GW - 1

WORK PLANS

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.
INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS & CONSULTANTS

May 24, 2005

Mr. Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, New Mexico 87505

RECEIVED
MAY 2005
Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505

Re: Voluntary Corrective Measures Work Plan
Giant Bloomfield Refinery – River Terrace Sheet Pile Area

Dear Mr. Price:

On behalf of Giant Refining Company Bloomfield (GRCB), Malcolm Pirnie, Inc. is pleased to submit to the New Mexico Oil Conservation Division (OCD) the Voluntary Corrective Measures Work Plan for the River Terrace Sheet Pile Area at the Giant Bloomfield Refinery.

If you have any questions or require any additional information, please contact me at 602-797-4623.

Sincerely,

MALCOLM PIRNIE, INC.

Dennis L. Tucker

Dennis Tucker, P.E.
Senior Associate

Enclosure

Cc: Denny Foust - OCD Aztec Office
Hope Monzeglio – NMED Hazardous Waste Bureau
Bob Wilkinson – EPA
Ed Riege - Giant
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VOLUNTARY CORRECTIVE MEASURES WORK PLAN
RIVER TERRACE SHEET PILE AREA
GIANT BLOOMFIELD REFINERY

May 24, 2005

Prepared for:

Giant Refining Company
50 Road 4990
Bloomfield, New Mexico 87413

Prepared by:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 PURPOSE

This Voluntary Corrective Measures (VCM) Work Plan describes Giant's proposed actions to reduce the concentrations of petroleum hydrocarbons in the shallow groundwater beneath the Giant Refinery River Terrace Sheet Pile Area (RTSPA) in Bloomfield, New Mexico. For the VCM, Giant proposes to install a bioventing system in the west end of the river terrace, extending from the existing sheet pile barrier to the east, parallel to the river bank, for petroleum hydrocarbon source reduction in the vadose zone. Monitored natural attenuation is the proposed remedy for impacted groundwater.

1.2 FACILITY DESCRIPTION

The Bloomfield refinery was originally built in the late 1950's and has been operated by Kimball Campbell, O.L. Garretson (Plateau), Suburban Propane, Inc. (Plateau), Bloomfield Refining Company and Giant Refining Company. The facility consists of approximately 285 acres and is located approximately one mile south of Bloomfield, New Mexico on a bluff overlooking the San Juan River (Figure 1). The RTSPA is located north of the refinery, below the bluff, along the San Juan River bank. Figure 2 shows the RTSPA.

1.3 INTERIM CORRECTIVE MEASURES DESCRIPTION

Based on the October 2004 site investigation, it is Malcolm Pirnie's opinion that the concentrations of hydrocarbons in the soil and groundwater in the RTSPA subsurface can be reduced using a bioventing technique. Results from previous site characterization activities, information collected during soil boring campaigns conducted between October 2004 and April 2005, a conceptual model of the RTSPA subsurface geology, and results from a bioventing pilot test will be used to determine the bioventing system design and develop performance specifications for construction of the bioventing system.

2.0 AREA GEOLOGY

The Bloomfield Refinery is located within the San Juan Basin, a sub-province of the Colorado Plateau physiographic province, approximately 120 ft above the present river level and 500 feet from the river. The river terrace is an approximate 3 acre area located north of the refinery, below the bluff, along the bank of the San Juan River.

There are two distinct stratigraphic units that underlay the RTSPA. From oldest to youngest these units are: the Nacimiento Formation and an unnamed alluvial deposit unit.

The alluvial river deposits consist of approximately 15 to 17 feet of sediment. It is primarily composed of silts, clays, sands, and gravel. Fine-grained sediments are located in the shallow subsurface (approximately three feet) and the underlining sands grade coarser with depth.

The Nacimiento Formation is described as an inter-bedded black carbonaceous mudstone/clay stone with white, medium to coarse-grained sandstones approximately 570 feet thick in this area. The Nacimiento Formation at the river bluff outcrop is a tight unfractured rock unit.

3.0 AREA HYDROLOGY

Surface water in the vicinity of the RTSPA includes the San Juan River to the north and west. The San Juan River level is approximately 100 feet lower than the grade level of the refinery complex.

Recharge in the RTSPA groundwater is primarily influenced by the flow of the San Juan River, which is typically higher in the summer months due to high irrigation water demands. Groundwater elevations observed monthly between October 2004 and May 2005 indicate that depth to groundwater in the proposed treatment area is approximately five to seven feet below ground surface (bgs).

4.0 SITE CHARACTERIZATION DATA

This section describes recent site characterization and monitoring data that will be used to design and construct the RTSPA vadose zone bioventing system.

4.1 WATER LEVEL & PHASE-SEPARATED HYDROCARBON (PSH) DATA

Since October 2004, Giant has conducted monthly groundwater and PSH measurements in monitoring wells and piezometers installed in the river terrace. Groundwater measurements collected between October 2004 and May 2005 at monitoring wells MW-48 and MW-49 are in Table 1. Figure 3 presents a graph of the groundwater elevations in MW-48 and MW-49 during this monitoring period. There has been no PSH measured in any of the river terrace monitoring wells or piezometers. This information, combined with data from the December 2004 aquifer test, will be used to design the RTSPA vadose zone treatment system.

4.2 GROUNDWATER QUALITY DATA

Monitoring wells MW-48 and MW-49 have been sampled on a monthly basis to monitor the RTSPA groundwater quality on both sides of the sheet pile barrier. Each temporary piezometer within the river terrace has been sampled at least once. Piezometers TP-1 through TP-8 were sampled in October 2004 and January 2005. Piezometers TP-9 through TP-13 were sampled in April 2005. The highest groundwater impacts were observed in wells and piezometers in the western portion of the river terrace (west of TP-4). VOCs have been detected in groundwater collected from piezometers installed in the eastern portion of the river terrace; however, those detections have been at concentrations below the maximum contaminant levels (MCLs).

VOC concentrations in samples collected from monitoring well MW-48, on the refinery side of the sheet pile barrier, are above the MCL for some compounds (e.g., benzene) and appear to fluctuate as the groundwater elevation fluctuates. VOC concentrations in samples collected from MW-49, if detected, have been below the MCLs except for benzene, which has increased slightly over the past three months. Table 2 and Figure 4 provide a summary of benzene, toluene, ethylbenzene, xylenes (BTEX), and naphthalene concentrations in MW-48 and MW-49 between November 2004 and April 2005. These data indicate the existing sheet pile wall is acting as a significant barrier against fuel hydrocarbon migration to the river.

In addition to VOC analysis, groundwater samples collected in January 2005 were analyzed for general water chemistry analyses including alkalinity, sulfate, total Kjeldahl nitrogen (TKN), and total organic carbon (TOC) to evaluate the potential for monitored natural attenuation as a corrective measure for groundwater impacts. The data suggest that the shallow groundwater is biologically active, which likely may result in the natural reduction of the dissolved-phase hydrocarbons over time. The data also suggests that dissolved-phase hydrocarbons in the river terrace groundwater are bioattenuating and the water chemistry is amenable to monitored natural attenuation as a corrective measure.

5.0 SHALLOW-ZONE CONCEPTUAL MODEL DEVELOPMENT

5.1 RTSP GEOLOGY

In October 2004, two monitoring wells (MW-48 and MW-49) and eight temporary piezometers (TP-1 through TP-8) were installed at the river terrace. In April 2005, five additional temporary piezometers (TP-9 through TP-13) were installed in this area. During each drilling event, boring logs were developed to document shallow-zone soil observations in the river terrace area.

The lithologic logs indicate that the near surface soil in the RTSPA consists of one to two feet of silt underlain by one to two feet of fine grained sand. In some areas a six inch clay lense was observed beneath the silt layer. Beneath the fine grained sediments are medium to coarse grained sands that extend from approximately three or four feet bgs to approximately ten feet bgs. At ten feet bgs the sand transitions to coarser grained material with some gravel. Borings advanced in October 2004 and April 2005 did not encounter bedrock; however, borings drilled in 1997 indicate that the Nacimiento Formation is present beneath the RTSPA at approximately 15 to 17 feet bgs.

Soil sample headspace monitoring, soil analytical data, and observations of black staining and hydrocarbon odors during drilling suggest that subsurface soil impacts in the RTSPA extend from approximately four to ten feet bgs, with the total depth of petroleum hydrocarbon impacts decreasing with increasing distance from the bluff. These impacts resemble a smear zone due to seasonal fluctuating groundwater elevations.

The lithologic logs for the borings installed in the RTSPA are included in Attachment A. Conceptual geologic cross sections of the RTSPA shallow-zone soil are presented in Figures 5 through 8.

5.2 RTSPA HYDROGEOLOGY

5.2.1 Aquifer Test Results

An aquifer test was conducted at the RTSPA in December 2004. The results of the test were reported to OCD and NMED in a letter from Giant dated January 31, 2005. The aquifer test consisted of pumping groundwater from monitoring well MW-48 at a constant rate (approximately 4.7 gallons per minute) and monitoring drawdown at the pumping well, monitoring well MW-49, and piezometers TP-1, TP-2, TP-5, TP-6, TP-7, and TP-8. The pumping test ran for approximately 1,050 minutes (17.5 hours) until the generator failed. The following is a summary of the results observed after 1,000 minutes of pumping:

- The drawdown observed in MW-48 showed a water level decline of a little over 2.5 feet.
- The maximum drawdown observed in all piezometers was 0.45 feet measured in TP-8.
- A minimum drawdown observed in the piezometers was 0.10 feet in TP-6.
- A staff gage showed no significant change in river stage height (>0.10 foot of change) during the test.
- No drawdown was observed in well MW-49, except for a slight decline measured near the end of the test The water level decline was measured <0.05 feet. The water level fully recovered prior to terminating the pumping test, suggesting the decline was caused by a slight decline in river stage height.

Recovery water levels were taken in well MW-48 and piezometers TP-6 and TP-8 for approximately 5 hours after the pump test was terminated. The water level in the test well MW-48 recovered 2.24 feet or 88% of recovery to static level after 5 hours. Water levels in TP-6, located east of pumping well MW-48, did not recover. Water levels in piezometer in TP-8 recovered 0.16 feet or 36 % of recovery from static water level.

5.2.2 Conclusions

River Effects

The semi log drawdown curves for the two piezometers TP-5 and TP-6 and well MW-49 show little to no effect from pumping well MW-48. A slight drawdown was observed after several hours of pumping in all three observation points. However, when recovery levels measured in TP-6 were reviewed, no recovery was evident as the water level had stabilized for 5 hours, suggesting the San Juan River stage had decreased about 0.10 foot. This drop likely caused aquifer levels to drop in response to the change. It appears that the area east of pumping well MW-48 is affected by recharge from the river.

Capture Zone

The hydraulic conductivities determined from the pump test analysis were used to estimate the capture zone for prospective pumping well constructed in the river terrace. The hydraulic conductivity input was evaluated based on the proximity of the pumping well to a hydraulic boundary. As the boundary conditions were observed to drive the hydraulic response of the aquifer during the pump test, similarly the capture zone of a pumping well will be affected by the boundaries.

In addition to the hydraulic conductivity, a pumping rate, aquifer thickness and hydraulic gradient were input parameters for the capture model. A sensitivity analysis of each parameter revealed various capture zone shapes and sizes. The hydraulic gradient was determined from a topographic map of the San Juan river basin, and ranged from 0.0005 foot per foot (ft/ft) to 0.001 ft/ft. The aquifer thickness was varied between 10 feet and 15 feet, and the pumping rate was varied between 1 gpm and 5 gpm. In this range of inputs the area of capture for a pumping well located on the river terrace extended as far as 500 feet downgradient, 1600 feet upgradient and 3000 feet wide.

After running multiple iterations of the capture zone model, Malcolm Pirnie estimated that an adequate capture zone can be obtained at a pumping rate of 2 to 5 gpm.

Drawdown

Analysis of the drawdown data revealed two distinct types of curves. These curves indicated the presence of distinct hydraulic boundaries in the vicinity of each well. At TP-8 the slope of the drawdown curve increased sharply as the test progressed, while TP-6 remained relatively flat. The response at TP-8 is characteristic of an impermeable boundary (e.g., slurry wall and/or bedrock), while that at TP-6 is characteristic of a recharging boundary (e.g., San Juan River).

The semi log drawdown curves for the three piezometers by the slurry wall and the bluff showed nearly 0.5 feet of drawdown after 17 hours of pumping. The drawdown data suggest the slurry wall and bluff (impermeable boundary) have a large effect on water level declines in TP-1, TP-2, and TP-8. After several hundred minutes of pumping, the drawdown curves show an increasing rate of drawdown. The drawdown curves, if extrapolated out to several days and weeks, suggest drawdown would likely accelerate due to the effects of the impermeable boundaries.

The installation of a groundwater extraction well northeast of MW-48, pumping approximately 20 gpm, should provide hydraulic control of river effects in the RTSPA. Combined with a groundwater extraction pump in MW-48 pumping at approximately 5 gpm, the anticipated groundwater drawdown in the RTSPA to facilitate vadose-zone treatment will be approximately five feet.

6.0 CORRECTIVE MEASURES EVALUATION

6.1 REMEDIAL ALTERNATIVES

Five corrective measure alternatives were evaluated to address petroleum-impacted soil at the RTSPA. The evaluation considered the reliability of the alternative to achieve contaminant removal, ease of implementation, cost, and remediation schedule. The evaluation also considered each alternative's potential benefits to groundwater.

The following alternatives were evaluated:

- Excavation and off-site disposal
- In-situ bioventing
- In-situ soil vapor extraction
- Ex-situ landfarming
- Ex-situ thermal desorption

The following paragraphs briefly describe each remedial alternative. A summary of the evaluation is provided in Table 3.

6.1.1 Excavation and Off-Site Disposal

Contaminated soil is excavated and transported to a permitted off-site treatment and/or disposal facility. Excavation and off-site disposal is an applicable remedial alternative for the RTSPA impacted soil. Excavation dewatering would be required during soil removal activities. Disposal facilities may include, but not be limited to, landfills, incinerators, composting facilities, or asphalt batch plants.

6.1..2 In-Situ Bioventing

In-situ bioventing is a remedial technique that enhances natural biodegradation to treat impacted soil. Biodegradation is a process in which indigenous or inoculated microorganisms degrade (metabolize) organic contaminants found in soil and/or groundwater. In the presence of sufficient oxygen (aerobic conditions), microorganisms will convert many organic contaminants to carbon dioxide, water, and microbial cell mass. In the absence of oxygen (anaerobic conditions), the organisms will metabolize the organic compounds to methane, limited amounts of carbon dioxide, and biomass.

With a bioventing system, air is injected into the impacted vadose zone soil via injection wells equipped with low flow blowers. The system is designed to provide only enough oxygen to sustain microbial activity and is not intended to volatilize the contaminants as is the case with soil vapor extraction systems. Nutrients and moisture can also be added to the vadose zone soil through a bioventing system to enhance biodegradation. Bioventing is efficient in treating petroleum-impacted soil.

6.1.3 In-Situ Soil Vapor Extraction

Soil vapor extraction (SVE) is an in-situ unsaturated (vadose) zone soil remediation technology in which a vacuum is applied to the soil to induce the controlled flow of air and remove volatile and some semivolatile contaminants from the soil. The gas leaving the soil may be treated to recover or destroy the contaminants, depending on local and state air discharge regulations. For the soil surface, geomembrane covers are often placed over soil surface to prevent short circuiting and to increase the radius of influence of the wells. Groundwater depression pumps may be used to reduce groundwater upwelling induced by the vacuum or to increase the depth of the vadose zone. The duration of operation and maintenance for in situ SVE is typically medium- to long-term.

6.1.4 Ex-Situ Landfarming

Ex-situ landfarming, like bioventing, is a remedial technique that enhances natural biodegradation to treat impacted soil. The landfarming process involves tilling to aerate the soil, thereby stimulating aerobic microbial activity. The addition of moisture and nutrients are also used to enhance microbial activity. The impacted soil is excavated and placed in a separate bermed treatment area that may include a liner and leachate collection system. The effective treatment depth for this remedial technology ranges between 1.5 to 3 feet per lift, depending on the type and size of the tilling equipment and soil texture. The treatment may be limited by climatic conditions. Soil temperature should be between 10 and 45 °C, and precipitation should be less than 30 inches per year for optimal performance. The climate in Bloomfield, NM would likely limit optimal landfarming performance at the refinery to the period between April and October.

This remedial strategy is preferred when large quantities of shallow-zone impacted soil require treatment and excavation / off-site disposal is cost prohibitive. A large open area is required for this treatment alternative.

6.1.5 Ex-Situ Thermal Desorption

Thermal adsorption is a soil treatment process that uses heat to remove chemicals of concern. It differs from incineration, in that thermal desorption units remove (desorb) and concentrate chemicals, while incineration is used to destroy the chemicals of concern. A thermal desorption unit typically consists of a desorber and off-gas collection equipment. The desorber works like a large oven that mixes and heats the soil to volatilize the contaminants. The vaporized contaminants are then condensed, collected, and shipped off-site for disposal. Thermal desorption is very effective in treating dry, petroleum-impacted soil. It is typically used at sites with large amounts of highly-impacted soil requiring a fast cleanup time. A thermal desorption system would require appropriate air permitting.

6.2 SELECTED CORRECTIVE MEASURES

After reviewing the magnitude and extent of petroleum-impacted soil at the RTSPA, the interim measure alternatives were evaluated for technical and economic feasibility as well as treatment schedule. In-situ bioventing was selected to address petroleum-impacted soil at the site. Ex-situ landfarming and ex-situ thermal desorption were eliminated from consideration due to higher treatment costs and potential permitting requirements. Excavation/off-site disposal was not chosen because of higher treatment costs. In-situ SVE could be an effective treatment technology; however, it was not chosen because in-situ bioventing is capable of achieving the remediation goals in a similar timeframe, at lower costs, and does not involve air emissions control / permitting issues. Table 3 provides a summary of the interim measures alternatives comparison. The proposed interim measure alternative is discussed in the next section.

7.0 PROPOSED INTERIM CORRECTIVE MEASURES

As a voluntary corrective measure, Giant proposes to install an in-situ bioventing treatment system at the RTSPA. The system will cover an approximate 25,000 square foot area from the sheet pile barrier and extending approximately 150 feet east. The system will provide vadose-zone source reduction that will result in beneficial impacts to the shallow groundwater, namely a reduction in dissolved-phase concentrations of petroleum hydrocarbons.

Dewatering will be conducted in the treatment area to increase exposure of the impacted soil in the RTSPA vadose zone to the bioventing system. Horizontal bioventing wells will be installed within the impacted vadose zone to enhance the biodegradation of residual petroleum hydrocarbons. Figure 9 presents the conceptual layout for the bioventing system in the RTSPA.

7.1 DEWATERING

Dewatering will be conducted to increase the thickness of vadose-zone available for bioventilation. Dewatering will be accomplished by installing an upstream extraction well for hydraulic control of river recharge and utilizing MW-48 as an extraction well to draw down groundwater within the treatment area. An additional extraction well may be required near MW-48 to provide adequate dewatering in the treatment area.

Groundwater will be removed from the wells using submersible pumps. Anticipated pumping rates are approximately 20 gpm for control of river recharge, and 5 gpm for drawdown within the treatment area. The groundwater will be pumped through a temporary carbon adsorption system and then discharged to the refinery holding ponds and used as process water.

7.2 VADOSE ZONE TREATMENT CONCEPT

Bioventing relies upon the injection of air into the subsurface, through vertical wells or horizontal trenches, to provide oxygen to stimulate naturally-occurring microorganisms that degrade hydrocarbons in soil. Horizontal trenches are proposed for the RTSPA to provide high air flow to the impacted vadose zone and reduce the treatment timeframe. Gaseous or liquid amendments can be added to the subsurface, if necessary, to enhance the desired microbial environment. Once the soil concentrations of hydrocarbons are reduced, a reduction of groundwater hydrocarbon concentrations typically occurs due to reduction of the contaminant source in the soil.

In general, the lateral bioventing wells will be constructed by excavating narrow trenches, approximately 2.5 feet wide, 7.5 feet deep, and 100-150 feet across the RTSPA. At a depth of 7.5 feet, the bioventing trenches are expected to effectively treat the extent of vadose zone soil impacts, believed to be between 4 and 10 feet bgs. The trenches will be oriented east to west, and the lateral wells installed within the trenches will be connected to a blower system located near the river terrace pump station (in the vicinity of TP-4). The bottom 4 to 5 feet of each trench will be backfilled with coarse sand, surrounding two 100-150 foot long, 4-inch diameter, slotted drainage pipes that will serve as horizontal air injection wells. One well will be installed at approximately 7 feet bgs and the second well will be installed approximately 5 feet bgs. The deeper well will be utilized during normal operation. The shallower well will be used in the event that the groundwater dewatering system is shut down for an extended period or if the groundwater drawdown is not sufficient and the groundwater elevation rises above 7 feet bgs.

A geotextile vapor barrier will be installed on top of the gravel/sand at an approximate depth of 2 to 3 feet to tie into the fine-grained silty sand or clay interval identified throughout the site at this depth. Two to three vertical headers will be installed in each trench for each well, with the headers tied into the bioventing system with aboveground PVC piping. A profile section of the conceptual bioventing trench design is presented in Figure 10.

The bioventing system design (i.e., number of trenches, trench spacing, air injection rate, blower size, etc.) and method of construction will be finalized upon the completion of a pilot test.

7.2.1 Pilot Test

A bioventing pilot test will be conducted to determine the distance air can physically be moved within the RTSPA vadose zone soil (i.e., radius of influence). One pilot trench and bioventing well will be installed across the middle of the RTSPA treatment area for the test. The pilot test will be accomplished through a series of pressure tests where air is injected at a constant flow rate into the pilot trench and the pressure increase is periodically measured at monitoring points, screened within the vadose zone, located at varying distance and direction from the pilot trench. Each test will last approximately one

to two hours (until the monitoring point measurements stabilize). A minimum of three different flow rates will be tested at the pilot trench. Determining the radius of influence at various flow rates will help to determine preferred trench spacing and blower sizing.
For each test, the log of the pressure data from the monitoring points will be plotted versus distance from the vent well. USEPA guidance, based on data collected during a U.S. Air Force Bioventing Initiative at various sites, suggests that the radius of influence for bioventing design is the distance at which the slope of the pressure/distance plot intersects a pressure of 0.1 inches of water (25 Pascals) on the graph.

7.3 MONITORED NATURAL ATTENUATION CONCEPT

Analysis of groundwater beneath the RTSPA indicates dissolved-phase petroleum hydrocarbon impacts are bioattenuating. These impacts are greater in the western portion of the river terrace where petroleum-impacted soil in the vadose zone may be contributing to groundwater impacts. The proposed vadose zone bioventing system in conjunction with the dewatering efforts should significantly reduce dissolved-phase groundwater impacts in this area. At the completion of vadose-zone remediation activities, Giant proposes to address any residual impacts to the river terrace groundwater through monitored natural attenuation. The natural attenuation process will be routinely monitored to confirm that bioattenuation is occurring.

7.3 IMPLEMENTATION CONCEPT

Implementation of the RTSPA corrective measures will be completed in four phases. Phase I will include installation of dewatering wells and the bioventing pilot test. Phase II will consist of the final design and installation of the bioventing system. Phase III will consist of operation and maintenance (O&M) of the vadose zone treatment system. Phase IV will consist of monitored natural attenuation to address any residual groundwater impacts.

7.4 CONSTRUCTION PERMITS

Giant will comply with applicable permitting requirements associated with the construction and operation of the dewatering wells, bioventing trenches/wells, and groundwater treatment system.

The proposed bioventing system installation will disturb less than one acre of soil; therefore, a construction storm water permit will not be required and a storm water pollution prevention plan (SWPPP) will not need to be developed.

VOC air emissions during the bioventing pilot test, drilling activities, and excavation activities are expected to be insignificant and not trigger any state permitting requirements.

At the completion of the final design for the bioventing system a monitoring plan will be developed. This plan will be submitted to OCD and NMED prior to start-up of the treatment system.

8.0 SCHEDULE

Phase I of the RTSPA bioventing system implementation is anticipated to start by June 1, 2005. Figure 11 shows the estimated implementation schedule.

9.0 REFERENCES

Malcolm Pirnie, 2005. Aquifer Test Summary Report, San Juan River Terrace Site, Giant Refinery, Bloomfield, NM, January 31, 2005

USEPA, 1995. Manual: Bioventing Principles and Practice. Volume II: Bioventing Design. EPA/625/XXX/001. September 1995.

TABLES

TABLE 1
Groundwater Elevation Data
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

	MW-48			MW-49		
Date	**TOC**	**DTW**	**GW Elev**	**TOC**	**DTW**	**GW Elev**
11/1/2004	5421.368	7.73	5413.638	5421.219	9	5412.219
12/27/2004	5421.368	7.97	5413.398	5421.219	9.3	5411.919
1/18/2005	5421.368	7.88	5413.488	5421.219	9.17	5412.049
2/24/2005	5421.368	7.74	5413.628	5421.219	9.5	5411.719
3/16/2005	5421.368	7.77	5413.598	5421.219	8.96	5412.259
4/4/2005	5421.368	7.55	5413.818	5421.219	8.78	5412.439
5/4/2005	5421.368	7.45	5413.918	5421.219	8.46	5412.759

TABLE 2
MW-48 & MW-49 Groundwater Quality
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

	MW-48					
	11/1/2004	**12/27/2004**	**1/18/2005**	**2/24/2005**	**3/16/2005**	**4/4/2005**
Volatile Organic Compounds (µg/L)						
Benzene	890	690	400	660	630	480
Toluene	<100	<50	<50	<25	<25	<25
Ethylbenzene	3700	1900	1400	2200	2100	1700
Xylenes	24000	8200	6550	11000	10000	7500
Naphthalene	1300	190	195	320	260	150

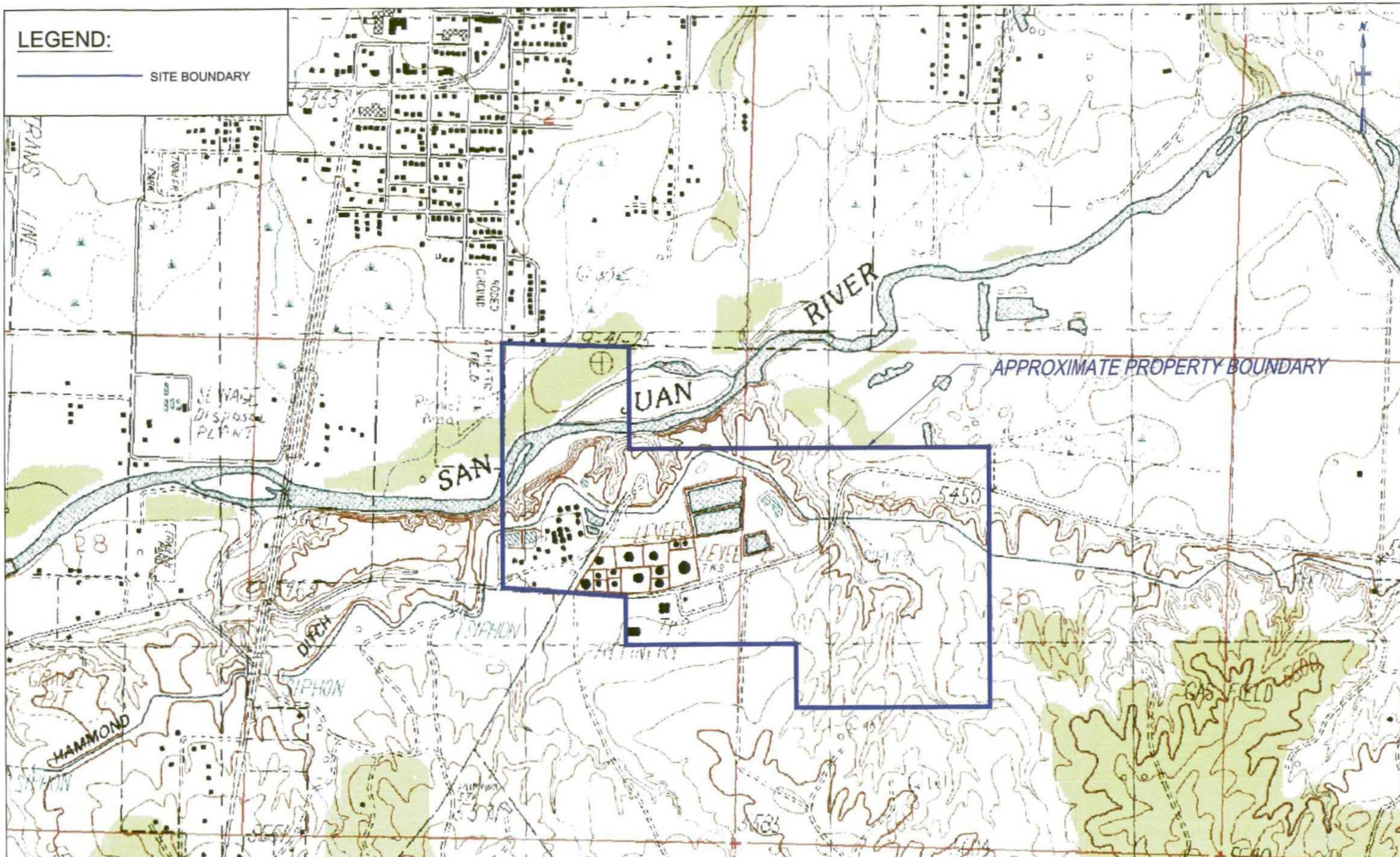
	MW-49					
	11/1/2004	**12/27/2004**	**1/18/2005**	**2/24/2005**	**3/16/2005**	**4/4/2005**
Volatile Organic Compounds (µg/L)						
Benzene	<10	9.7	4	35	24	41
Toluene	<10	<0.5	<50	0.55	0.5	0.68
Ethylbenzene	15	1.9	<1.0	6.6	9.4	15
Xylenes	320	0.52	<1.0	4.1	16	24
Naphthalene	39	<2.5	<2.0	<2.5	<2.5	<2.5

Table 3
Comparative Evaluation of Corrective Measure Alternatives
Voluntary Corrective Measures Work Plan
River Terrace Sheet Pile Area – Giant Bloomfield Refinery

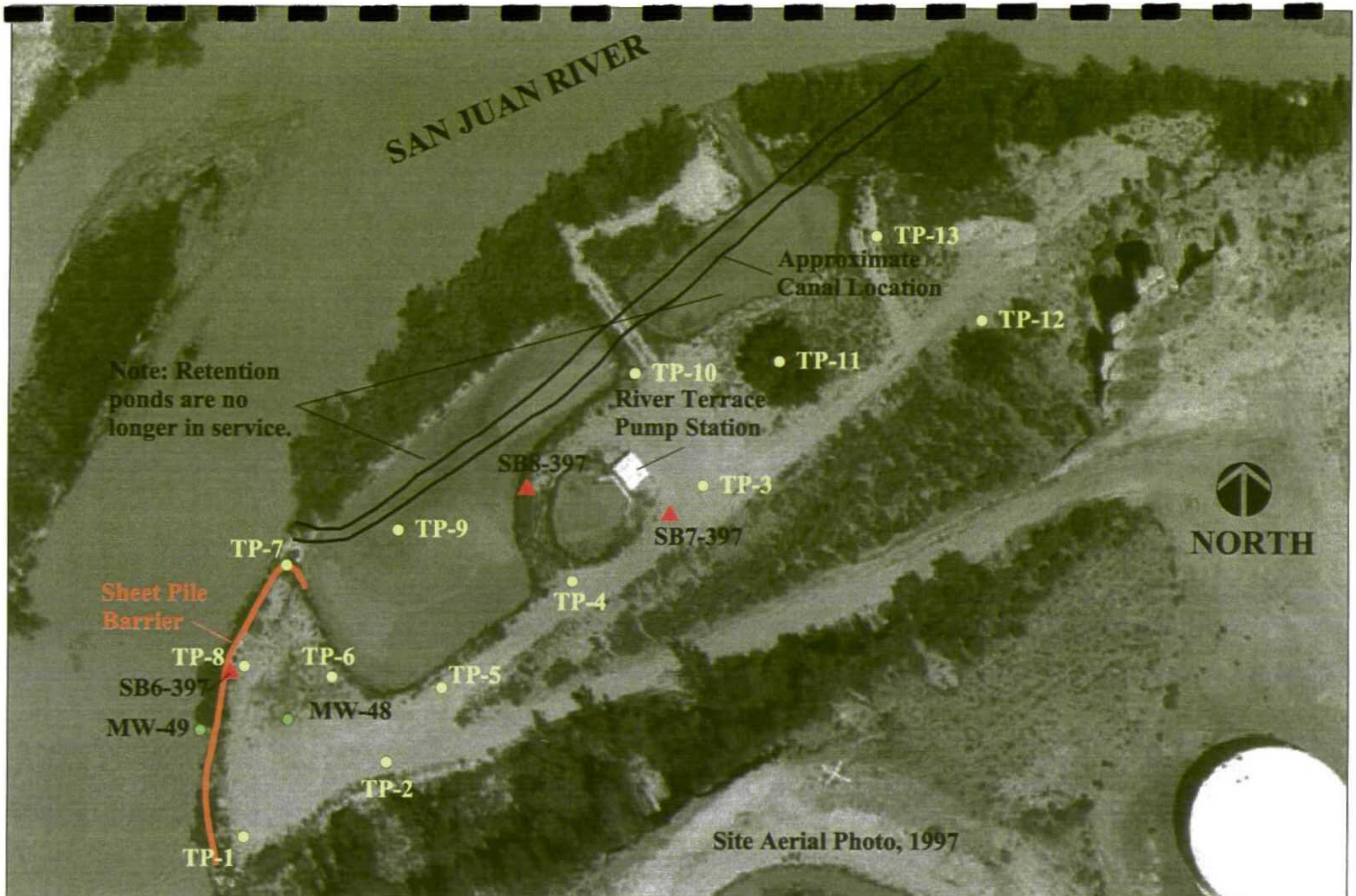
Alternative	Reliability	Implementation and Schedule	Relative Cost	Comments
Excavation and off-site disposal	High	Readily available, short duration	Moderate - High	Meets all criteria. Cost may be high if impacted soil characterized as hazardous waste per RCRA. Will require excavation dewatering.
In-situ bioventing	High	Readily available, moderate duration	Low - Moderate	Meets all criteria. Would require groundwater depression to effectively treat vadose zone soil.
In-Situ SVE	Moderate to High	Available, long duration	Moderate to High	Meets all criteria. Would require groundwater depression to effectively treat vadose zone soil. May also require permitting and off-gas treatment.
Ex-situ landfarming	High	Available, longer duration	Moderate	Requires large open area. May require leachate collection/treatment. Includes excavation/dewatering. May not be effective during winter months.
Ex-Situ Thermal Desorption	Moderate to High	Available, short duration	High	High cost. Permitting required. Includes excavation/dewatering.

SVE – soil vapor extraction

FIGURES



MALCOLM PIRNIE	GIANT REFINERY BLOOMFIELD, NEW MEXICO VOLUNTARY CORRECTIVE MEASURES WORK PLAN	SITE LOCATION MAP NOT TO SCALE
		MALCOLM PIRNIE, INC. MAY 2005 FIGURE 1



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SITE PLAN
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

FIGURE 2

FIGURE 3
MW-48 & MW-49 Groundwater Elevations
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

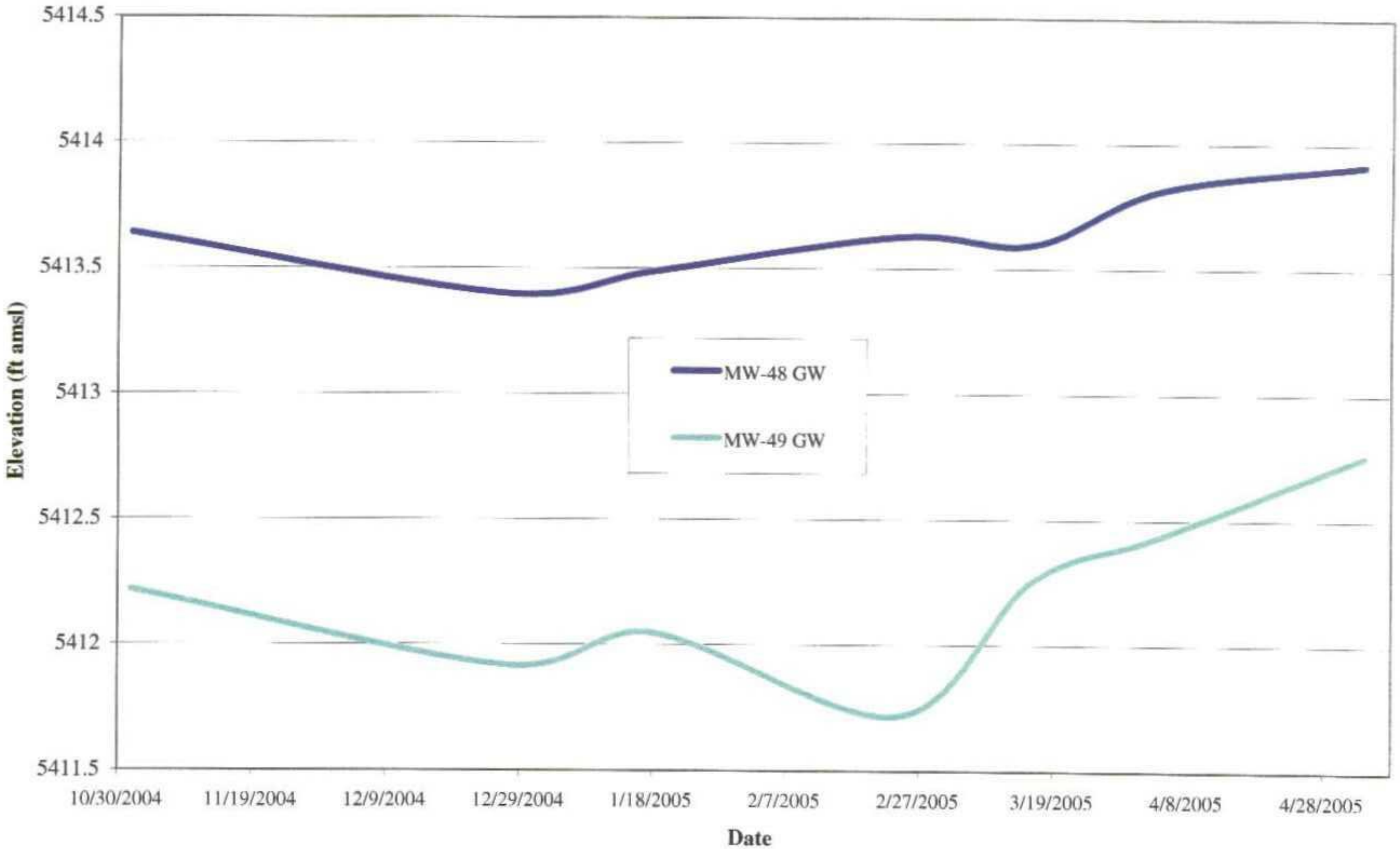
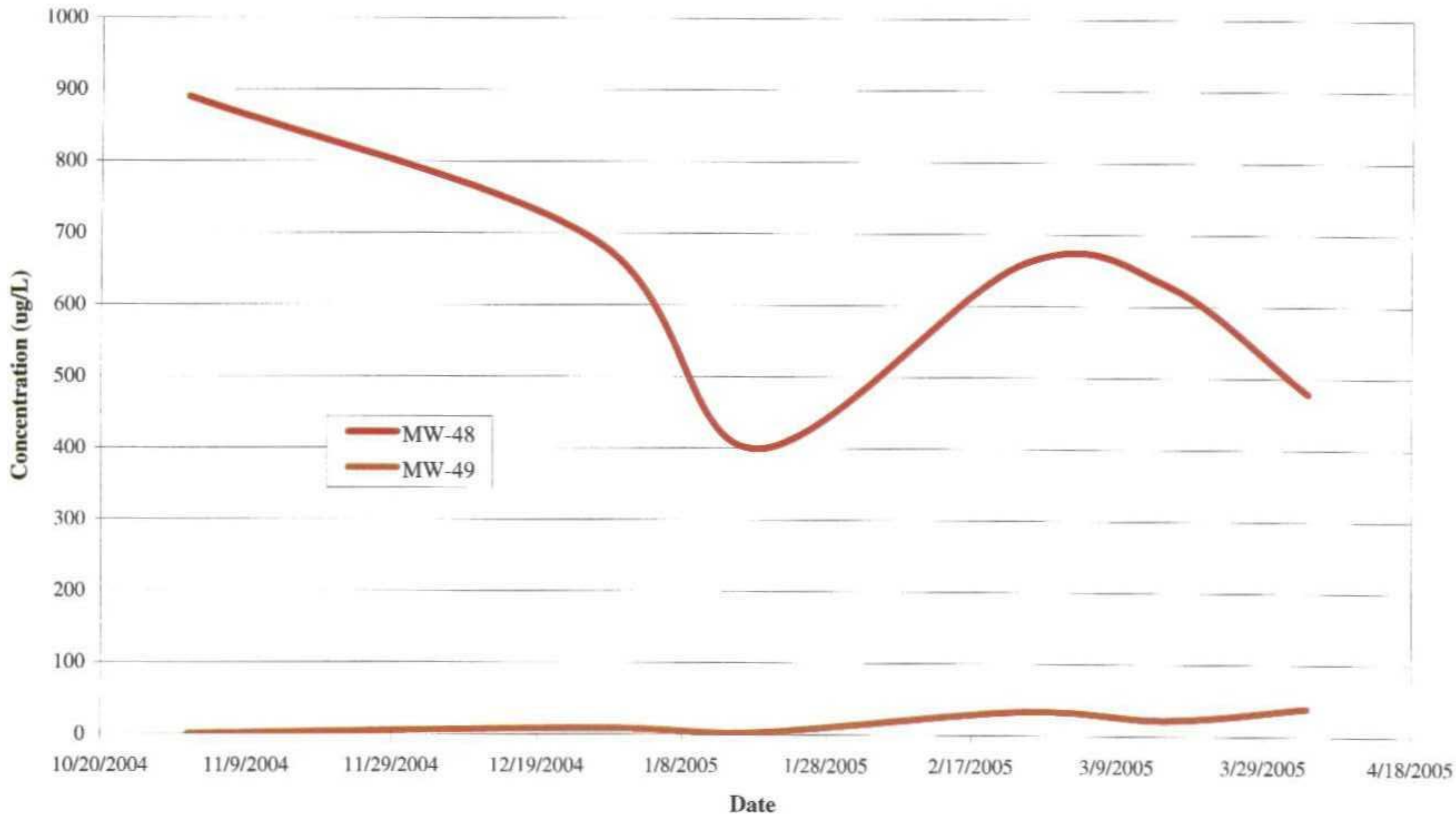
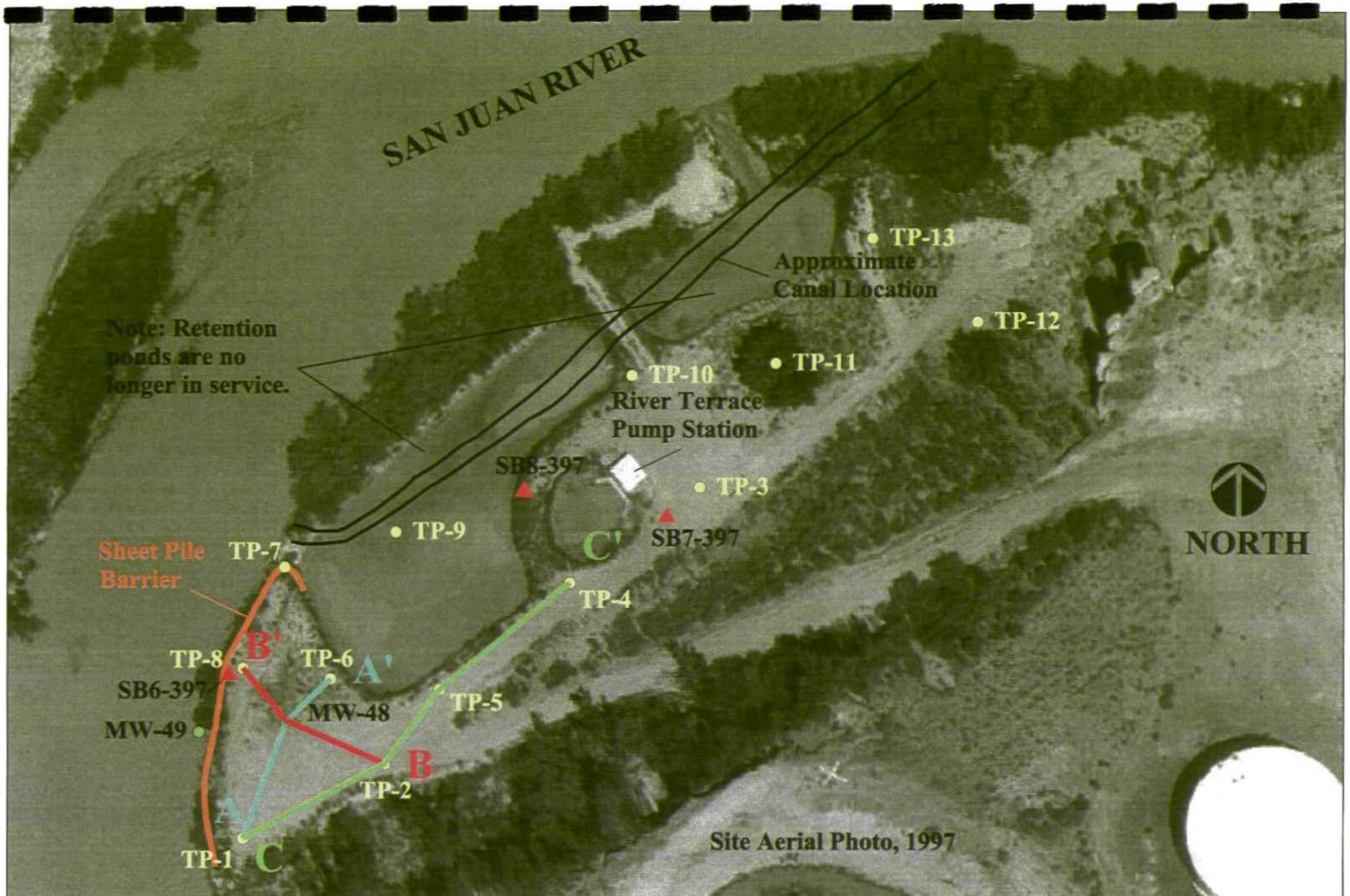


FIGURE 4
Benzene Concentrations in MW-48 and MW-49
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

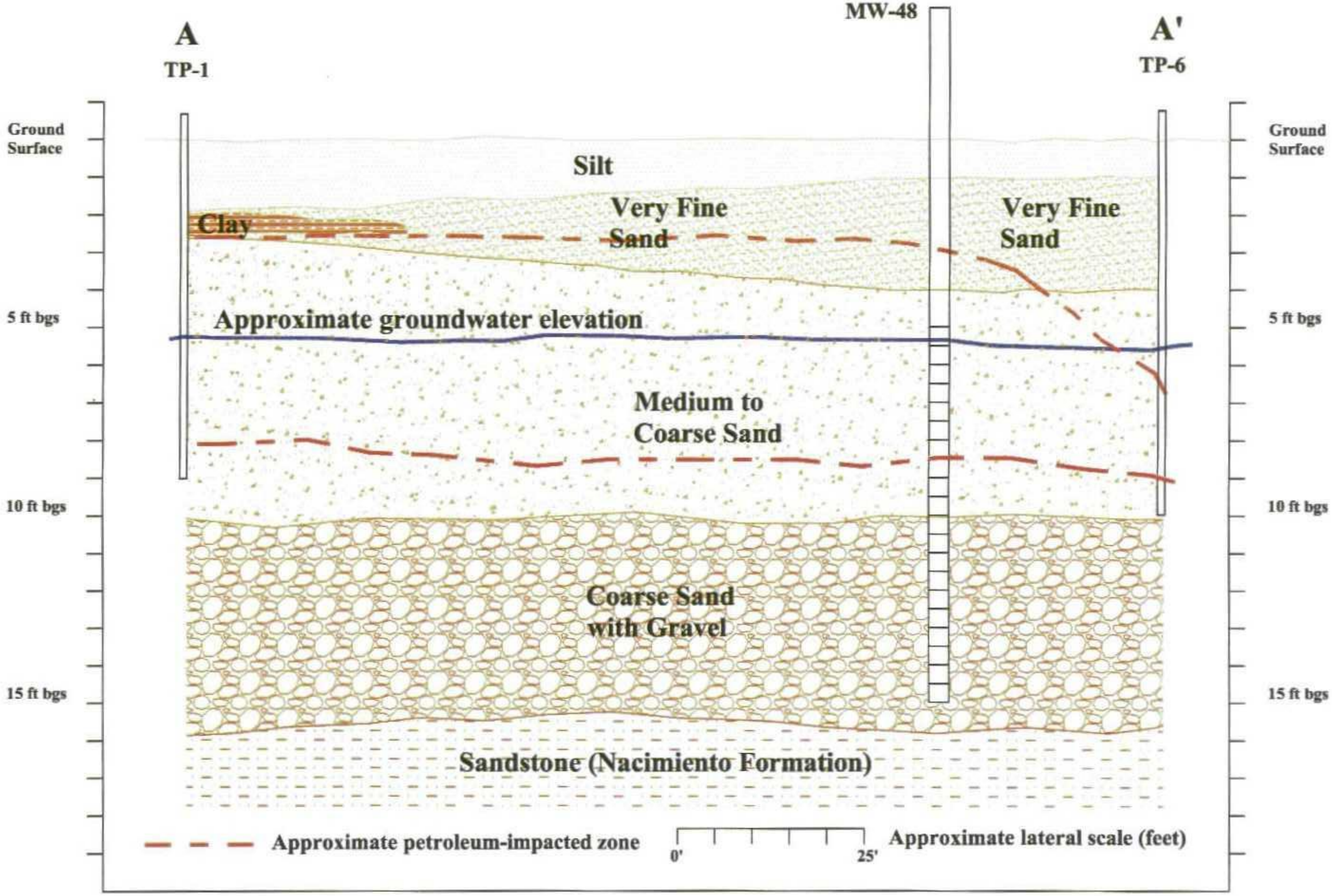




MALCOLM PIRNIE

GEOLOGIC CROSS SECTION LOCATIONS
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

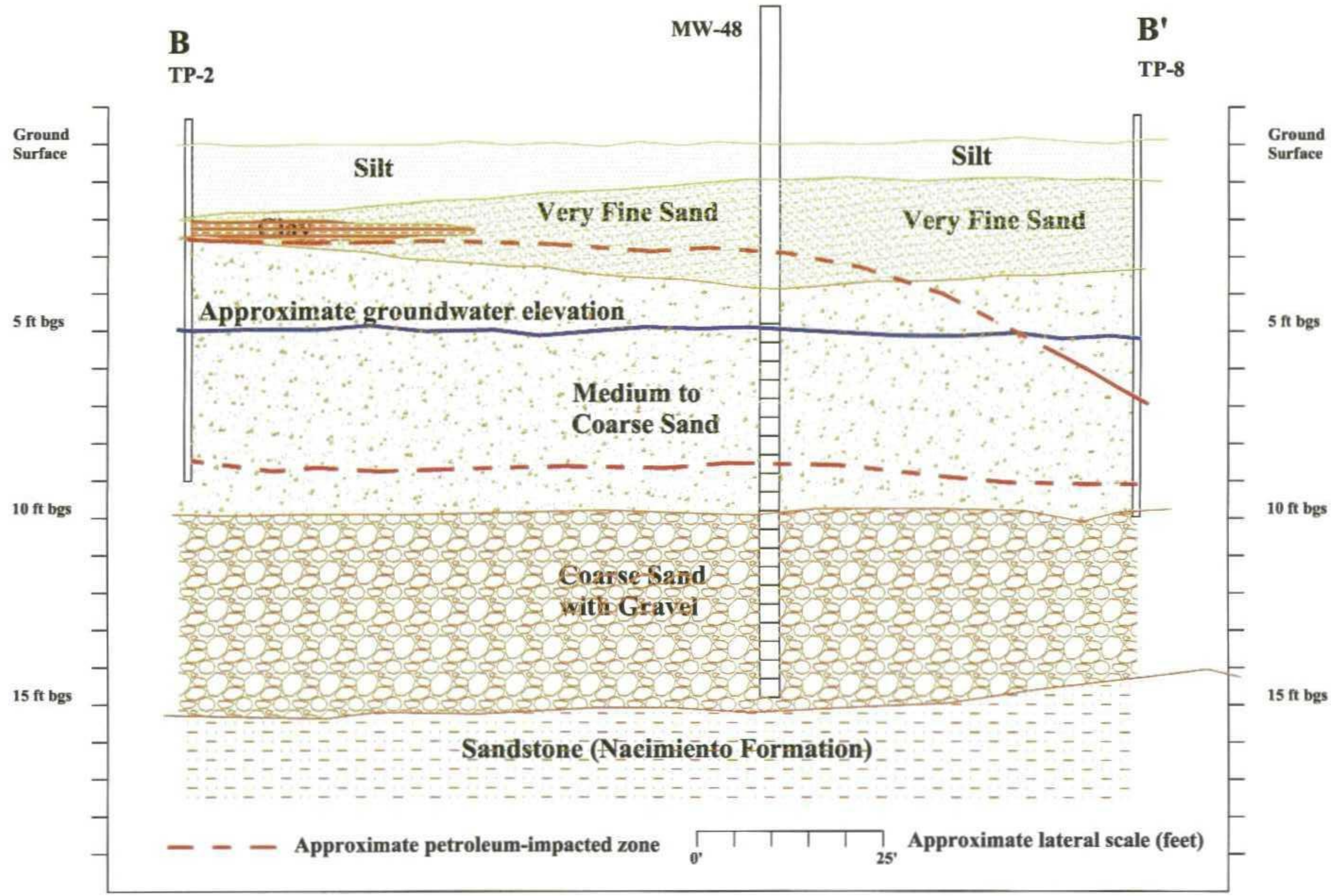
FIGURE 5



MALCOLM PIRNIE

Cross Section A - A'
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

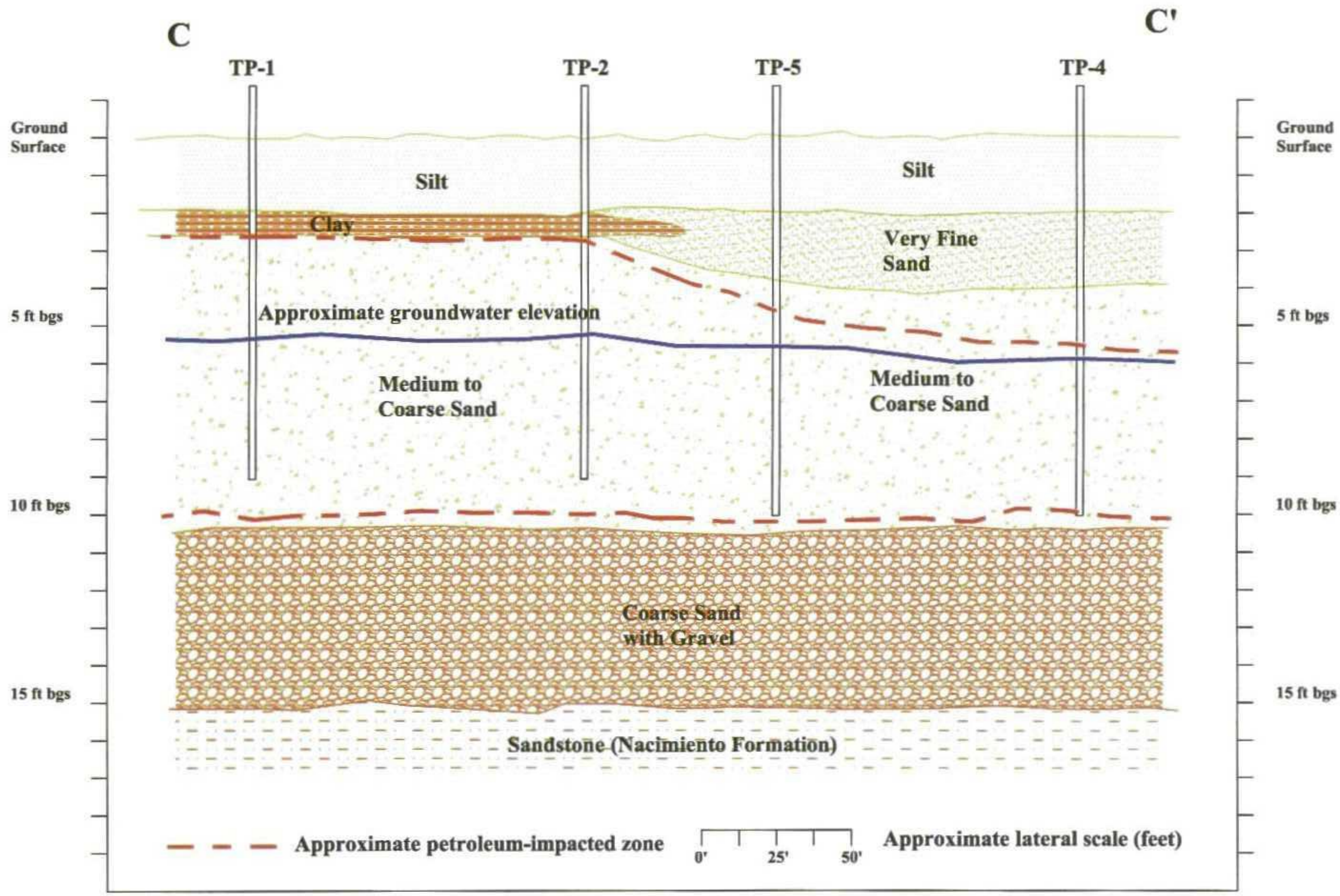
FIGURE 6



MALCOLM PIRNIE

Cross Section B - B'
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

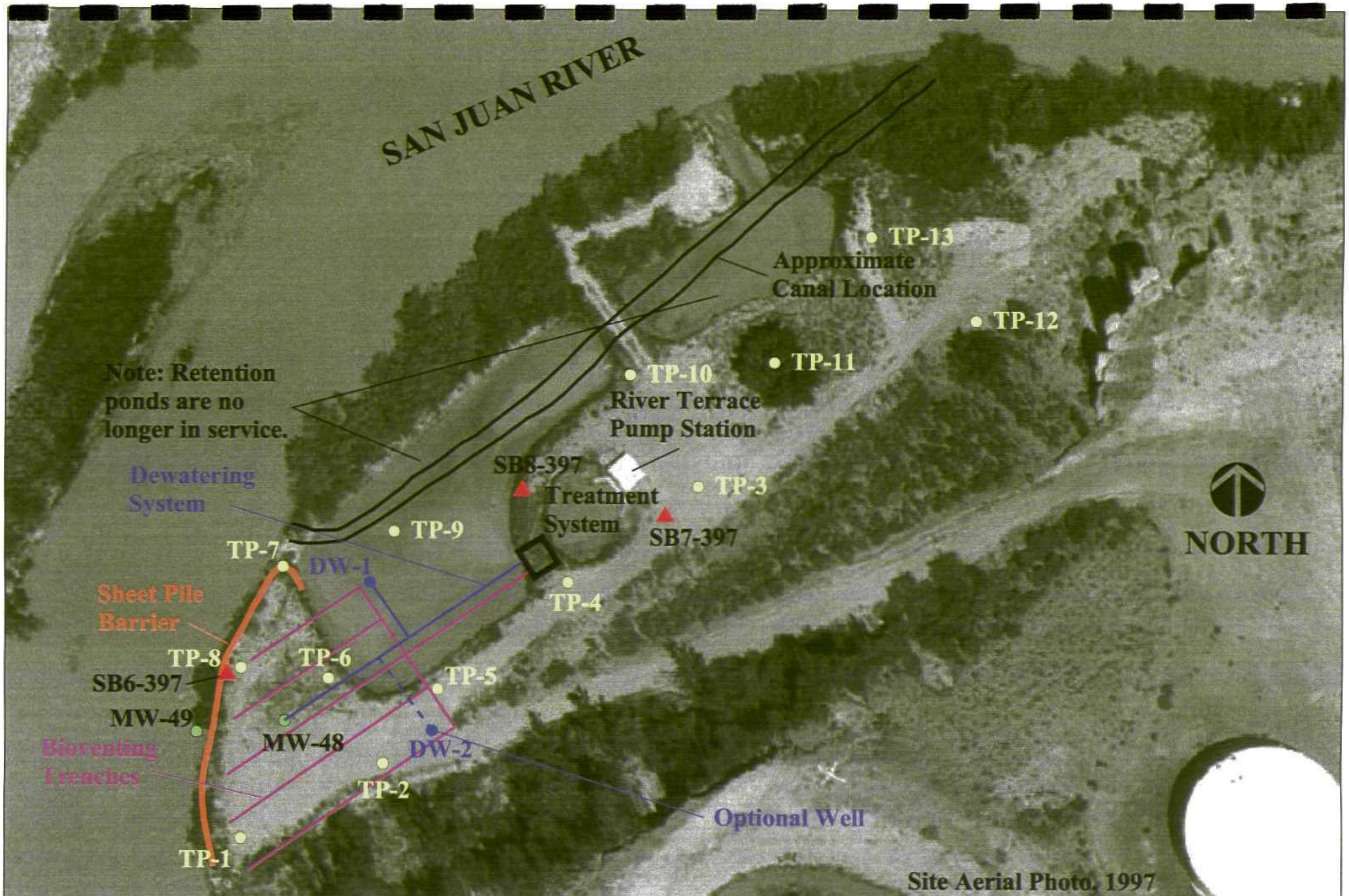
FIGURE 7



MALCOLM PIRNIE

Cross Section C - C'
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

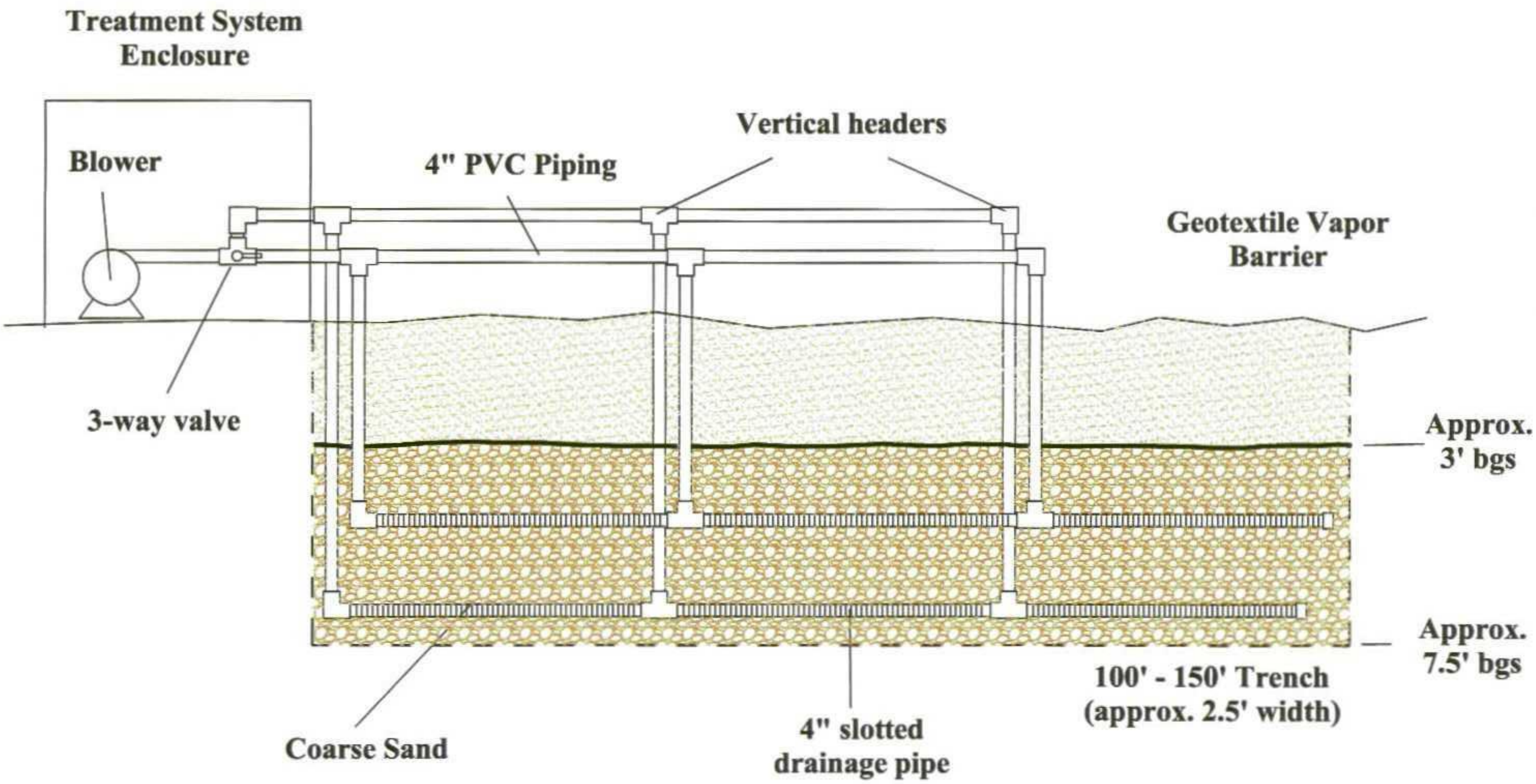
FIGURE 8



MALCOLM PIRNIE

CONCEPTUAL CORRECTIVE MEASURES LAYOUT
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

FIGURE 9



NOT TO SCALE

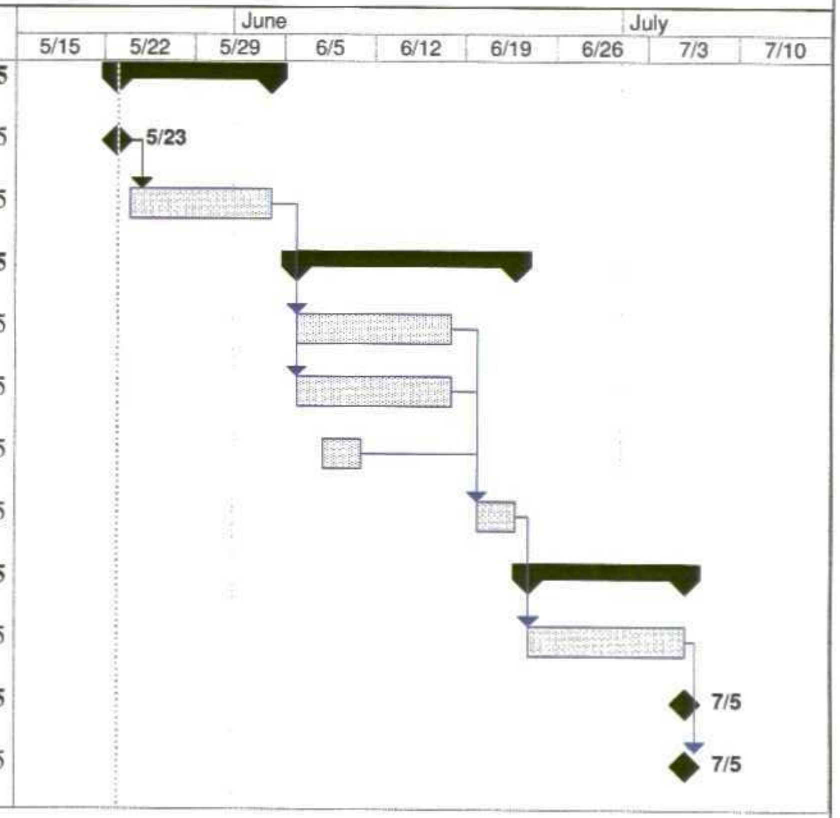
MALCOLM PIRNIE

Conceptual Bioventing Trench Design
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

FIGURE 10

FIGURE 11
Estimated Corrective Measures Implementation Schedule
River Terrace Sheet Pile Area
Giant Refinery - Bloomfield, NM

ID	Task Name	Duration	Start	Finish
1	**VCM Work Plan**	**10 days**	**Mon 5/23/05**	**Fri 6/3/05**
2	Submit Work Plan to NMED	0 days	Mon 5/23/05	Mon 5/23/05
3	NMED Approval	9 days	Tue 5/24/05	Fri 6/3/05
4	**Phase I VCM Activities**	**13 days**	**Mon 6/6/05**	**Wed 6/22/05**
5	Dewatering Well installation	10 days	Mon 6/6/05	Fri 6/17/05
6	Pilot Trench installation	10 days	Mon 6/6/05	Fri 6/17/05
7	GW Dewatering System Installation	3 days	Wed 6/8/05	Fri 6/10/05
8	Pilot Test	3 days	Mon 6/20/05	Wed 6/22/05
9	**Phase II VCM Activities**	**8 days**	**Fri 6/24/05**	**Tue 7/5/05**
10	Complete Bioventing System Installation	8 days	Fri 6/24/05	Tue 7/5/05
11	**Phase III VCM Activities**	**0 days**	**Tue 7/5/05**	**Tue 7/5/05**
12	Treatment System Start-Up and O&M	0 days	Tue 7/5/05	Tue 7/5/05



Project: VCM Implementation Schedu
Date: Mon 5/23/05

5127-003

May 2005

APPENDIX A
SOIL BORING LOGS

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)
0-4.5	**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		
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		
-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		
3.5	***000***		C		
5-16.5	***00****		C	SAND, FINE, SLIGHTLY GRAVELLY, WATER BEARING, GREY, NO ODOR	
	00*		C		
	00*	15	C		
	00*		C		
	00*		C		
6.5	***00****		C		
-17.5	=========		C	NACIMIENTO FORMATION	
17.5	=========		C	SHALE, BLACK, FISSLE, DENSE, MOIST, NOT WATER BEARING	
AL DEPTH					

LOGGED BY: WHK

ND TYPE OF BORING: 4 1/4" ID CONTINUOUS FLIGHT HSA

PRECISION ENGINEERING, INC.

LOG OF TEST BORINGS

LOCATION: SEE SITE PLAN

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		
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		
L DEPTH					

LOGGED BY: WHK

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

Sheet: 1 of 1
Bore Point: See plan
Water Elevation: 4.6' below ground surf.
Boring No.: TP1-1004

Precision Engineering, Inc.
P.O. Box 422
Las Cruces, NM 88004
505-523-7674

File #: 03-122
Site: Bloomfield
Giant Refining
Elevation: unsurveyed
Date: 10/27/2004

Log of Test Borings

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR,ETC.)	%M	LL	PI	CLASS.
	0-2		O-*--O*- O-*--O*- O-*--O*- O-*--O*-		**Silt**, sand, very fine to fine, cobbles, gravel, brown, moist				
	2-2.5		*-*--*-*	2.5	**Clay**, sandy, very fine, brown, wet				
	2.5-9.0		********* ********* ********* ********* ********* ********* ********* ********* ********* ********* ********* ********* *********	5.0 7.5	**Sand**, fine to medium, black, damp, water bearing				
				10.0 15.0 20.0	T.D. 9.0 Placed 2" PVC, 5' hand slotted screen Backfilled with clean cuttings bottom at 9.0				

SIZE & TYPE OF BORING: 4 1/4" ID HOLLOW STEMMED AUGER LOGGED BY: KM

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Sheet: 1 of 1
Bore Point: See plan
Water Elevation: 6.3' below ground surf.
Boring No.: TP2-1004

Precision Engineering, Inc.
P.O. Box 422
Las Cruces, NM 88004
505-523-7674

File #: 03-122
Site: Bloomfield
Giant Refining
Elevation: unsurveyed
Date: 10/27/2004

Log of Test Borings

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR,ETC.)	%M	LL	PI	CLASS.
	0-2		O-*--O*- O-*--O*- O-*--O*- O-*--O*-		**Silt**, sand, very fine to fine, cobbles, gravel, brown, moist				
	2-2.5		*-*--*-*	2.5	**Clay**, sandy, very fine, brown, wet				
	2.5-9.0		********* ********* ********* ********* ********* ********* ********* ********* ********* ********* ********* ********* *********	5.0 7.5	**Sand**, fine to medium, black, damp, water bearing				
				10.0 15.0 20.0	T.D. 9.0 Placed 2" PVC, 5' hand slotted screen Backfilled with clean cuttings bottom 9.0'				

SIZE & TYPE OF BORING: 4 1/4" ID HOLLOW STEMMED AUGER LOGGED BY: KM

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Sheet: 1 of 1
Bore Point: See plan
Water Elevation: 5.8' below ground surf.
Boring No.: TP3-1004

Precision Engineering, Inc.
P.O. Box 422
Las Cruces, NM 88004
505-523-7674

File #: 03-122
Site: Bloomfield
Giant Refining
Elevation: unsurveyed
Date: 10/28/2004

Log of Test Borings

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR,ETC.)	%M	LL	PI	CLASS.
	0-2		O-*--O*- O-*--O*- O-*--O*- O-*--O*-		**Silt**, sand, very fine to fine, cobbles, gravel, brown, moist				
	2-3.5		*--*--*--* *--*--*--* *--*--*--*	2.5	**Clay**, sandy, very fine, brown				
	3.5-13.0		********* (×19 rows)	5.0 7.5 10.0	**Sand**, medium to coarse, brown, damp,				
				15.0 20.0	T.D. 13.0 Placed 2" PVC, 5' hand slotted screen Backfilled with clean cuttings bottom 9.0'				

SIZE & TYPE OF BORING: 4 1/4" ID HOLLOW STEMMED AUGER LOGGED BY: KM

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Sheet: 1 of 1
Bore Point: See plan
Water Elevation: 5.4' below ground surf.
Boring No.: TP4-1004

Precision Engineering, Inc.
P.O. Box 422
Las Cruces, NM 88004
505-523-7674

File #: 03-122
Site: Bloomfield
Giant Refining
Elevation: unsurveyed
Date: 10/28/2004

Log of Test Borings

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR,ETC.)	%M	LL	PI	CLASS.
	0-2		O-*--O*- O-*--O*- O-*--O*- O-*--O*-		**Silt**, sand, very fine to fine, cobbles, gravel, brown, moist				
	2-10.0		*-*--*-*	2.5	**Sand**, silty, very fine, gravel to 2", brown				
			---*-*						
			**********						
			**********						
			**********						
			**********	5.0					
			**********						
			**********						
			**********		black, hydrocarbon odor				
			**********		water bearing				
			**********	7.5					
			**********						
			**********						
			**********						
			**********						
			**********	10.0					
					T.D. 10.0 Placed 2" PVC, 5' hand slotted screen Backfilled with clean cuttings bottom at 9.0				
				15.0					
				20.0					

SIZE & TYPE OF BORING: 4 1/4" ID HOLLOW STEMMED AUGER LOGGED BY: KM

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Bore Point: See plan
Water Elevation: 5.4' below ground surf.
Boring No.: TP5-1004

Precision Engineering, Inc.
P.O. Box 422
Las Cruces, NM 88004
505-523-7674

File #: 03-122
Site: Bloomfield
Giant Refining
Elevation: unsurveyed
Date: 10/28/2004

Log of Test Borings

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR,ETC.)	%M	LL	PI	CLASS.
	0-2		O-*--O*-		**Silt**, sand, very fine to fine, cobbles, gravel,				
			O-*--O*-		brown, moist				
			O-*--O*-						
			O-*--O*-						
	2-10.0		****o****	2.5	**Sand**, silty, very fine, gravel to 2", brown				
			****o****						
			****o****						
			****o****						
			****o****						
			*********	5.0					
			*********						
			*********		sand, coarse, black				
			*********		Hydrocarbon odor				
			*********						
			*********	7.5	water bearing				
			*********						
			*********						
			*********						
			*********						
			*********	10.0					
					T.D. 10.0				
					Placed 2" PVC, 5' hand slotted screen				
					Backfilled with clean cuttings				
					bottom at 8.0				
				15.0					
				20.0					

SIZE & TYPE OF BORING: 4 1/4" ID HOLLOW STEMMED AUGER — LOGGED BY: KM

Sheet: 1 of 1
Bore Point: See plan
Water Elevation: 4.8' below ground surface
Boring No.: TP6-1004

Precision Engineering, Inc.
P.O. Box 422
Las Cruces, NM 88004
505-523-7674

File #: 03-122
Site: Bloomfield
Giant Refining
Elevation: unsurveyed
Date: 10/28/2004

Log of Test Borings

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR,ETC.)	%M	LL	PI	CLASS.
	0-1		O-*--O*-		**Silt**, sand, very fine to fine, cobbles, gravel,				
			O-*--O*-		brown, moist				
	1-10.0		****O****		**Sand**, silty, very fine, cobbly, brown				
			****O****						
			****O****	2.5					
			****O****						
			****O****						
			****O****						
			*********						
			*********	5.0					
			*********						
			*********						
			*********						
			*********						
			*********	7.5	sand, coarse, black				
			*********		Hydrocarbon odor				
			*********						
			*********						
			*********						
			*********	10.0					
					T.D. 10.0				
					Placed 2" PVC, 5' machine slotted screen				
					Backfilled with clean cuttings				
					#10 slot, bottom at ten feet				
				15.0					
				20.0					

SIZE & TYPE OF BORING: 4 1/4" ID HOLLOW STEMMED AUGER — LOGGED BY: KM

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Sheet: 1 of 1
Bore Point: See plan
Water Elevation: 5.7' below ground surface
Boring No.: TP7-1004

Precision Engineering, Inc.
P.O. Box 422
Las Cruces, NM 88004
505-523-7674

File #: 03-122
Site: Bloomfield
Giant Refining
Elevation: unsurveyed
Date: 10/28/2004

Log of Test Borings

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR,ETC.)	%M	LL	PI	CLASS.
	0-2		O-*--O*- O-*--O*- O-*--O*- O-*--O*-		**Silt**, sand, very fine to fine, cobbles, gravel, brown, moist				
	2-5.0		*-*--o-* *-*--o-* *-*--o-* *-*--o-* *-*--o-* *-*--o-*	2.5 5.0	**Sand**, silty, very fine, cobbly, brown				
	5-10.0		********* ********* ********* ********* ********* ********* ********* ********* ********* *********	7.5 10.0	**Sand**, fine to medium, dark brown, moist slight hydrocarbon odor, black				
				15.0 20.0	T.D. 10.0 Placed 2" PVC, 5' hand slotted screen Backfilled with clean cuttings				

SIZE & TYPE OF BORING: 4 1/4" ID HOLLOW STEMMED AUGER — LOGGED BY: KM

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Sheet: 1 of 1
Bore Point: See plan
Water Elevation: 4.6' below ground surf.
Boring No.: TP8-1004

Precision Engineering, Inc.
P.O. Box 422
Las Cruces, NM 88004
505-523-7674

File #: 03-122
Site: Bloomfield
Giant Refining
Elevation: unsurveyed
Date: 10/28/2004

Log of Test Borings

LAB #	DEPTH	BLOW COUNT	PLOT	SCALE	MATERIAL CHARACTERISTICS (MOISTURE, CONDITION, COLOR,ETC.)	%M	LL	PI	CLASS.
	0-1		O-*--O*- O-*--O*-		**Silt**, sand, very fine to fine, cobbles, gravel, brown, moist				
	1-3.5		****O**** ****O**** ****O**** ****O**** ****O****	2.5	**Sand**, silty, very fine, cobbly, brown				
	3.5-10.0		********* ********* ********* ********* ********* ********* ********* ********* ********* ********* ********* ********* *********	5.0 7.5 10.0	**Sand**, silty, fine to medium, cobbly, grey, Hydrocarbon odor, moist, black				
				15.0 20.0	T.D. 10.0 Placed 2" PVC, 5' machine, slotted screen Backfilled with clean cuttings, #10 slot				

SIZE & TYPE OF BORING: 4 1/4" ID HOLLOW STEMMED AUGER — LOGGED BY: KM

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