECT: Bloomfield Refinery
ff stigation

LOG OF TEST BORINGS

FILE #: 96-181
ELEVATION:
TOTAL DEPTH: 85'
LOGGED BY: Kingsley
DATE: 12/10/1996
STATIC WATER: 10.2'
BORING ID: MW24N Bore
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0-10.2	00o00O0ou0		▼	<u>Cobbles</u>. gravelly. sandy. very dense. rounded and disked. composed of chrystalline	
	o00oc00oo		▼	intrusives and high density metamorphic rocks. dry to 10.2 feet where the soil	
	00o00000o0			becomes water bearing. Generally light colored rocks and light brown fine grained	
	o00o00O0oo		▼	soils.	
10.2-12.5	00o00O0oo0			As above but water bearing. Materials coated black and have hydrocarbon odor.	
12.5	o00o00O0oo		▼	Odor is of older tetted hydrocarbon. Sheen on water. no free hydrocarbon observed	
12.5-39.0	*********		▼	<u>Sandstone</u>. fine. poorly cemented. argillaceous. hand sample crumbles. grey blue.	
	*********		▼	wet but not water bearing. weak hydrocarbon odor. mod. dense. massive (no jointing)	
	*********		▼	Yellow brown color at 13.0'. no hydrocarbon odor. slightly less moisture.	
	*********	20	▼	Blue grey at 15.0'. no hydrocarbon odor. Sandstone dries white to light grey.	
	*********		▼	Sample recovery 100%. Cores are high quality. Core rate using carbide NWD4 bit	
	*********		▼	approx. 1'/min	
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		•	Thin (<1cm) carbonaceous shale seams. appears coaly. random orientation but	
	*********		▼	typically near flat lying. No free water. samples moist.	
.0	*********		▼		
42.0	---------	40	▼	<u>Shale</u>. damp to moist. no water at interface of sandstone above and shale. blue grey	
42.0	---------		▼	to steel grey. crumbles easily in hand samples but dense in situ. Core rate 3"/min	
42.0-85.0	*********		▼	No jointing observed in cores. Recovery 100%. Occasional sandstone stringer	
	*********		▼	6" or less in thickness (rare). Cores are high quality. Some carbonaceous zones.	
	*********		▼	<u>Sandstone</u>. fine. weakly cemented. argillaceous. sample crumbles with difficulty.	
	*********		▼	grey to light brown. some calcite filling along flat lying bedding planes. moist	
	*********		▼	dense. more cemented than sandstone above. Core rate 7"/min.	
	*********		▼	Some shale in very thin lenses >60'.	
	*********		▼		
	*********		▼		
	*********	60	▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********	80	▼		
	*********		▼		
85.0	*********		▼		
TD					

LOGGED BY: Kingsley

SIZE AND TYPE OF BORING: 8-5/8 od HSA to 12.5'. NWD4 core to 85'

PRECISION ENGINEERING. INC.

LOG OF TEST BORINGS

PROJECT: Bloomfield Refinery
uff estigation

FILE #: 96-181
ELEVATION:
TOTAL DEPTH: 80
LOGGED BY: Kingsley
DATE: 12/11-12/1996
STATIC WATER: 11.7
BORING ID: N Point Bore
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE.CONDITION.COLOR.GRAINSIZE.ETC.)	PID (ppm)
0-11.7	00oo00ooo0		▼	Cobbles. gravelly. sandy. very dense. rounded and disked. composed of chrystalline	
	o00oo00oo			intrusives and high density metamorphic rocks. dry to 11.7 feet where the soil	
	00oo00ooo0			becomes water bearing. Generally light colored rocks and light brown fine grained	
	o00oo00oo		▼	soils.	
11.7-12.0	00oo00ooo0			As above but water bearing. Materials coated black and have hydrocarbon odor.	
12.0	o00oo00oo		▼	Odor is of older fetted hydrocarbon. No sheen observed. no free hydrocarbon.	
12.0-34.7	*********		▼	Sandstone. fine. poorly cemented. argillaceous. hand sample crumbles. grey blue.	
	*********			wet but not water bearing. weak hydrocarbon odor to 13.0. >13.0 no odor. mod. dense	
	*********			Yellow brown color at 13.0'. no hydrocarbon odor. slightly less moisture.	
	*********	20	▼	Auger drill to 20.0'. Rotary drill using NWD4 core with carbide bit to TD.	
	*********		▼	21'-23' carbonaceous shale laminae in the sandstone <5mm. >25' sandstone is	
	*********		▼	yellow streaked (limonitic banding).	
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
34.7	*********		▼		
7-52.0	---------		▼	Shale. damp to moist. no water at interface of sandstone above and shale. blue grey	
	---------		▼	to steel grey. crumbles easily in hand samples but dense in situ. Core rate 2"/min	
	---------	40	▼	No jointing observed in cores. Recovery 100%. Cores are high quality.	
	---------		▼		
	---------		▼		
	---------		▼		
	---------		▼		
	---------		▼		
52.0	---------		▼		
52.0-80.0	*********		▼	Sandstone. fine. moderately cemented. argillaceous. sample difficult to crumble.	
	*********		▼	grey to light brown. some calcite filling along flat lying bedding planes. moist	
	*********		▼	dense. more cemented than sandstone above. Core rate 5"/min.	
	*********	60	▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼	mud volume virtually unchanged during the coring.	
	*********		▼	significantly more dense at 73'. Core rate 3"/min.	
	*********		▼		
	*********		▼		
	*********		▼		
80.0	*********	80	▼		
TD					

LOGGED BY: Kingsley

SIZE AND TYPE OF BORING: 8-5/8 od HSA to 20'. NWD4 core to 80'

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

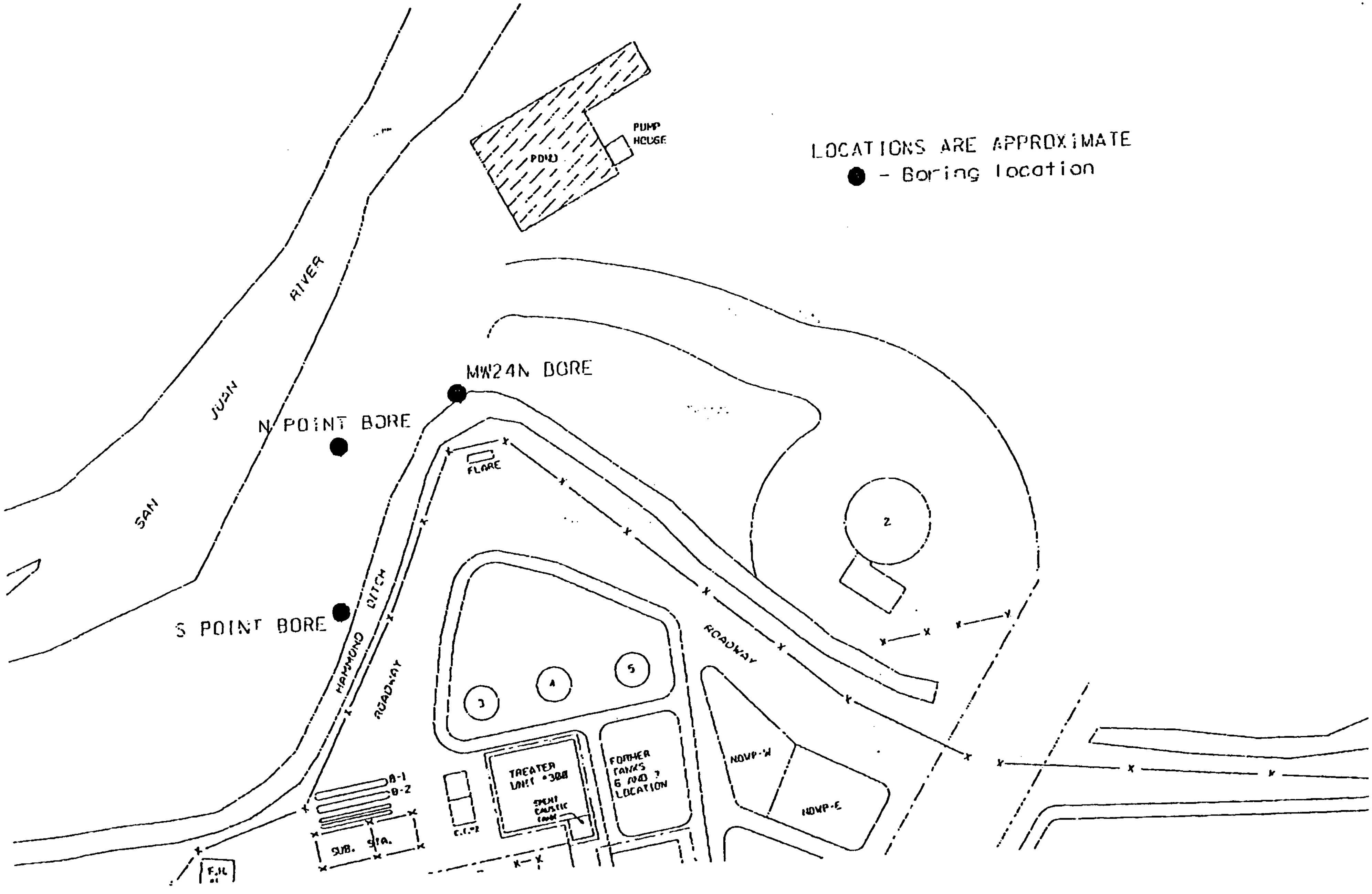
PROJECT: Bloomfield Refinery
f ,tigation

FILE #: 96-181
ELEVATION:
TOTAL DEPTH: 85
LOGGED BY: Kingsley
DATE: 12/13/1996
STATIC WATER: 19.5
BORING ID: S Point Bore
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE CONDITION COLOR, GRAINSIZE, ETC.)	PID (ppm)
0-19.5	00oo00ooo0		▼	Cobbles, gravelly, sandy, very dense, rounded and disked, composed of chrystalline	
	o00oo000oo			intrusives and high density metamorphic rocks, dry to 19.5 feet where the soil	
	00oo00ooo0			becomes water bearing. Generally light colored rocks and light brown fine grained	
	o00oo000oo		▼	soils.	
	00oo00ooo0				
	o00oo000oo		▼		
	00oo00ooo0		▼		
	o00oo000oo				
19.5-22.0	00oo00ooo0			As above but water bearing. Materials coated black and have hydrocarbon odor.	
	o00oo000oo	20	▼	Odor is of older fetted hydrocarbon. Slight sheen observed, no free hydrocarbon.	
22.0	00oo00ooo0		▼		
22.0-36.0	*********		▼	Sandstone, fine, poorly cemented, argillaceous, hand sample crumbles, grey blue,	
	*********		▼	wet but not water bearing, weak hydrocarbon odor to 22.6, >22.6 no odor, mod. dense	
	*********		▼		
	*********		▼	Auger drill to 25.0'. Rotary drill using NWD4 core with carbide bit to TD.	
	*********		▼		
	*********		▼	Some limonitic banding >30'.	
.0	*********		▼		
-50.5	---------		▼	Shale, damp to moist, no water at interface of sandstone above and shale, blue grey	
	---------	40	▼	to steel gray, crumbles easily in hand samples but dense in situ. Core rate 2"/min	
	---------		▼	No jointing observed in cores. Recovery 100%. Cores are high quality.	
	---------		▼		
	---------		▼		
	---------		▼		
50.5	---------		▼		
50.5-85.0	*********		▼	Sandstone, fine, moderately cemented, argillaceous, sample difficult to crumble,	
	*********		▼	grey to light brown, some calcite filling along flat lying bedding planes, moist	
	*********		▼	dense, more cemented than sandstone above. Core rate 4.5"/min.	
	*********		▼		
	*********	60	▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼		
	*********		▼	mud volume virtually unchanged during the coring.	
	*********		▼	more dense at 75'. Core rate 3.5"/min.	
	*********		▼		
	*********		▼		
	*********		▼		
	*********	80	▼		
	*********		▼		
85.0	*********		▼		
TD					

LOGGED BY: Kingsley

SIZE AND TYPE OF BORING: 8-5/8 od HSA to 25.0' NWD4 core to 85'


LOCATIONS ARE APPROXIMATE
● - Boring location
PUMP HOUSE
POND
SAN JUAN RIVER
MW24N BORE
N POINT BORE
S POINT BORE
HAMMOND DITCH
ROADWAY
ROADWAY
FLARE
2
3
4
5
TREATER UNIT #300
SPENT CAUSTIC TANK
FORMER TANKS 6 AND 7 LOCATION
NOVP-W
NOVP-E
B-1
B-2
SUB. STA.
C.C.#2
F.H. #1

PRECISION ENGINEERING. INC.

LOG OF TEST BORINGS

LOCATION:

FILE #: 97-028
ELEVATION: 5464.8
TOTAL DEPTH: 31.5'
LOGGED BY: WHK
DATE: 3-13-97
STATIC WATER: 6.0'/16 HRS
BORING ID: SB1-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-6.1	***000***		C	SAND. GRAVELLY. SOME GREY SANDSTONE. LOOSE. (SLOPE TALUS)	0.0-10.0
	000		C		0
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000	5.0	C		
	000		C		
6.1	***000***		C		
6.1-30.3	===**====		C	SHALE. SLIGHTLY SANDY. DARK GREY. WET (NOT WATER BEARING). DENSE	
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====	10	C		
	===**====		C	OLD HYDROCARBON ODOR (DEGRADED)	302
	===**====		C	SLIGHTLY MORE FISSLE AT 12 FEET. DRY GREATER THAN 11 FEET	11.0-31.5
	===**====		C		0
	===**====		C	12.0-13.0 FEET-BROWNER AND SANDY. DRY	
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====	15	C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====	20	C	SHALE. DARK GREY. HARD. DRY FISSLE. SLIGHTLY SANDY	
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION:

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5464.80
TOTAL DEPTH: 31.5'
LOGGED BY: WHK
DATE: 3-13-97
STATIC WATER: 6.0'/16 HRS
BORING ID: SB1-397
PAGE: 2

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
	===**====		C		23.0-31.5
	===**====		C		0
	===**====		C		
	===**====		C		
	===**====	25	C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====		C		
	===**====	30	C	SHALE-HARD FISSLE. SOME SANDY STRINGERS APPROXIMATELY 3 FOOT THICK AT 22'-25'	
30.3	===**====		C		
30.3-31.5	SSSSSSSSS		C	SANDSTONE. WHITE. DENSE. DRY. FINE	
TOTAL DEPTH			C	SOME CUTTINGS OBSERVED AT 20'-25' THAT WERE SATURATED. THEN DRIES OUT.	
			C	SAME OBSERVED WHEN DRILLING 25'-30'.	
			C	SUSPECT WATER AT 10.5'-11.0' RUNNING DOWN BORE HOLE. ANNULUS IS SATURATING	
			C	CUTTINGS.	
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		
			C		

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION:

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5446.64
TOTAL DEPTH: 37.0'
LOGGED BY: WHK
DATE: 3-13-97
STATIC WATER: 28.0'/16 HRS
BORING ID: SB2-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-6.0	***000***		C	NOTE: SEEP AT SURFACE OF PAD	0.0-2.0
	000		C	SAND, GRAVELLY, WET/MOIST, LOOSE, BROWN, BLACK IN ZONES, HAS (POOR) HYDROCARBON	0
	000		C	ODOR-OLD SMELL	
	000		C		2.0-5.0
	000		C		5
	000		C		
	000		C		
	000		C		
	000		C		
	000	5.0	C		
	000		C		
6.0	***000***		C		
6.0-17.0	***000***		C	SAND, FINE, GRAVELLY, FLUID BEARING, JET BLACK, STRONG HYDROCARBON ODOR-OLD FETTED,	
	000		C	LOOSE	
	000		C	NOT WATER BEARING GREATER THAN 15.0'	
	000		C	MORE CLAY GREATER THAN 15.0'	
	000		C		
	000		C		
	000		C		
	000	10	C		
	000		C		537
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000	15	C		
	000		C		975
	000		C		
	000		C		
17.0	***000***		C		
17.0-23.5	SSSSSSSSS		C	SANDSTONE, LIGHT GREY/WHITE, HARD, WET, LAMINATED, SHOWS SOME ANGULAR DISCONTINUITY	
	SSSSSSSSS		C	(NOT WATER BEARING)	
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS	20	C		
	=S=S=S=S=		C	SHALE AND SANDSTONE IN RANDOM DISCONTINUOUS LAYERS AND DIPS-SUSPECT TOPPLED BLOCK	
	=S=S=S=S=		C	FROM ADJACENT CLIFF FACE	1331
	=S=S=S=S=		C		
	=S=S=S=S=		C		
	=S=S=S=S=		C		67
	=S=S=S=S=		C		

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION:

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5446.64
TOTAL DEPTH: 37.0'
LOGGED BY: WHK
DATE: 3-13-97
STATIC WATER: 28.0'/16 HRS
BORING ID: SB2-397
PAGE: 2

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
23.5	=S=S=S=S=		C		
23.5-29.0	*********		C	SAND. MEDIUM. WET. LOOSE. DARK GREY. OLD HYDROCARBON ODOR FETTED. NOT WATER BEARING	
	*********		C		
	*********	25	C		
	*********		C		571
	*********		C		
	*********		C		1037
	*********		C		
	*********		C		
	*********		C		
	*********		C	WATER BEARING AT 28.0'. BLACK. HYDROCARBON ODOR (OLD)	449
29.0	*********		C		
29.0-32.5	SSSSSSSSS		C	NACIMIENTO FORMATION	773
	SSSSSSSSS	30	C	SANDSTONE. HARD. MOIST. ARGILLACEOUS. LIGHT BROWN	
	SSSSSSSSS		C		155
	SSSSSSSSS		C		40
	SSSSSSSSS		C		48
	SSSSSSSSS		C		
32.5	SSSSSSSSS		C		22
[illegible]5-37.0	=========		C	SHALE. GREY-GREEN. HARD. DRY/DAMP. FISSLE	32.0-37.0
	=========		C		0
	=========		C		
	=========		C		
	=========	35	C		
	=========		C		
	=========		C		
	=========		C		
37.0	=========		C		
TOTAL DEPTH				WATER AT 28.0' IN AUGER AFTER 16 HOURS	

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING. INC.

LOCATION:

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5419.09
TOTAL DEPTH: 10.0'
LOGGED BY: WHK
DATE: 3-14-97
STATIC WATER: 4.0'
BORING ID: SB3-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-1.0	****0****		C	SAND. LOOSE. BROWM. MOIST. (FILL) GRAVELLY	
1.0	****0****		C		
1.0-2.2	///**-///		C	CLAY. SANDY. SILT. BLACK-GREY. OLD HYDROCARBON ODOR. WET. NEARLY WATER BEARING	109
2.2	///**-///		C		
2.2-6.0	*********		C	SAND. FINE-MEDIUM. WELL SORTED. BLACK. WET. WATER BEARING GREATER THAN 4.0 FEET	
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********	5.0	C		
	*********		C		1068
6.0	*********		C		
6.0-10.0	SSSSSSSSS		C	NACIMIENTO FORMATION	16.5
	SSSSSSSSS		C	SANDSTONE. ARGILLACEOUS. FINE. DENSE. GREENGREY. WET. NO ODOR	
	SSSSSSSSS		C		
	SSSSSSSSS		C		0
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS		C		
	SSSSSSSSS	10	C	MOIST AT 10.0 FEET	0
TOTAL DEPTH					

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5428.88
TOTAL DEPTH: 20.0'
LOGGED BY: WHK
DATE: 3-14-97
STATIC WATER: 11.5'
BORING ID: SB4-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-6.0	///--*0//		C	CLAY, SILTY, SANDY, SOME LARGE COBBLES, BOULDER INFILL	0.0-20.0
	///--*0//		C	LARGE COBBLE (BOULDER) 4.5-6.0, BROWN	0
	///--*0//		C		
	///--*0//		C		
	///--*0//		C		
	///--*0//		C		
	///--*0//		C		
	///--*0//		C		
	///--*0//		C		
	///--*0//	5.0	C		
	///--*0//		C		
6.0	///--*0//		C		
6.0-9.5	*********		C	SAND, FINE, LIGHT BROWN, LOOSE, MOIST	
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
9.5	*********		C		
5-17.0	***000***	10	S	SAND, GRAVELLY, DENSE, BROWN, MOIST, WATER BEARING AT 11.5 FEET	
	000		S		
	000		S		
	000		S		
	000		S		
	000		S		
	000		S		
	000		S		
	000		S		
	000		S		
	000	15	S		
	000		S		
	000		S	GLASS FRAGMENT, HIGHLY WEATHERED FOUND AT 16.0 FEET	
	000		S		
17.0	***000***		S		
17.0-20.0	=========		S	NACIMIENTO FORMATION	
	=========		S	SHALE, BLACK/GREY, MOIST, HARD, FISSLE, LITTLE TO NO SAND	
	=========		S		
	=========		S		
	=========		S		
	=========	20	S		
TOTAL DEPTH					

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5423.26
TOTAL DEPTH: 17.5'
LOGGED BY: WHK
DATE: 3-20-97
STATIC WATER: 4.0'
BORING ID: SB5-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-11.5	*********		C	SAND, FINE, LOOSE, MOIST, BROWN	
	*********		C		
	*********		C		
	*********		C		
	*********		C		60
	*********		C		
	*********		C		
	*********		C	BLACK, WATER BEARING AT 4.0'	
	*********		C		603
	*********	5.0	C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********	10	C		
	*********		C	SOME SHEEN	1056
	*********		C		
11.5	*********		C		
11.5-13.5	***00****		C	SAND, MEDIUM GRAINED, SOME COBBLES, DENSE, FLOWS, BLACK	
	00*		C		
	00*		C		231
13.5	***00****		C		
13.5-15.0	***00****		C	SAND, MEDIUM, GRAVELLY, GREY (DARK), NO ODOR, LOOSE	
	00*		C		
15.0	***00****	15	C		0
15.0-17.5	=========		C	SHALE, GREY, HARD, DAMP, FISSLE, (APPEARS DRY), LITTLE SAND	
	=========		C		
	=========		C		
	=========		C		0
17.5	=========		C		
TOTAL DEPTH				NO SHEEN-ANY DEPTH	

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5422.69
TOTAL DEPTH: 17.5'
LOGGED BY: WHK
DATE: 3-20-97
STATIC WATER: 4.67'
BORING ID: SB6-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-14.5	*********		C	SAND, FINE, DAMP, BROWN, MODERATELY DENSE, BLACK, FINE AND COARSE GRAVEL	
	*********		C		
	*********		C		0
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C	BLACK AT 4.0 FEET	
	*********	5.0	C	WATER BEARING AT 4.67 FEET-NO SHEEN (NO SEPARATE PHASE)	
	*********		C	GRAVELLY AT 5.0 FEET, GRAVEL UP TO 2 INCHES IN SIZE	981
	*********		C	LITTLE TO NO SILT	
	*********		C		
	*********		C		
	*********		C		
	*********		C		511
	*********		C		
	*********		C		970
	*********		C		
	*********	10	C		
	*********		C		13
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		50
	*********		C		
	*********		C		
14.5	*********		C		
14.5-17.5	SSSSSSSSS	15	C	NACIMIENTO FORMATION	
	SSSSSSSSS		C	SANDSTONE, FINE, GREY-BLUE, DENSE, MOIST-WET, NOT WATER BEARING, FRESH SAMPLE LOOKS	3
	SSSSSSSSS		C	DRY	
	SSSSSSSSS		C		
	SSSSSSSSS		C		0
17.5	SSSSSSSSS		C		
TOTAL DEPTH					

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5423.17
TOTAL DEPTH: 17.5'
LOGGED BY: WHK
DATE: 3-20-97
STATIC WATER: 5.0'
BORING ID: SB7-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-1.0	///000///		C	CLAY, GRAVELLY, DRY-DAMP, SOFT, BROWN, NO ODOR	0.0-17.5
1.0	///000///		C		0
1.0-5.0	*********		C	SAND, FINE, LOOSE, MOIST, BROWN, NO ODOR	
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
	*********		C		
5.0	*********	5.0	C		
5.0-16.3	***000***		C	SLIGHTLY GRAVELLY GREATER THAN 4.0'	
	000		C	SAND, FINE-MEDIUM, WATER BEARING, GRAVELLY, LOOSE, BROWN, NO ODOR	
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000	10	C		
	000		C		
	000		C		
	000		C		
	000		C	BOULDER AT 11.5'-12.9'	
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000	15	C		
	000		C		
	000		C		
16.3	***000***		C		
16.3-17.5	=========		C	SHALE, GREY-BLUE, HARD, FISSLE, MOIST, APPEARS DRY	
17.5	=========		C		
TOTAL DEPTH					

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION: SEE SITE PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5421.52
TOTAL DEPTH: 17.5'
LOGGED BY: WHK
DATE: 3-20-97
STATIC WATER: 4.0'
BORING ID: SB8-397
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR, GRAINSIZE, ETC.)	PID (ppm)
0.0-4.5	**0000***		C	SAND. FINE. LOOSE. BROWN. VERY COBBLEY. MOIST	0.0-17.5
	0000*		C		0
	0000*		C		
	0000*		C		
	0000*		C		
	0000*		C		
	0000*		C		
	0000*		C		
4.5	**0000***		C		
4.5-9.0	***///***	5.0	C	SAND. CLAYEY. WATER BEARING. LIGHT GREY. VERY LOOSE. NO ODOR	
	///		C	WATER BEARING GREATER THAN 4.0 FEET	
	///		C		
	///		C		
	///		C		
	///		C		
	///		C		
	///		C		
9.0	***///***		C		
9.0-13.5	***000***		C	SAND. COBBLEY. WATER BEARING. NO ODOR. MODERATELY DENSE. GREY-BROWN	
	000	10	C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
	000		C		
13.5	***000***		C		
13.5-16.5	***00****		C	SAND. FINE. SLIGHTLY GRAVELLY. WATER BEARING. GREY. NO ODOR	
	00*		C		
	00*	15	C		
	00*		C		
	00*		C		
16.5	***00****		C		
16.5-17.5	=========		C	NACIMIENTO FORMATION	
17.5	=========		C	SHALE. BLACK. FISSLE. DENSE. MOIST. NOT WATER BEARING	
TOTAL DEPTH					

LOGGED BY: WHK

SIZE AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOCATION:BLOOMFIELD REFINERY
SEE BORING PLAN

LOG OF TEST BORINGS

FILE #: 97-028
ELEVATION: 5420.0
TOTAL DEPTH: 15.0'
LOGGED BY: TM
DATE: 6-13-97
STATIC WATER: 4.2'
BORING ID: SB9-697
PAGE: 1

DEPTH	PLOT	SCALE	SAMPLE	MATERIAL CHARACTERISTICS (MOISTURE,CONDITION,COLOR,GRAINSIZE,ETC.)	PID (ppm)
0.0-1.0	****-/***		C	**SAND**, VERY FINE TO FINE, SLIGHTLY SILTY, CLAYEY, MOIST TO WET, BROWN, NO ODOR	ALL SAMPLES
	****-/***		C		0
1.0-9.0	***-/o***		C	**SAND**, VERY FINE TO FINE, SILTY, CLAYEY, GRAVELLY, FINE TO COARSE, COBBLY, WET	
	-/o		C	BROWN, NO ODOR	
	-/o		C		
	-/o		C	WATER BEARING @ 4.2'	
	-/o		C		
	-/o		C		
	-/o		C		
	-/o	5.0	C		
	-/o		C		
	-/o		C		
	-/o		C		
	-/o		C		
	-/o		C		
	-/o		C		
	-/o		C		
9.0	***-/o***		C		
9.0-14.0	OOOoooOOO		C	**COBBLES**, GRAVELLY, FINE TO COARSE, NO ODOR	
	OOOoooOOO	10	C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
	OOOoooOOO		C		
14.0	OOOoooOOO		C		
14.0-15.0	/////////		C	**NACIMIENTO FORMATION**	
15.0	/////////	15	C	**CLAY**, WHITISH GREY, DENSE, VERY MOIST TO WET, NO ODOR	
TOTAL DEPTH					

LOGGED BYTM

AND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

APPENDIX C

ASSAIGAI ANALYTICAL LABORATORIES, INC.
7300 Jefferson, NE • Albuquerque, New Mexico 87109 • (505) 345-8964 • FAX (505) 345-7259
3332 Wedgewood, E-5 • El Paso, Texas 79925 • (915) 593-6000 • FAX (915) 593-7820
127 Eastgate Drive, 212-C • Los Alamos, New Mexico 87544 • (505) 662-2558

March 12, 1999

R.T Hicks Consulting, Ltd.
4665 Indian School Road NE, Ste. 106
Albuquerque, NM 87110

Attn: R.T. Hicks

Project Number: 9902007 Site: Giant

Seven non-aqueous or biphasic samples for fuel ID analysis were received February 1, 1999 and assigned AALI Project # 9902007. (See Table 1 for laboratory fraction IDs) The non-aqueous portions of the samples were diluted 1000:1 in dichloromethane and run by GC/FID the following February 12, 1999.

The resulting chromatograms displayed patterns that can be grouped into three categories:

1) Very similar to AAL's Diesel #2 standard with some reduction of alkane constituents.
2) A pattern consisting of some compounds common to Diesel #2 with the alkane compounds very low or absent.
3) Light Hydrocarbons, mostly <C10, pre-diesel range material.

The first pattern type was observed in samples labeled MP-4, MW-42 and MP-3. These samples appear to be a substance very similar to AAL's Diesel #2 standard with some reduction in the ratios of alkane to non alkane constituents as compared to the stock pattern. The alkanes are the large, evenly spaced peaks in the diesel pattern. See chromatograms; 5DS0309.D, Diesel #2 at 500ppm in dichloromethane and 5DS0313.D, 5DS0316.D and 5DS0318.D, samples MP-4, MW-42 and MP-3 respectively. Note that the largest peak in the stock diesel chromatogram at ~ 9.5 minutes is the surrogate, O-terphenyl, and is not representative of that fuel.

The second pattern type was observed in samples RW-18, MW-9 and MW-40. These samples exhibit a pattern similar to a diesel pattern with the alkanes greatly reduced or absent. The remaining pattern very closely resembles a diesel #2 fuel without the alkane peaks. See chromatograms; 5DS0314.D, 5DS0315.D and 5DS0317.D, samples RW-18, MW-9 and MW-40 respectively.

The third pattern type was observed only in the sample MW-43 extract. This sample chromatogram displayed the majority of material eluting near the solvent front identifying it as a material lighter than diesel such as gasoline or a similar mixture. Comparison of the sample chromatogram with an unleaded gasoline standard prepared in dichloromethane did not exhibit sufficient similarities to positively identify the sample as that product but differences may be attributable to field effects. See chromatograms; 5DS0383.D, unleaded gasoline 1000x in dichloromethane and 5DS0319.D, sample MW-43.

The majority of detector response for all samples except MW-43 was observed in a range that corresponds to decane (C10 @ 3.59min) through nonadecane (C19 @ ˜9.48min). The quantities observed for the sample extracts compared to the standard are such that the samples can be presumed to be completely, or nearly completely, weathered diesel (#2) or a similar fuel.

Table 1
Project # 9902007

Laboratory Fraction ID	Field ID	Pattern observed
-01A	MP-4	Very similar to AAL's Diesel #2 standard with some reduction of alkane constituents.
-02A	RW-18	A pattern consisting of some compounds common to Diesel #2 with the alkane compounds very low or absent.
-03A	MW-9	A pattern consisting of some compounds common to Diesel #2 with the alkane compounds very low or absent.
-04A	MW-42	Very similar to AAL's Diesel #2 standard with some reduction of alkane constituents.
-05A	MW-40	A pattern consisting of some compounds common to Diesel #2 with the alkane compounds very low or absent.
-06A	MP-3	Very similar to AAL's Diesel #2 standard with some reduction of alkane constituents.
-07A	MW-43	Light Hydrocarbons, mostly <C10, pre-diesel range material.

We appreciate the opportunity to perform analytical work for you. If you have any questions, please call.

Respectfully submitted,

David Hunter
Organics Supervisor - Assaigai Analytical Laboratories, Inc.

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

[illegible]nt: RT HICKS CONSULTING, LTD

Project: 9809304 GIANT BLOOMFIELD

Client Sample ID ***SB H4 5'*** Sample Matrix Sample Collected ***09/26/98***

Test: SW846 8015A/8020A GRO / Purgeable Aromatics

Fraction	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
9809304-03A	X98441	71-43-2	Benzene	ND	mg / Kg	1	0.005		XG.1998.874-5	09/29/98
	X98441	100-41-4	Ethylbenzene	ND	mg / Kg	1	0.005		XG.1998.874-5	
	X98441	95-47-6	o-Xylene	ND	mg / Kg	1	0.005		XG.1998.874-5	
	X98441		p/m Xylenes	ND	mg / Kg	1	0.01		XG.1998.874-5	
	X98441	108-88-3	Toluene	ND	mg / Kg	1	0.005		XG.1998.874-5	

Client Sample ID ***SB H4 18'*** Sample Matrix Sample Collected ***09/26/98 15:05:00***

Test: SW846 8015A/8020A GRO / Purgeable Aromatics

Fraction	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
9809304-04A	X98449	71-43-2	Benzene	27	mg / Kg	2500	0.005		XG.1998.879-4	10/01/98
	X98449	100-41-4	Ethylbenzene	27	mg / Kg	2500	0.005		XG.1998.879-4	
	X98449	95-47-6	o-Xylene	ND	mg / Kg	2500	0.005		XG.1998.879-4	
	X98449		p/m Xylenes	ND	mg / Kg	2500	0.01		XG.1998.879-4	
	X98449	108-88-3	Toluene	29	mg / Kg	2500	0.005		XG.1998.879-4	

Client Sample ID ***SB H4 14'*** Sample Matrix Sample Collected ***09/26/98 14:45:00***

Test: SW846 8015A/8020A GRO / Purgeable Aromatics

Fraction	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
9809304-05A	X98449	71-43-2	Benzene	ND	mg / Kg	1	0.005		XG.1998.879-7	10/01/98
	X98449	100-41-4	Ethylbenzene	ND	mg / Kg	1	0.005		XG.1998.879-7	
	X98449	95-47-6	o-Xylene	ND	mg / Kg	1	0.005		XG.1998.879-7	
	X98449		p/m Xylenes	ND	mg / Kg	1	0.01		XG.1998.879-7	
	X98449	108-88-3	Toluene	ND	mg / Kg	1	0.005		XG.1998.879-7	

Client Sample ID ***MW-26 PSH*** Sample Matrix Sample Collected ***09/25/98 10:26:00***

Test: Modified 8015 Carbon Chain ID by GC/FID

Fraction	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
9809304-06A	X98452		C08	ND	mg / L	1000	10		XG.1998.888-4	10/06/98
	X98452		C09-C10	120000	mg / L	1000	10		XG.1998.888-4	

ient: **RT HICKS CONSULTING, LTD**

roject: **9809304 GIANT BLOOMFIELD**

9809304-06A	X98452		C11-C12	320000	mg / L	1000	10		XG.1998.888-4	10/06/98
	X98452		C13-C14	180000	mg / L	1000	10		XG.1998.888-4	
	X98452		C15-C16	33000	mg / L	1000	10		XG.1998.888-4	
	X98452		C17-C18	ND	mg / L	1000	10		XG.1998.888-4	
	X98452		C19-C20	ND	mg / L	1000	10		XG.1998.888-4	
	X98452		C21-C22	ND	mg / L	1000	10		XG.1998.888-4	
	X98452		C23-C24	ND	mg / L	1000	10		XG.1998.888-4	
	X98452		C25-C26	ND	mg / L	1000	10		XG.1998.888-4	
	X98452		Estimated>C26	ND	mg / L	1000	10		XG.1998.888-4	

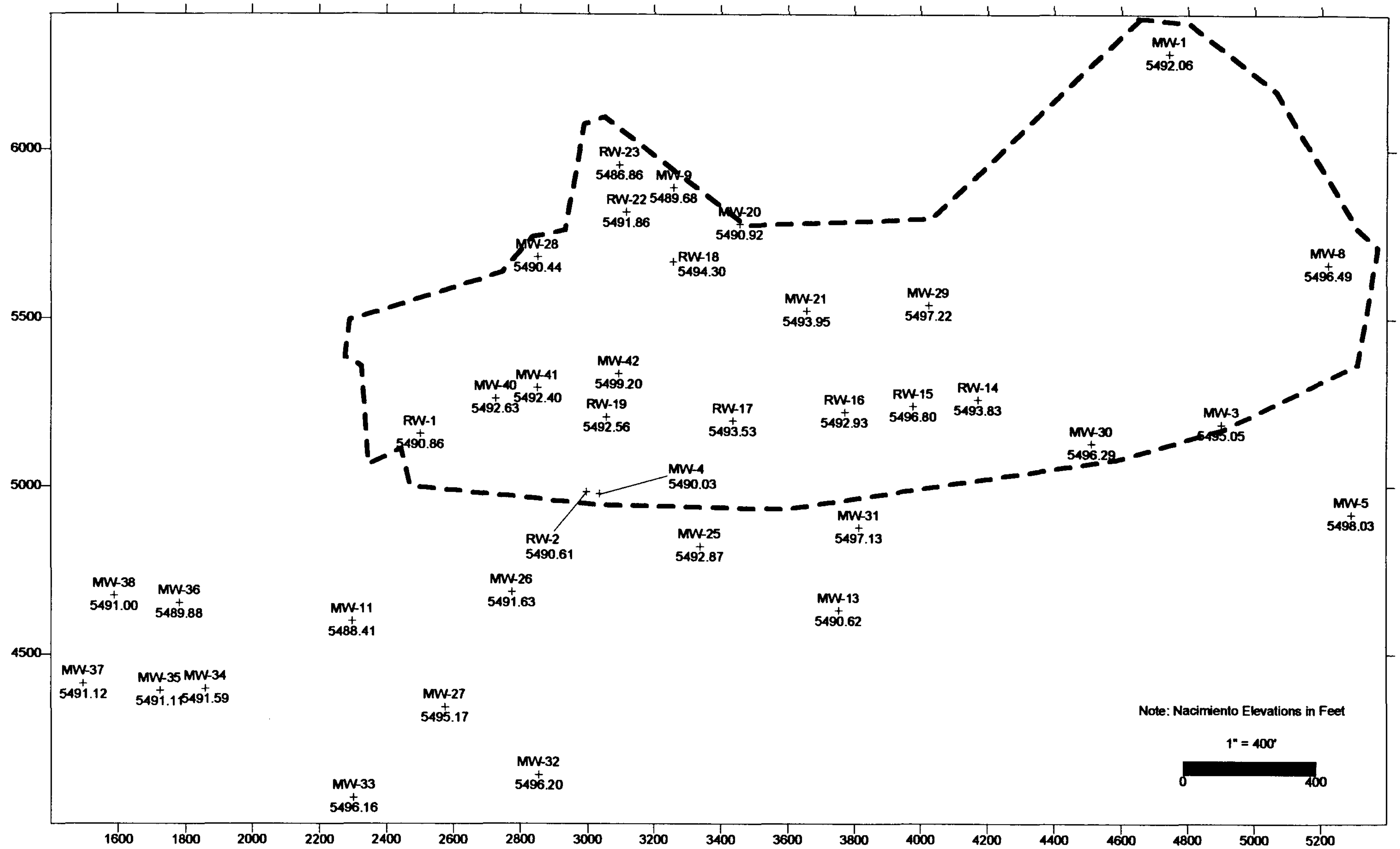
Test: SM 2710F

9809304-06A	MT.1998.2596		Specific Gravity	0.75	g	1	0.015		MT.1998.2596-1	10/07/98

Test: SW846 8240B Purgeable VOCs by GC/MS

9809304-06A	X98435	75-34-3	1,1 Dichloroethane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	10/09/98
	X98435	75-35-4	1,1 Dichloroethene	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	71-55-6	1,1,1 Trichloroethane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	630-20-6	1,1,1,2 Tetrachloroethane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	79-00-5	1,1,2 Trichloroethane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	79-34-5	1,1,2,2 Tetrachloroethane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	106-93-4	1,2 Dibromoethane (EDB)	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	95-50-1	1,2 Dichlorobenzene	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	107-06-2	1,2 Dichloroethane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	78-87-5	1,2 Dichloropropane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	96-18-4	1,2,3 Trichloropropane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	541-73-1	1,3 Dichlorobenzene	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	764-41-0	1,4 Dichloro-2-butene	ND	mg / Kg	100000	0.05	E	XG.1998.900-3	
	X98435	106-46-7	1,4 Dichlorobenzene	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	78-93-3	2-Butanone (MEK)	ND	mg / Kg	100000	0.025	1E	XG.1998.900-3	
	X98435	110-75-8	2-Chloroethylvinylether	ND	mg / Kg	100000	0.025	E	XG.1998.900-3	
	X98435	591-78-6	2-Hexanone (MBK)	ND	mg / Kg	100000	0.025	E	XG.1998.900-3	
	X98435	108-10-1	4-Methyl-2-pentanone (MIBK)	ND	mg / Kg	100000	0.025	E	XG.1998.900-3	
	X98435	67-64-1	Acetone	ND	mg / Kg	100000	0.025	1E	XG.1998.900-3	
	X98435	107-02-8	Acrolein	ND	mg / Kg	100000	0.1	E	XG.1998.900-3	
	X98435	107-13-1	Acrylonitrile	ND	mg / Kg	100000	0.1	E	XG.1998.900-3	
	X98435	71-43-2	Benzene	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	75-27-4	Bromodichloromethane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	75-25-2	Bromoform	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	74-83-9	Bromomethane	ND	mg / Kg	100000	0.025	E	XG.1998.900-3	
	X98435	75-15-0	Carbon disulfide	ND	mg / Kg	100000	0.025	E	XG.1998.900-3	
	X98435	56-23-5	Carbon tetrachloride	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	108-90-7	Chlorobenzene	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	124-48-1	Chlorodibromomethane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	75-00-3	Chloroethane	ND	mg / Kg	100000	0.025	E	XG.1998.900-3	
	X98435	67-66-3	Chloroform	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	74-87-3	Chloromethane	ND	mg / Kg	100000	0.025	E	XG.1998.900-3	
	X98435	156-59-2	cis-1,2 dichloroethene	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	10061-01-5	cis-1,3 dichloropropene	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	74-95-3	Dibromomethane	ND	mg / Kg	100000	0.005	E	XG.1998.900-3	
	X98435	97-63-2	Ethyl methacrylate	ND	mg / Kg	100000	0.025	E	XG.1998.900-3	

APPENDIX D



Note: Nacimiento Elevations in Feet

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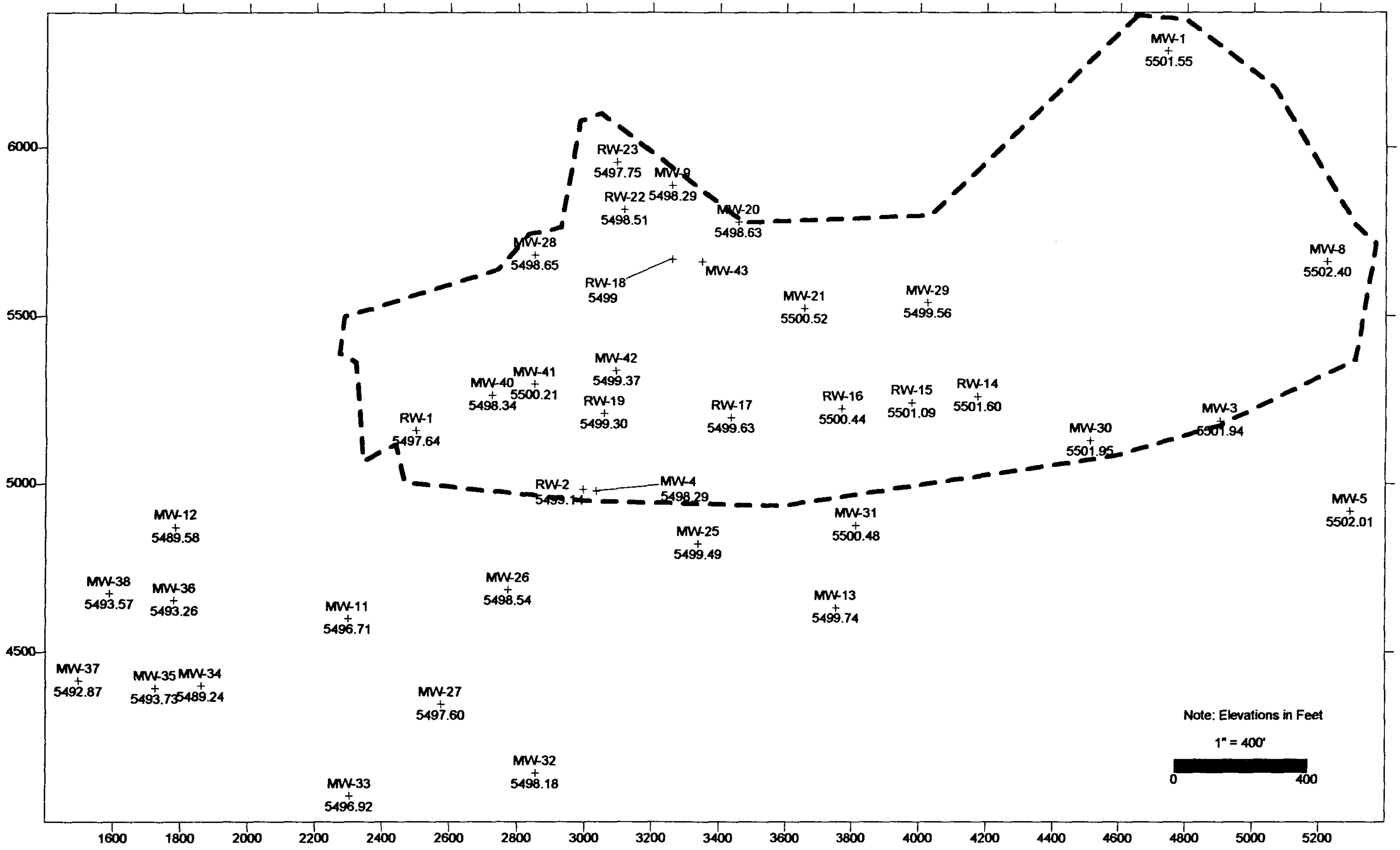
Bloomfield Refinery

Plate 9: Top of Nacimiento Elevations

Appendix D

June 1999



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Bloomfield Refinery

Plate 11: April 1999 Potentiometric Surface

Appendix D

June 1999

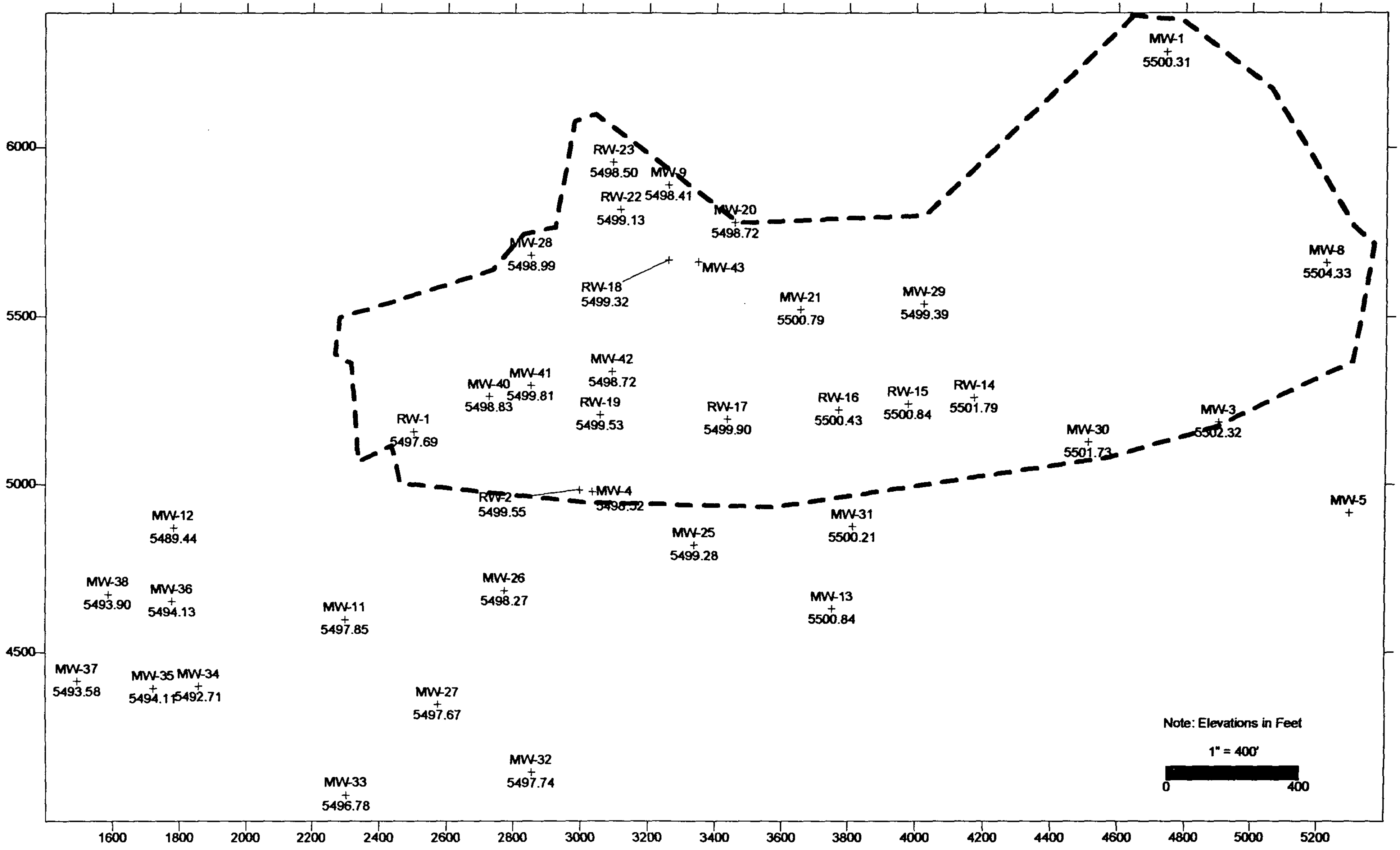

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Plate 12: October 1998 Potentiometric Surface

Appendix D

June 1999

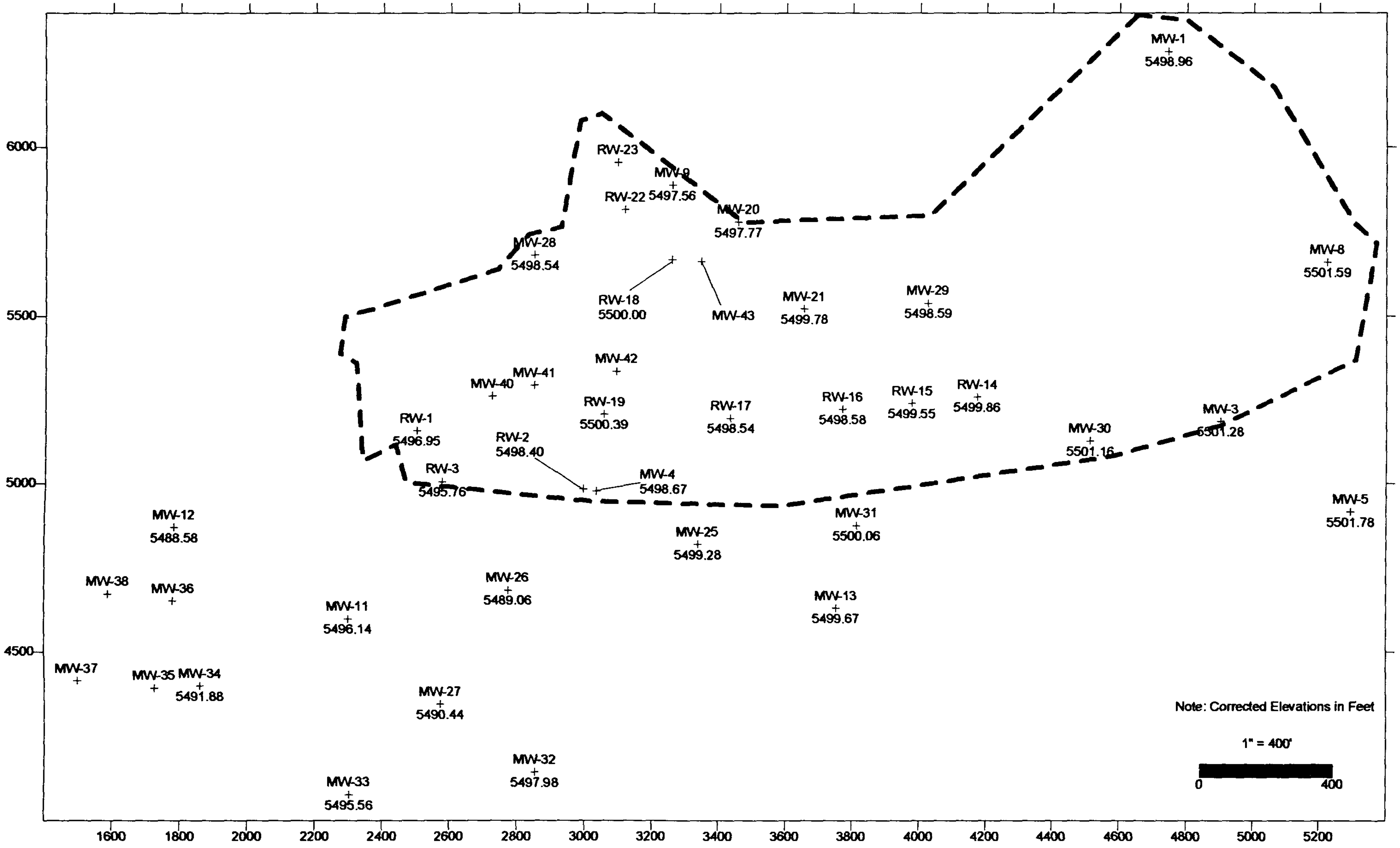

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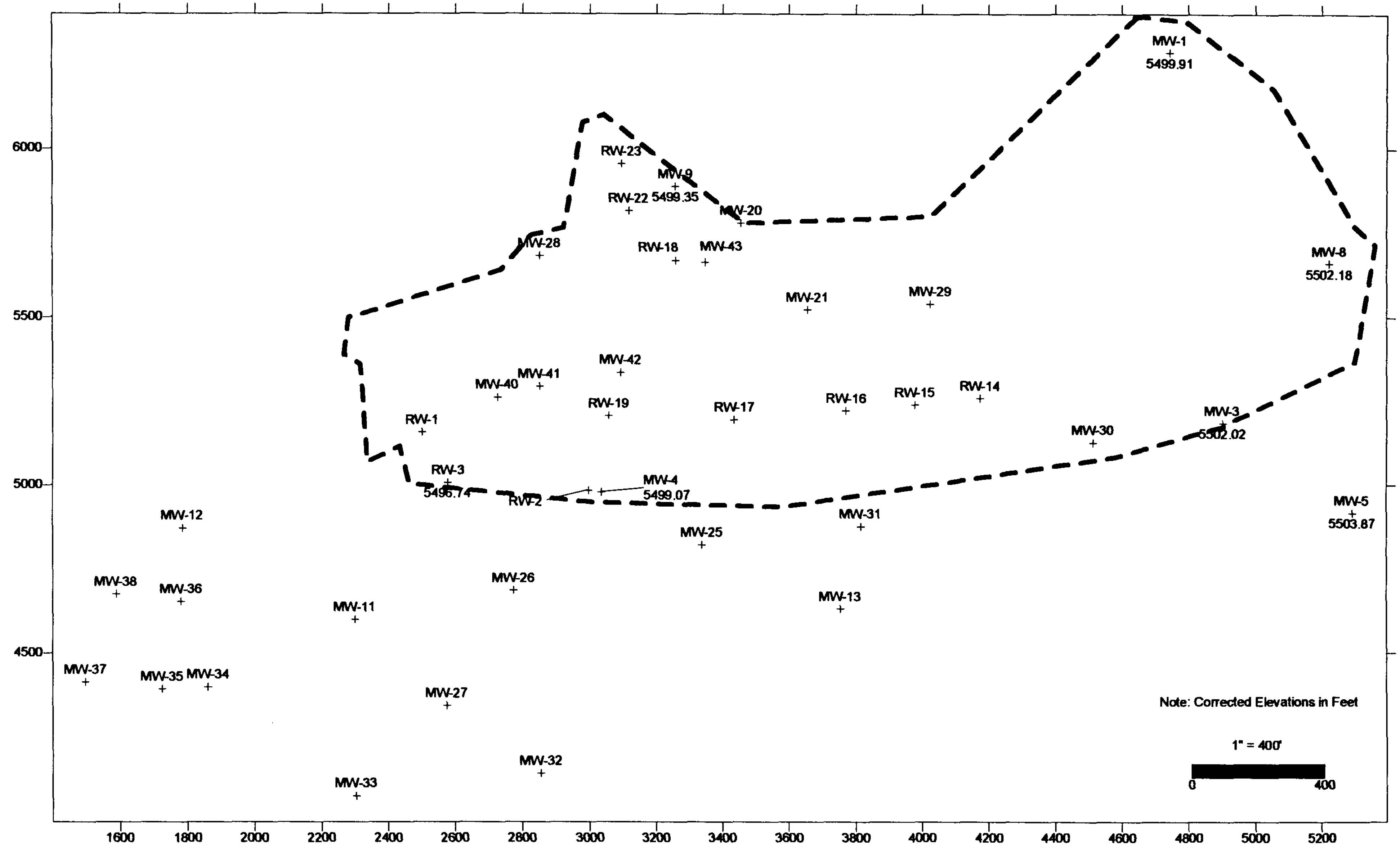
Plate 13: March 1995 Poteniometric Surface

Appendix D

June 1999



Note: Corrected Elevations in Feet

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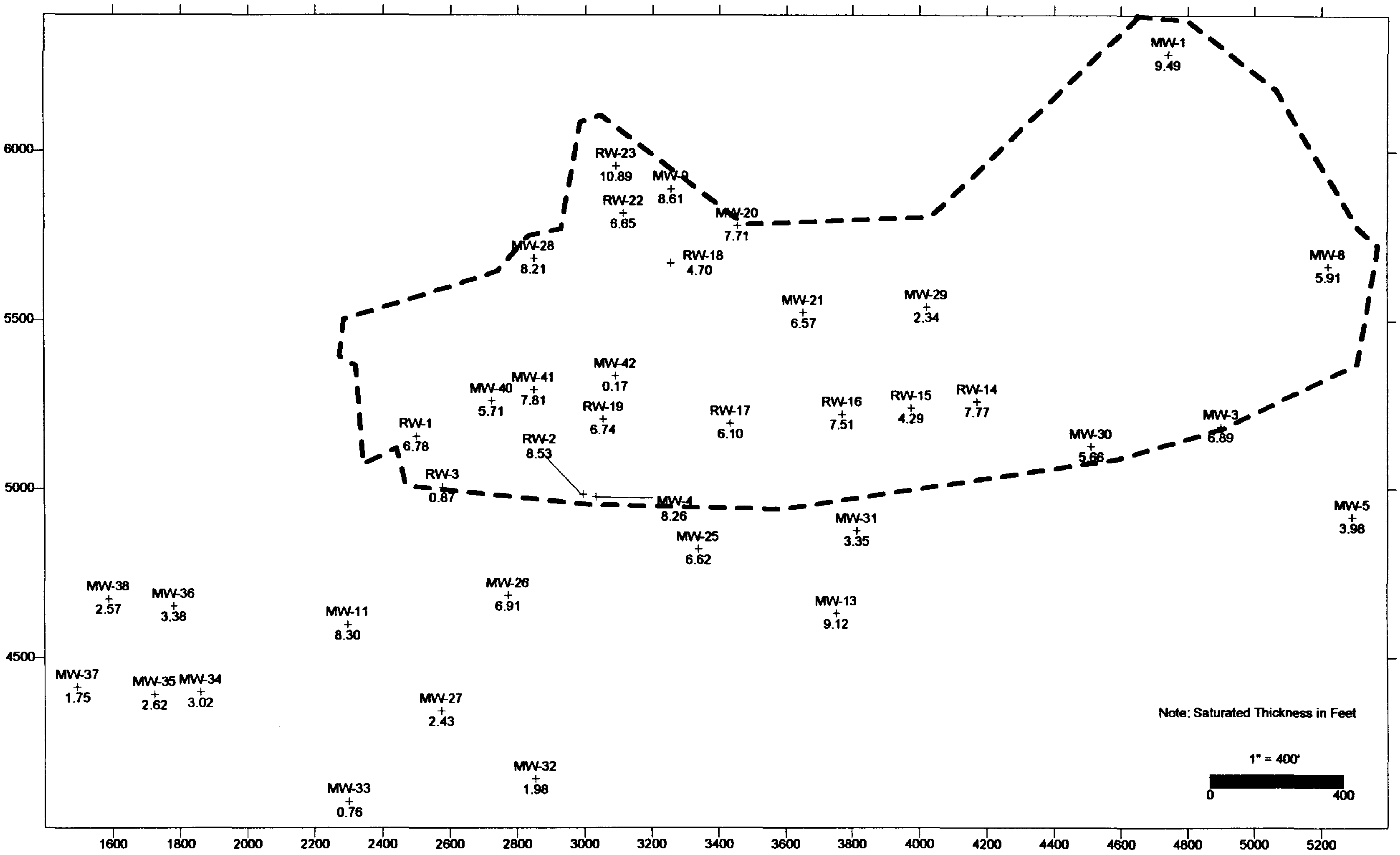
Plate 14: October 1986 Poteniometric Surface

Appendix D

June 1999



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Bloomfield Refinery

Plate 15: Saturated Thickness of Jackson Lake Terrace

Appendix D

June 1999

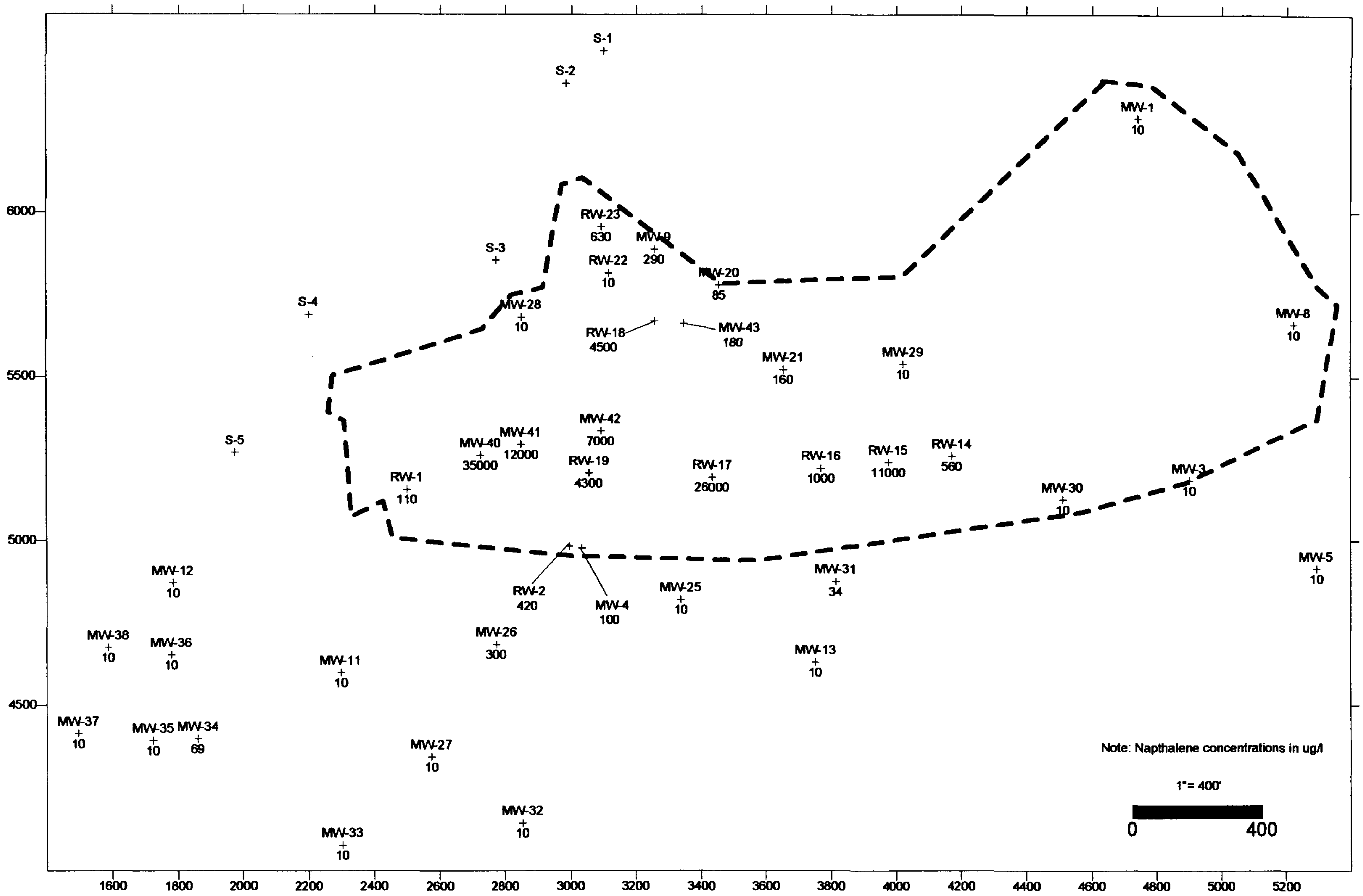

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Plate 21: Naphthalene Concentrations April 1999

Appendix D

June 1999

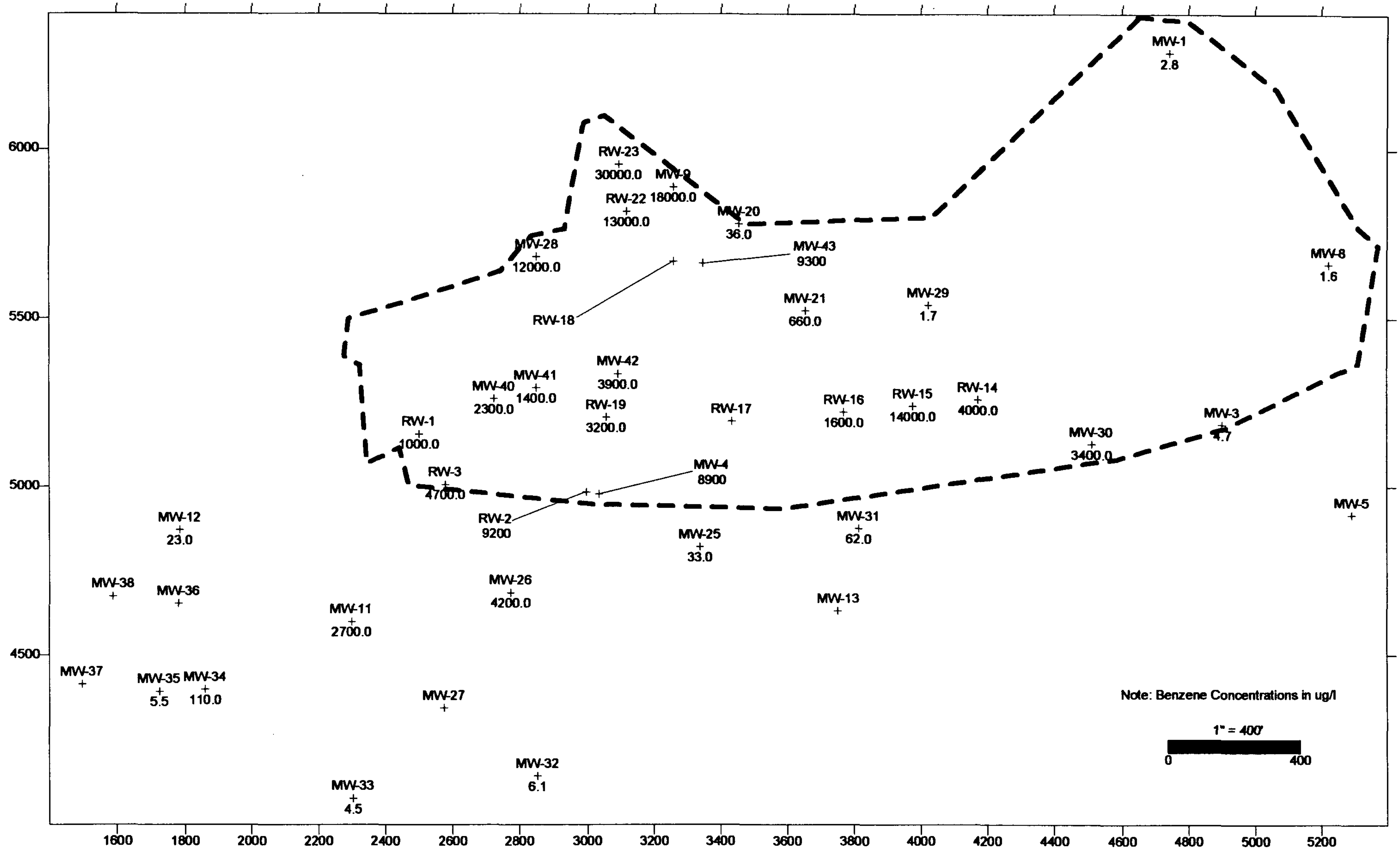

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Plate 23: Benzene Concentrations April 1999

Appendix D

June1999

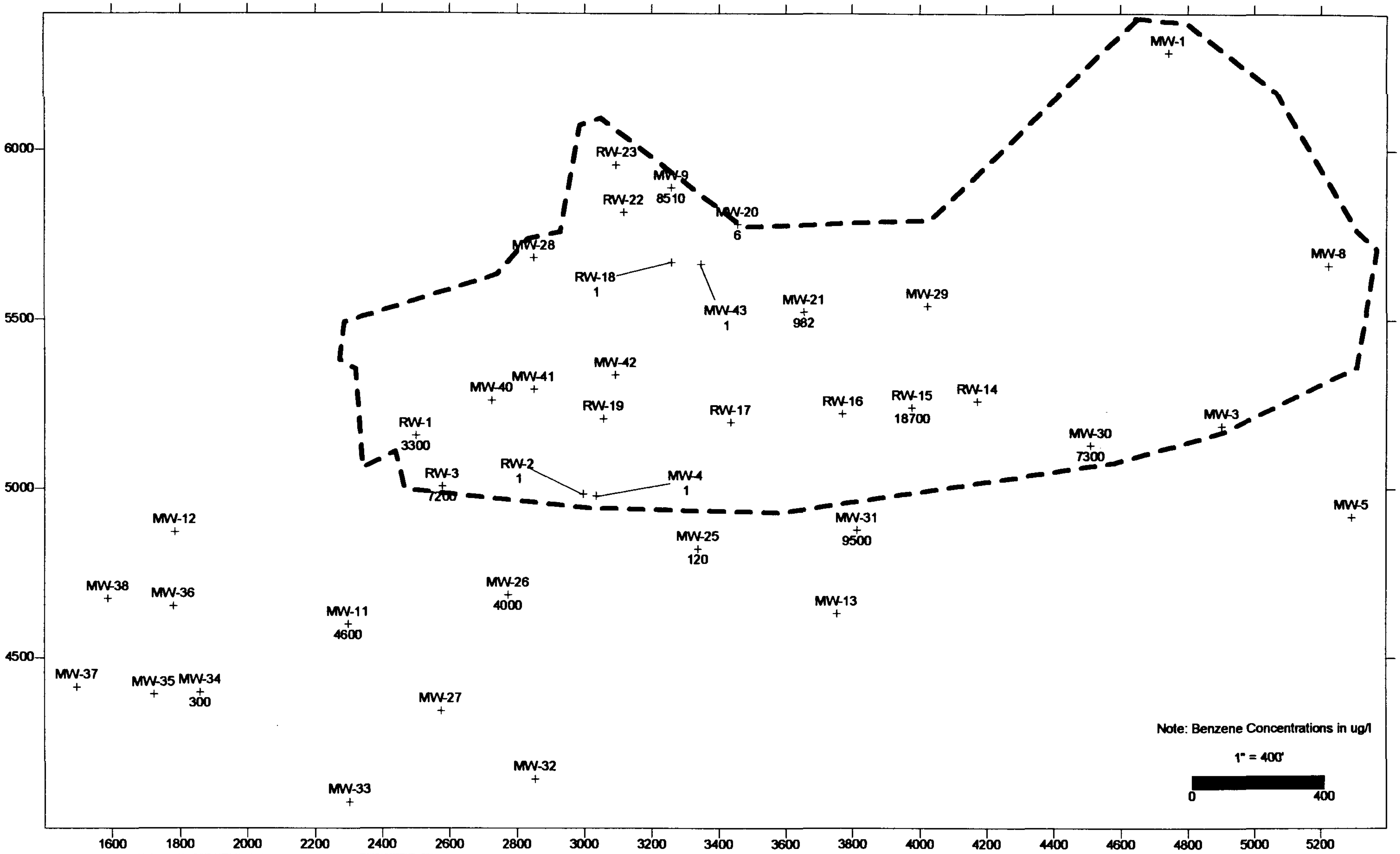

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Plate 39: Benzene Concentrations 94/95

Appendix D

June 1999