GW - 28

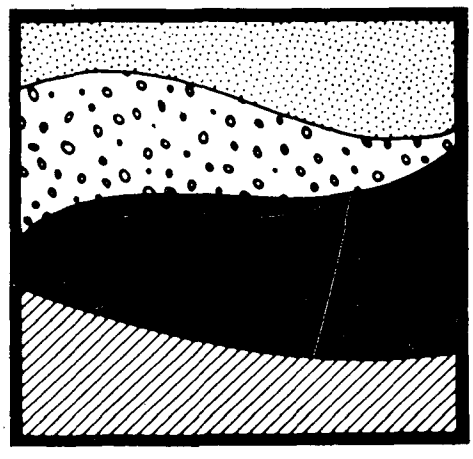
MONITORING REPORTS

DATE:

1987

2 of 2

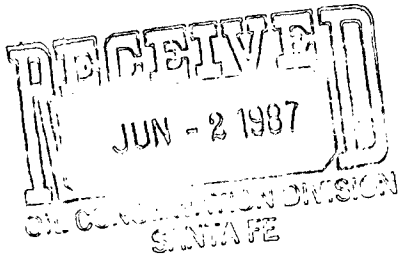
GCL



VOLUME II

APPENDICES AND PLATES FOR FINAL REPORT GROUND WATER INVESTIGATIONS OF POND #1 AND CONVEYANCE DITCH, NAVAJO REFINING COMPANY, ARTESIA, NEW MEXICO

May 12, 1987



Prepared for:

Navajo Refining Company
Mr. David Griffin
P.O. Drawer 159
Artesia, New Mexico 88210

Prepared by:

Geoscience Consultants, Ltd.
500 Copper Avenue NW
Suite 200
Albuquerque, New Mexico 87102

Bayer

Geoscience Consultants, Ltd.

500 Copper Avenue NW, Suite 200
Albuquerque, New Mexico 87102
(505) 842-0001 TELEX (505) 842-0595

1109 Spring Street, Suite 706
Silver Springs, Maryland 20910
(301) 587-2088

April 30, 1987

Mr. Zeke Sherman
Department of Environmental Affairs
Navajo Refining Company
P.O. Drawer 159
Artesia, New Mexico 88210

RE: WATER-LEVEL DATA FROM 4/24/87

Dear Zeke:

Enclosed is a copy of the field notes from John Appel's water-level survey last week. Please call if you have any questions.

Yours very truly,
GEOSCIENCE CONSULTANTS, LTD.

James C. Hunter
Senior Hydrogeologist
Project Director, Navajo Ground Water Quality Assessment

JCH/lp/NVJO/SHERM001.LTR

Enclosures

cc: David Griffin, Navajo

4/24/87:

Recovery of water level recorders and measurement of water levels.

(Legend for this date:

WP = Old well point

MW = Monitor well (pre 1987)

u-m = unable to measure

All depths to water are b.t.c.

Well	Depth to water (ft)	Time
WP-10	5.67	9:35 a.m.
WP-17	5.73	
WP-7	5.52	
WP-5	7.51	
MW-2	6.08	10:30 a.m.
N. Recorder Well	7.20	
MW-1	7.96	
WP-2	6.55	
WP-11	7.72	10:35 a.m.
MW-5	5.59	
S. Recorder Well	5.22	11:05 a.m.
MW-4	8.67	11:30 a.m.
WP-16	7.55	
MW-3	6.03	
MW-6	9.19	
WP-12	2.99 (= stickup; water standing on ground surface at well head	

Well	Depth to water	Time
WP-9? (11)? (=100 ft west of WP-12)	2.21	12:00 noon
P87-13	u-t-m	
P87-14	u-t-m	
P87-15	5.90	2:25 p.m.
MW-7	4.15	2:12 p.m.
P87-2	8.11	
P87-1	u-t-m	
P87-10	u-t-m*	
P87-11	u-t-m	
P87-12	u-t-m*	
P87-3	u-t-m*	4:10 p.m.

*Note: P87-3 - Settled about 4 inches during attempt to open.

*Note: P87-12 - Stickup is < 2 inches. Well casing settled about ½ inch further during attempt to open.

*Note: P87-10 - While attempting to remove cap, casing settled over 1 foot deeper into hole. Measured t.o.c. is no longer valid.

Well		Depth to water (ft)	Time
P87-4	E	UTM	
P87-19	E	7.02	
P87-16	E (N)	UTM	
P87-17	S (W)	8.02	6:05 p.m.
P87-18	W	Unable to locate	
P87-7	S	4.18	5:00 p.m.
P87-9E	W	UTM	5:30 p.m.
P87-9	W	4.10	
P87-2	N	~5.42*	6:50 p.m.
P87-5	E	~6.17*	6:40 p.m.
P87-6		UTM	

*P87-5: UTM inside casing. W.L. measured in open hole adjacent to casing. P87-2 Likewise.

MW-8 8.79 7:30 p.m.

MW-9 9.23

TDS
WP 87-13 = 36,266 mg/l
87-14 = 29,092
87-17 = 15,898
MW 7 = 8600
P87-15 = 31,824
87-16 17,032
HP-2 21,227
P-87-9E = 10,300
P87-7 = 41,030
P87-19 = 13,000
P87-2 = 20,122
MW 5 = 21,300
P87-9 = 11,900
P87-6 = 33,800
P87-4 = 32,500
P87-1 = 12578
MW 4 = 6100
MW 3 = 6322
HP-3 = 44622
P87-8 = 28500
P87-5 = 9290
P87-3 = 11560
P87-12 = 27716
P87-11 = 36176
P87-10 = 44622
MW 6 = 5400

Copy of GCL draft to be given to you next Tues.

TO David

DATE _____ TIME _____

WHILE YOU WERE OUT

MR. Leke Sherman

OF Navajo Refining Co/Artesia

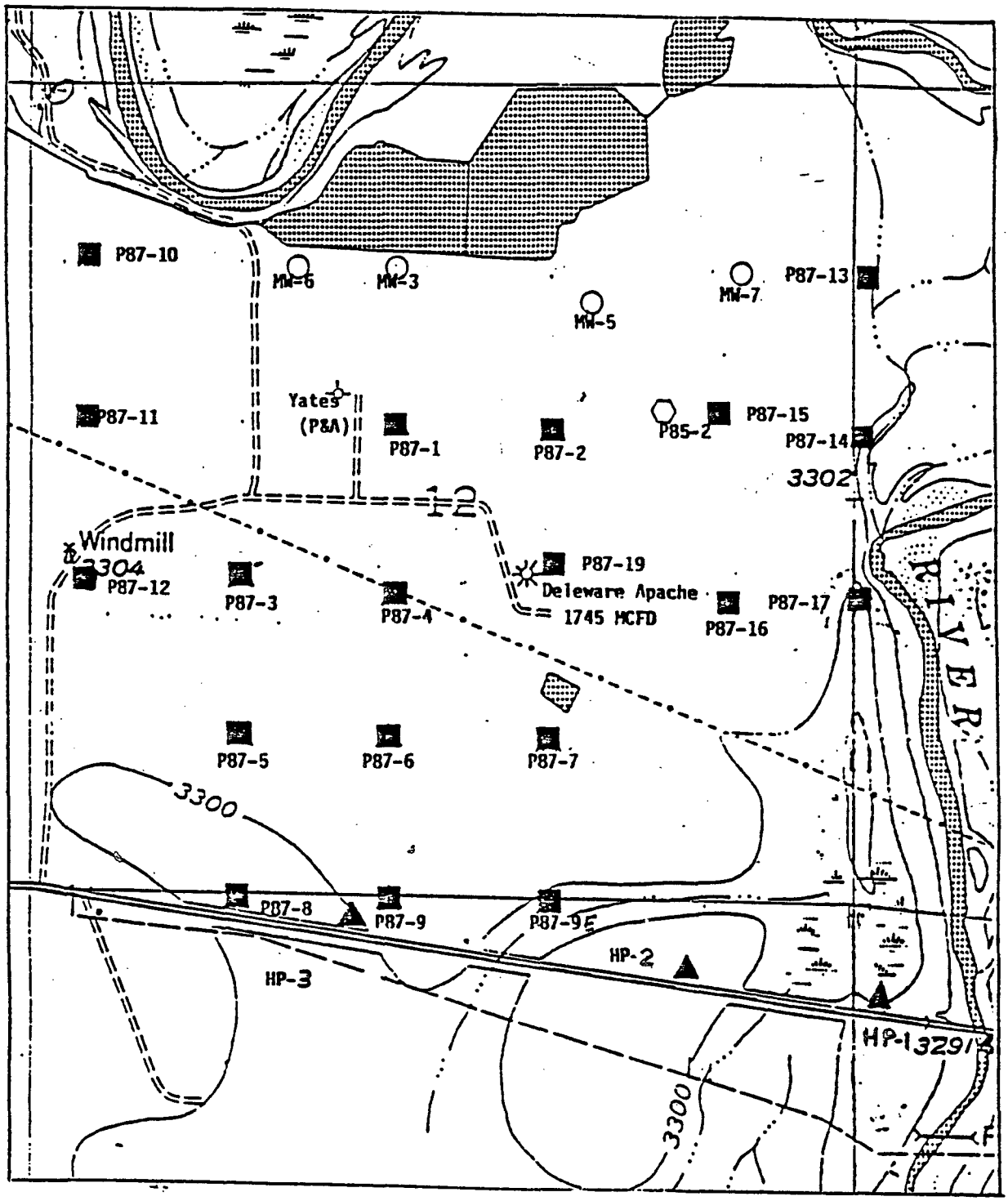
PHONE 748-3311 AREA CODE _____

TELEPHONED		PLEASE PHONE	
CALLED TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		RETURNED YOUR CALL	

MESSAGE RE: Visit of May 26.

Bring recpt.
Tour pipeline area
USGS well sampling
Ditch, Pit & Pond Closure

MESSAGE TAKEN BY _____



LOCATIONS OF WELL POINTS

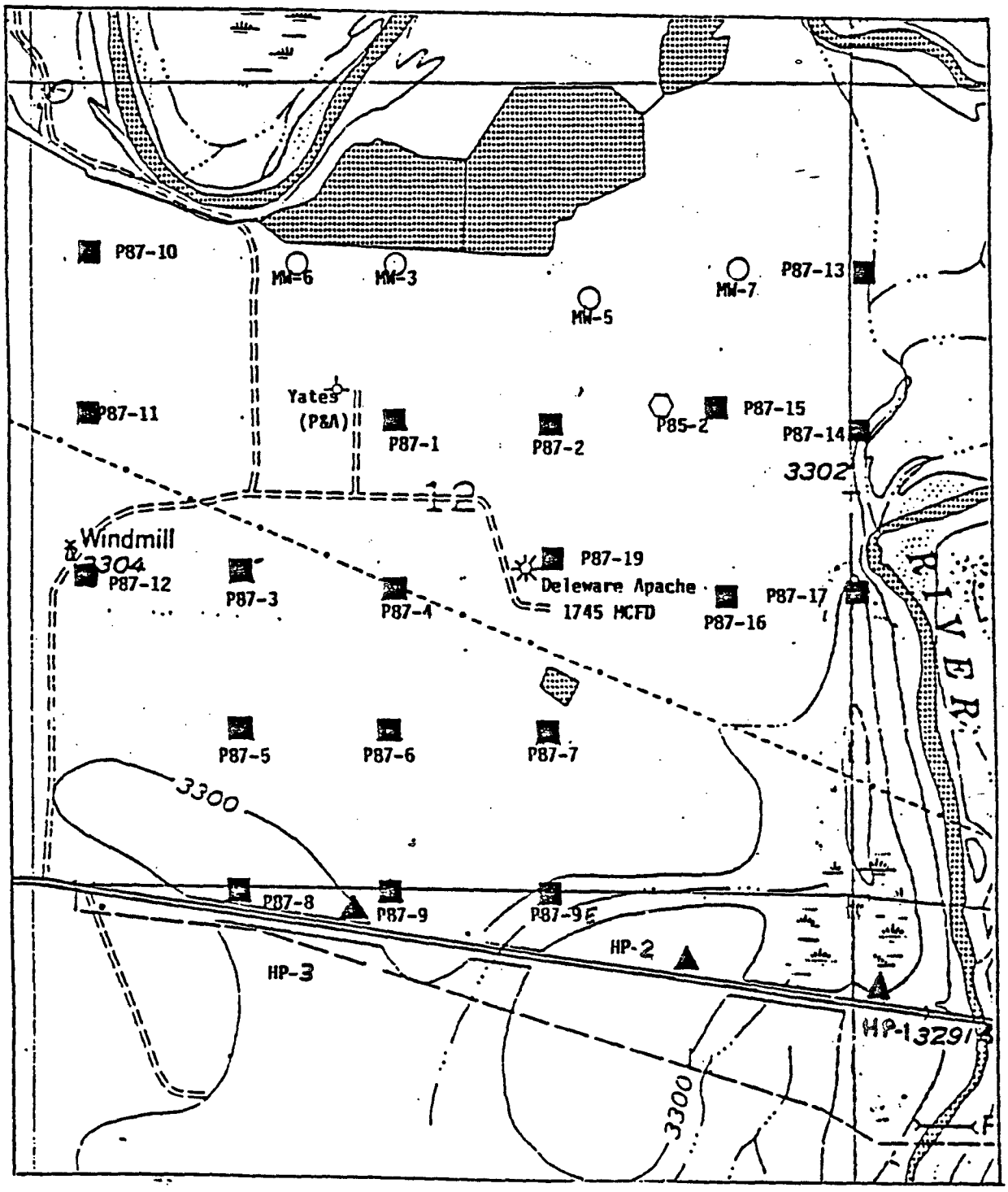
EVAPORATION POND AREA

○ MW-6 Monitor Well

■ P87-1 Point installed in this study (1987)

⬡ P85-2 Point installed in earlier study (1985)

▲ HP-2 Point installed by unknown agency



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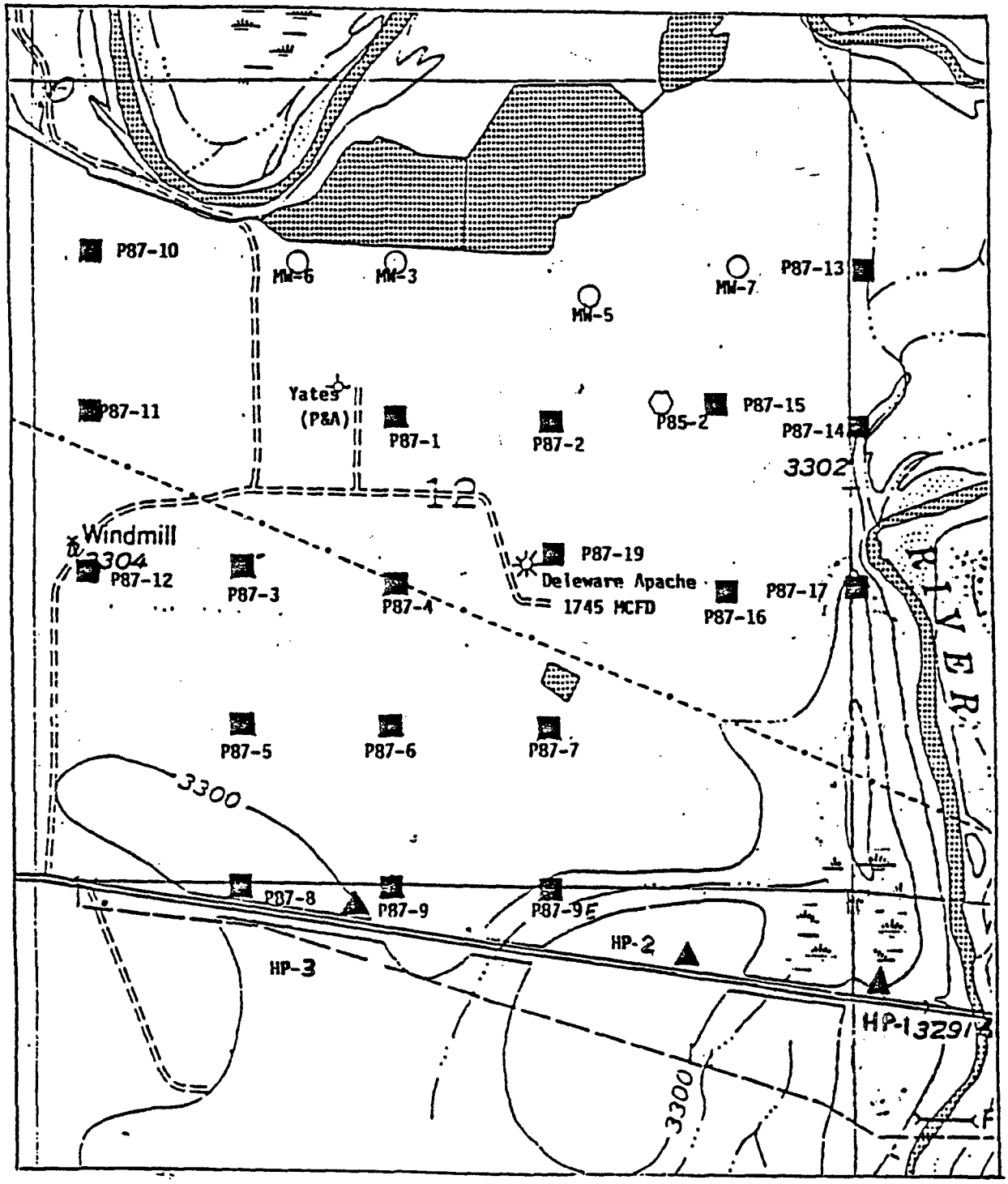

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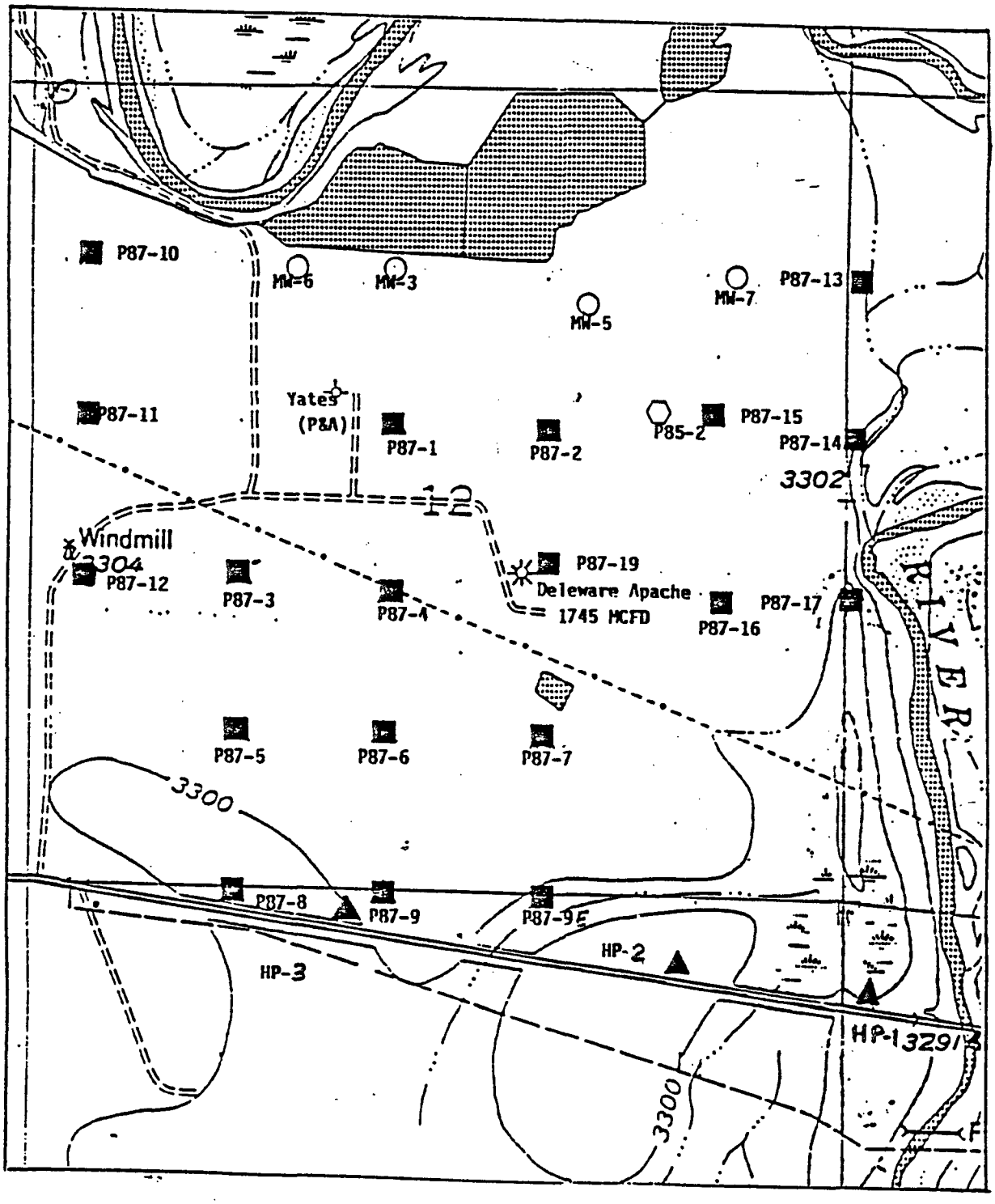

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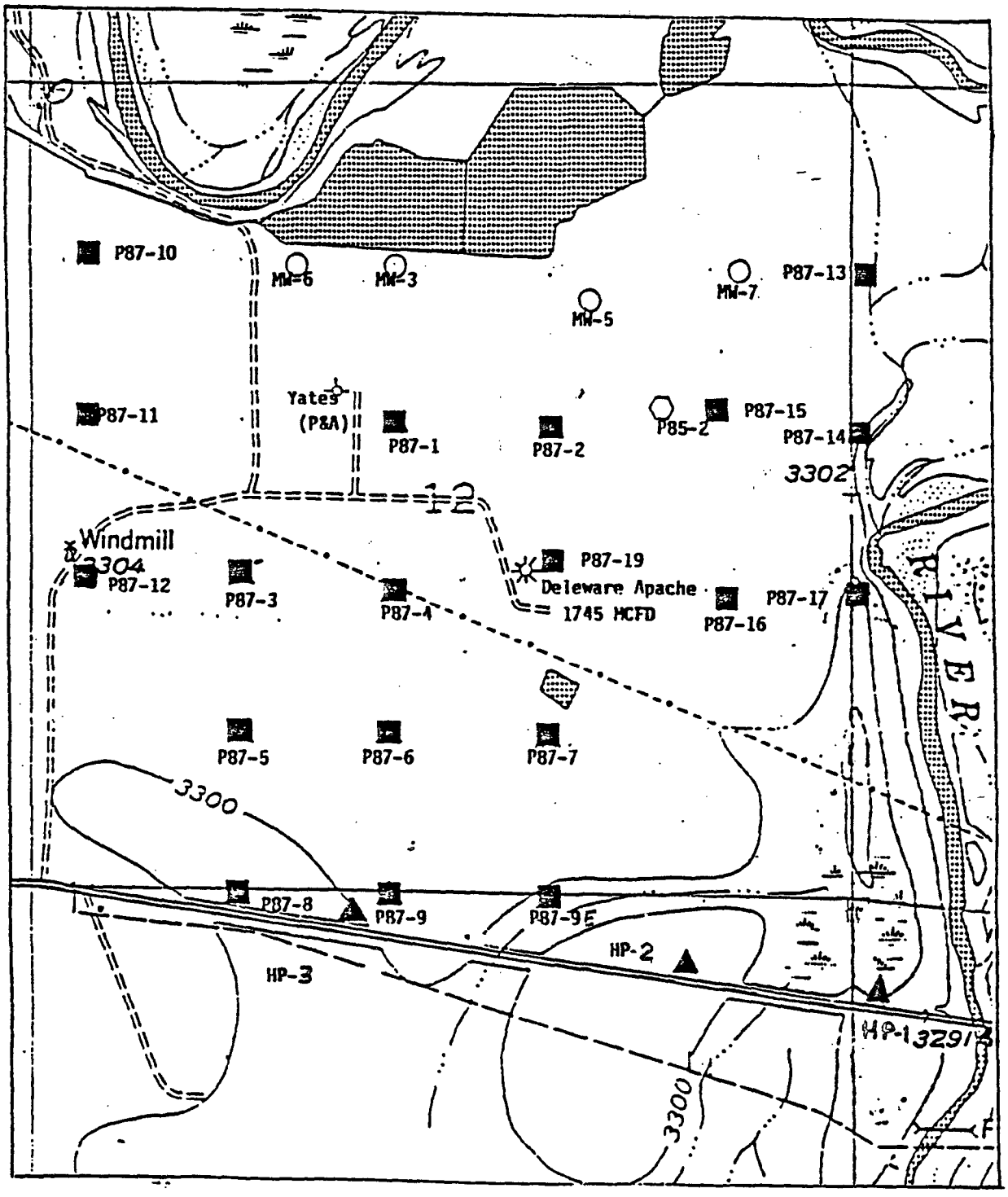

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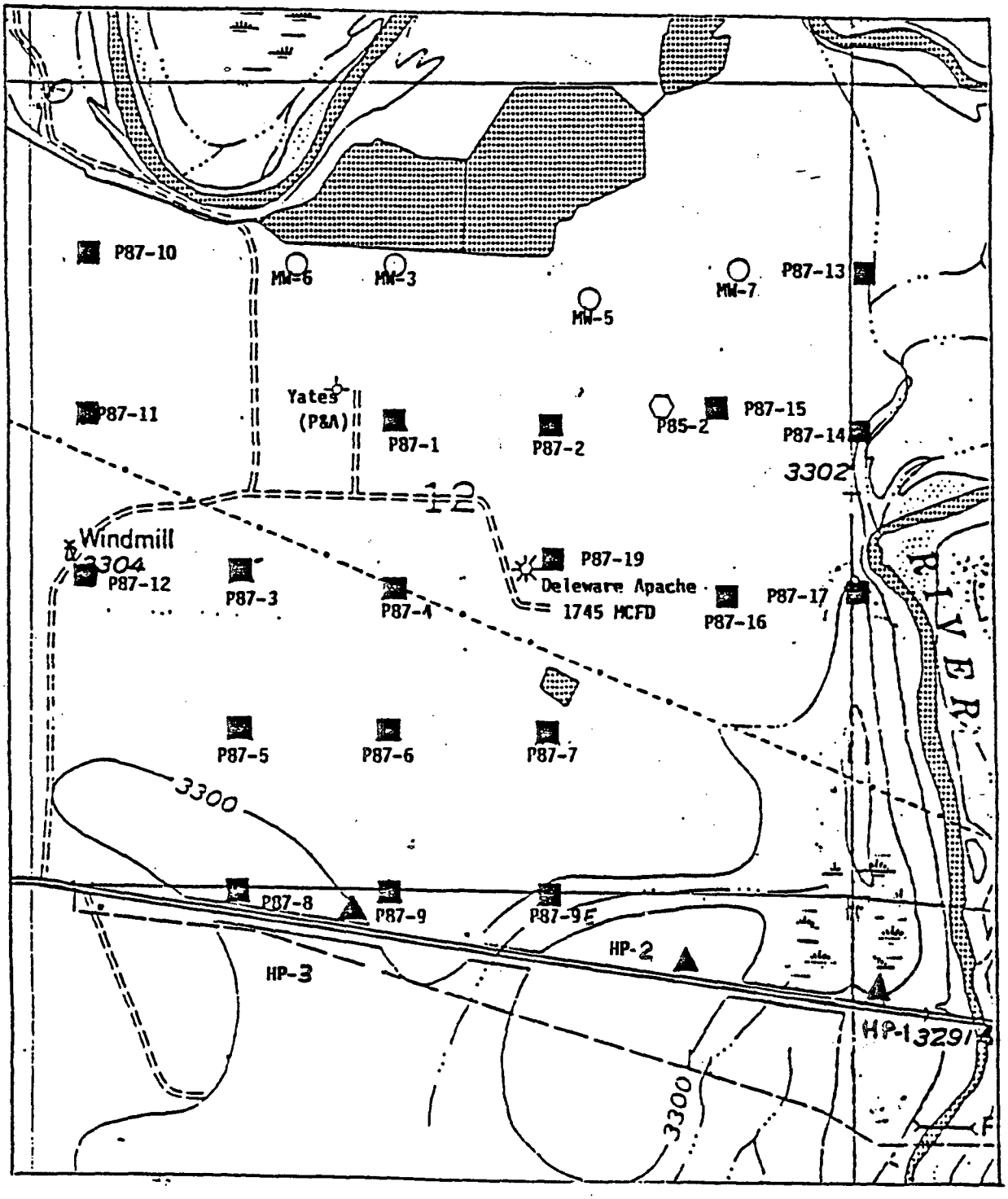

LOCATIONS OF WELL POINTS

EVAPORATION POND AREA

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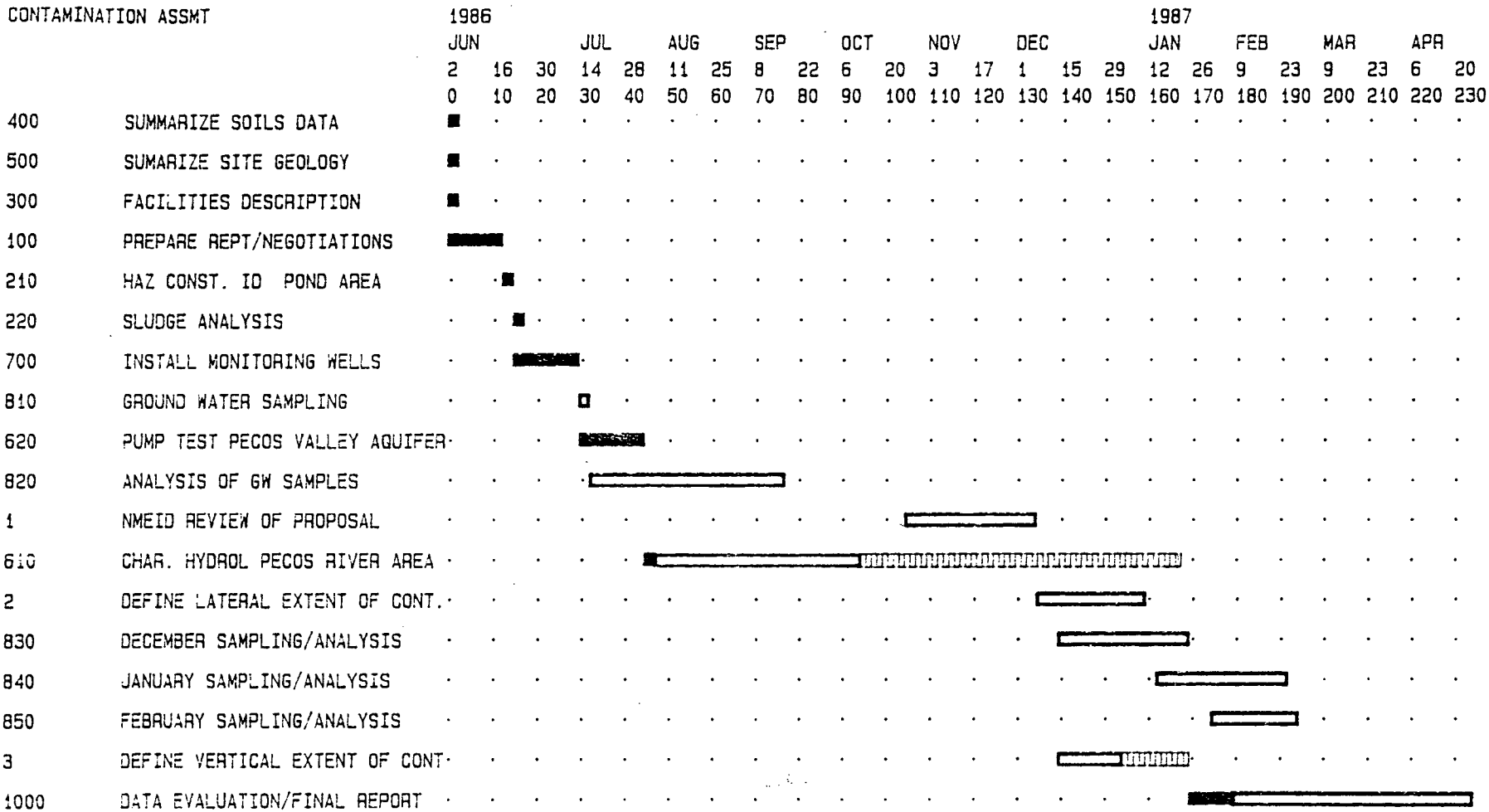
APPENDIX A

APPENDIX A

NMEID RECOMMENDED WORK ITEMS FOR NAVAJO REFINERY CONTINUING RELEASE STUDY

GANTT CHART REPORT - Current Date: 10-22-86
Summarize Level: 11 Wildcard WBS: ?????????? Resource Number: 0
CONTAMINATION ASSMT



NMEID RECOMMENDED WORK ITEMS FOR NAVAJO REFINERY CONTINUING RELEASE STUDY

[BRACKETED TEXT IS BASED UPON NOTES FROM NAVAJO/GCL/NMEID MEETING]

(1) The location, and amounts of all chemical and other wastes identified by EPA as hazardous constituents in 40 Code of Federal Regulations part 261 which have been stored, treated or disposed of or which may be located on the site [Pond #1 and conveyance ditch]

(2) A description of the facility in which such waste/constituents were or are being stored, treated or disposed of, together with engineering plans, specifications and drawings, if any, of the facility used for such storage, treatment or disposal. If such plans, specifications or drawings are unavailable, please submit any other information available regarding the existence and characteristics of liners, leachate collection systems, or other waste containment systems [Short narrative with any plans and specifications]

(3) The manner in which such waste/constituents were stored, treated or disposed of, including whether all or a part of such waste/ constituents were or are containerized or non-containerized and the depth of burial of any waste [Short narrative]

(4) A determination of soils depth, type, characteristics and areal distribution [Use existing SCS data, class I survey if available]

(5) Determination of horizontal and vertical permeabilities of soils at the site [Use existing SCS data]

(6) Definition of location, type, transmissivity, bedding, structure and other characteristics of bedrock and/or other confining strata [Based upon existing data]

(7) Determination of strike and dip of bedrock; and location and attitude of any faults [Available geologic maps]

(8) Determination of direction and velocity of ground water flow in all water-bearing zones in an area likely to be affected by migration of constituents from the site, considering soils and bedrock characteristics, and the location of aquifers most likely to be affected which are or may be a source of public or private water supply [Site study and pump test]

(9) Determination of areas of discharge and recharge for ground water in the area likely to be affected by migration of constituents from the site [Site study]

(10) Determination of interaction between ground water and Pecos River [Monitor water levels in wells and river]

(11) Establishment of a network of monitoring wells, including recommendations as to the location, depth, and construction thereof, designed to monitor ground water elevations and water quality [By June 30, 1985]

(12) A sampling and analysis program for monitoring ground water, both on-site and off-site, which describes frequency of sampling and sampling and analytical procedures

(13) A proposed schedule for the implementation of the items set forth above

(14) The means and frequency of reporting to NMEID the implementation of the items set forth above, and the results of the sampling, analysis and monitoring program as the same may be approved

(15) Proposed plan to define contaminant plume, if one exists

(16) Proposed corrective action, if necessary

APPENDIX B

APPENDIX B

SAMPLE DESCRIPTION INFORMATION

I. INTRODUCTION

On June 6, 1986, Rocky Mountain Analytical Laboratory received three sludge samples from Navajo Refinery. These samples were collected by GeoScience. The analyses performed on these samples were for the refinery Appendix VIII constituents (metals and organics), plus additional parameters.

The analytical parameters selected were based on recent communication with EPA concerning RCRA monitoring requirements for petroleum companies. The parameters selected were based on a subset of Appendix VIII hazardous constituents commonly referred to as the "Skinner" list. Communications from EPA in late 1984 contained various versions of this list. During this time RMAL, under contract to the American Petroleum Institute, performed several studies evaluating analytical methods proposed for measuring the constituents in these various lists. Due in part to efforts by RMAL and others, the EPA in early 1985 revised this list. The documents which were used by RMAL in defining the analytical parameters are listed in a bibliography at the end of this report. This list, as revised, consisted of 12 metals and 46 organic compounds and is presented in Table 1. The organic compounds are further subdivided into volatile and semivolatile (extractable) compounds.

All samples were shipped by air freight to RMAL's Denver, Colorado laboratory. Each sample was assigned a unique RMAL sample number as shown in the enclosed Sample Description Information sheet. These sample numbers were used throughout the project to track and control the analytical work and are used in this document for reporting the results from each analyses.

TABLE 1. APPENDIX VIII HAZARDOUS CONSTITUENT SUBSET FOR PETROLEUM REFINERY STUDIES*

Metals

Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Lead
Mercury
Nickel
Selenium
Silver
Vanadium

Volatile Organics

Benzene
Carbon Disulfide
Chlorobenzene
Chloroform
1,2-Dibromoethane
1,2-Dichloroethane
1,4-Dioxane
Methyl ethyl ketone
Styrene
Ethyl Benzene
Toluene
Xylenes
  Xylenes, m
  Xylenes, o & p

Base/Neutral Organics

Anthracene
Benz(a)anthracene
Benzo(b)fluoranthene

Base/Neutral Organics (Cont.)

Benzo(j)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Bis(2-ethylhexyl)phthalate
Butyl benzyl phthalate
Chrysene
Dibenz(a,h)acridine
Dibenz(a,h)anthracene
Di-n-butyl phthalate
Dichlorobenzenes
  o-Dichlorobenzene
  m-Dichlorobenzene
  p-Dichlorobenzene
Diethyl phthalate
7,12-Dimethylbenz(a)anthracene
Dimethyl phthalate
Di-n-octyl phthalate
Fluoranthene
Indene
Methyl chrysene
1-Methylnaphthalene
Naphthalene
Phenanthrene
Pyrene
Pyridine
Quinoline

Acid Organics

Benzenethiol
Cresols
  o-Cresol
  p&m-Cresol
2,4-Dimethylphenol
2,4-Dinitrophenol
4-Nitrophenol
Phenol

*"Petitions to Delist Hazardous Wastes, A Guidance Manual," EPA/530-SW-85-003, April, 1985.

Rocky Mountain Analytical Laboratc

SAMPLE DESCRIPTION INFORMATION

for

GeoScience Consultants

RMA Sample No.	Sample Description	Sample Type	Date Sampled	Date Received
61555-01	8606041350	Sludge	06/04/86	06/06/86
61555-02	8606041625	Sludge	06/04/86	06/06/86
61555-03	8606041715	Sludge	06/04/86	06/06/86

July 9, 1986

FOR APPENDIX B

GCL Note: Sample 8606041350 taken from the east pond area

Sample 8606041625 taken from the middle pond area

Sample 8606041715 taken from west pond area

Pages 4 and 8 of laboratory report to be submitted in final draft

II. RESULTS

The analytical results are presented in the data tables in this section. The data are organized into the tables described below:

- o Metals,
- o Volatile Organics,
- o Base/Neutral Organics, and
- o Acid Organics.

For the metals tables, the result and detection limit is presented for each sample. The term ND is used to indicate the parameter was not detected at the detection limit shown.

The term BDL (Below Detection Limit) is used in the organic results tables to indicate that the compound is not present at the detection limit shown. The detection limits for the Appendix VIII organic compounds were obtained from a study of the analytical methods performed by RMAL under contract to the American Petroleum Institute (API)[1]. Analytical standards are not available for three compounds. These compounds cannot be measured; they have been listed in the results tables and have been footnoted to show that standards were not available.

As explained in more detail in the analytical methodology section, the samples analyzed for volatile organics were screened prior to analysis in order to optimize the detection limit for each sample and minimize instrumental problems associated with analyzing samples containing relatively high concentrations. This process resulted in high dilutions for several samples containing high concentrations of the target compounds. For these samples, the detection limits for compounds not detected are proportionately high. Also, the compounds which were reported close to (less than two times) the detection limits may be suspect.

[1]"Recovery and Detection Limits of Organic Compounds in Petroleum Refinery Wastes", January 25, 1985.

ANALYTICAL RESULTS

for

GeoScience Consultants

METALS

Parameter	Units	61555-01		61555-02		61555-03	
Antimony	mg/kg	ND	(0.4)	ND	(0.4)	ND	(0.4)
Arsenic	mg/kg	14	(0.4)	15	(2.)	11	(2.)
Barium	mg/kg	96	(0.5)	92	(1)	75	(1)
Beryllium	mg/kg	0.6	(0.1)	0.4	(0.2)	0.4	(0.2)
Cadmium	mg/kg	ND	(0.5)	ND	(1)	ND	(1)
Chromium	mg/kg	250	(0.5)	410	(1)	820	(1)
Cobalt	mg/kg	3.8	(0.3)	3.6	(0.6)	4.0	(0.6)
Copper	mg/kg	310	(0.3)	360	(0.6)	89	(0.6)
Lead	mg/kg	38	(2)	61	(4)	31	(4)
Mercury	mg/kg	0.52	(0.05)	0.38	(0.05)	0.06	(0.05)
Nickel	mg/kg	9.4	(1)	11	(2)	7.5	(2)
Selenium	mg/kg	4	(1)	ND	(0.4)	ND	(2)
Silver	mg/kg	ND	(0.3)	ND	(0.6)	ND	(0.6)
Thallium	mg/kg	ND	(2)	ND	(0.8)	ND	(4)
Vanadium	mg/kg	18	(0.2)	15	(0.4)	12	(0.4)
Zinc	mg/kg	62	(0.4)	190	(0.8)	330	(0.8)

ND = Not detected. Detection limits in parentheses.

ANALYTICAL RESULTS

for

GeoScience Consultants

VOLATILE ORGANICS

Refinery Organics	Units	61555-01		61555-02		61555-03	
Benzene	ug/kg	BDL	(1500)	BDL	(2000)	2000	(2000)
Carbon disulfide	ug/kg	BDL	(1500)	BDL	(2000)	BDL	(2000)
Chlorobenzene	ug/kg	BDL	(1500)	BDL	(2000)	BDL	(2000)
Chloroform	ug/kg	BDL	(1500)	BDL	(2000)	BDL	(2000)
1,2-Dibromoethane	ug/kg	BDL	(6000)	BDL	(8000)	BDL	(8000)
1,2-Dichloroethane	ug/kg	BDL	(1500)	BDL	(2000)	BDL	(2000)
1,4-Dioxane	ug/kg	BDL	(30000)	BDL	(40000)	BDL	(40000)
Methyl ethyl ketone	ug/kg	BDL	(15000)	BDL	(20000)	BDL	(20000)
Styrene	ug/kg	BDL	(1500)	BDL	(2000)	BDL	(2000)
Ethyl Benzene	ug/kg	6700	(1500)	4500	(2000)	8700	(2000)
Toluene	ug/kg	3900	(1500)	5600	(2000)	12000	(2000)
Xylene, m	ug/kg	5100	(1500)	5400	(2000)	10000	(2000)
Xylenes,o & p	ug/kg	3700	(1500)	4500	(2000)	9100	(2000)
Additional Compounds							
Acetone	ug/kg	BDL	(15000)	BDL	(20000)	BDL	(20000)
Methylene chloride	ug/kg	BDL	(3000)	BDL	(4000)	BDL	(4000)
Tetrachloroethene	ug/kg	BDL	(1500)	BDL	(2000)	BDL	(2000)

BDL = Below detection limit. Detection limits in parentheses.

ANALYTICAL RESULTS

for

GeoScience Consultants

BASE/NEUTRAL ORGANICS

Refinery Organics	Units	61555-01		61555-02		61555-03	
Anthracene	ug/kg	5300	(3200)	BDL	(11000)	8500	(8000)
Benzo(a)anthracene	ug/kg	4600	(3200)	BDL	(11000)	13000	(8000)
Benzo(b)fluoranthene	ug/kg	BDL	(3200)	BDL	(11000)	9200	(8000)
Benzo(j)fluoranthene	ug/kg	-	-	-	-	-	-
Benzo(k)fluoranthene	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Benzo(a)pyrene	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Bis(2-ethylhexyl)phthalate	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Butylbenzyl phthalate	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Chrysene	ug/kg	8500	(3200)	27000	(11000)	30000	(8000)
Dibenz(a,h)acridine*	ug/kg	-	-	-	-	-	-
Dibenz(a,h)anthracene	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Di-n-butyl phthalate	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
o-Dichlorobenzene	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
m-Dichlorobenzene	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
p-Dichlorobenzene	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Diethyl phthalate	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
7,12-Dimethylbenz(a)anthrac	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Dimethyl phthalate	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Di-n-octyl phthalate	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Fluoranthene	ug/kg	7800	(3200)	24000	(11000)	16000	(8000)
Indene	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Methyl chrysene*	ug/kg	-	-	-	-	-	-
1-Methylnaphthalene	ug/kg	34000	(3200)	39000	(11000)	59000	(8000)
Naphthalene	ug/kg	4200	(3200)	BDL	(11000)	8100	(8000)
Phenanthrene	ug/kg	74000	(3200)	120000	(11000)	110000	(8000)
Pyrene	ug/kg	14000	(3200)	35000	(11000)	33000	(8000)
Pyridine**	ug/kg	ND	-	ND	-	ND	-
Quinoline	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Additional Compounds							
Acenaphthene	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Acenaphthylene	ug/kg	BDL	(3200)	BDL	(11000)	BDL	(8000)
Fluorene	ug/kg	17000	(3200)	27000	(11000)	21000	(8000)

BDL = Below detection limit. ND = Not detected. Detection limits in parentheses.
*No analytical standard available. **Not recovered using Method 8270.

ANALYTICAL RESULTS

for

GeoScience Consultants

ACID ORGANICS

Parameter	Units	61555-01		61555-02		61555-03	
Benzenethiol**	ug/kg	ND	-	ND	-	ND	-
o-Cresol	ug/kg	4900	(3200)	5500	(4000)	7700	(1600)
p & m-Cresol	ug/kg	BDL	(3200)	5800	(4000)	10000	(1600)
2,4-Dimethylphenol	ug/kg	BDL	(3200)	BDL	(4000)	4100	(1600)
2,4-Dinitrophenol	ug/kg	BDL	(16000)	BDL	(20000)	BDL	(8000)
4-Nitrophenol	ug/kg	BDL	(16000)	BDL	(20000)	BDL	(8000)
Phenol	ug/kg	4400	(3200)	5200	(4000)	12000	(1600)

BDL = Below detection limit. Detection limits in parentheses.
**Not recovered using Method 8270.

QUALITY ASSURANCE DATA FOR SURROGATE RECOVERIES

GeoScience Consultants

Parameters	% Recovery 61555-01	61555-02	61555-03
Volatiles-QC Limit[a]			
1,2-Dichloroethane-D_4	106	100	99
Toluene	101	103	102
Bromofluorobenzene(BFB)	128	99	101
Base/Neutral Compounds-QC Limits: 50-120%[b]			
Nitrobenzene-D_5	90	84	96
2-Fluorobiphenyl	90	88	94
Terphenyl-D_{14}	95	92	99
Pyrene-D_{10}	80	31*	18*
Acids-QC limits: 40-115%[b]			
Phenol-D_5	59	44	56
2-Fluorophenol	70	53	62
2,4,6-Tribromophenol	100	83	86

Notes

*Value outside recovery limit in Refinery Handbook.
a = QC limits not established; EPA Las Vegas limits for these surrogates in soil samples range from 70-121%.
b = EPA Las Vegas limits for these surrogates in soil samples range from 18-137%.

III. ANALYTICAL METHODOLOGY

The methods for the metals and organic compounds were derived from three sources of EPA methods, 1) the methods promulgated in 40 CFR 136 for priority pollutants, 2) the methods published in SW-846 and 3) methods developed by the EPA-EMSL/LV for Superfund investigations, as well as several documents published by the EPA and RMAL in 1984 and 1985. These methods all use the same generic technology as summarized below:

- o Metals, acid digestion followed by analysis by ICP supported by graphite furnace AA,
- o Volatile Organics, purge and trap GC/MS, and
- o Semivolatile (base/neutral and acid) organics, solvent extraction followed by capillary column GC/MS.

The EPA (40 CFR 136, SW-846 and Superfund) methods were, to a large degree, developed and validated to determine the priority pollutants in a broad spectrum of environmental samples. Between October 1983 and July 1985 the EPA released three methods manuals and a "Guidance Manual" which were compendiums of modified SW-846 methods specifically adapted for the analysis of Appendix VIII constituents in petroleum refining wastes (not water samples). The most useful of these documents was an October, 1984 draft methods manual which unfortunately was never formally distributed by EPA, apparently in order to avoid a conflict with a proposed rule in the October 1, 1984 Federal Register. However, even this document (as discussed by an RMAL review for API in December, 1984) lacked many important details that are critical to the successful analysis of environmental samples impacted by petroleum refineries.

Thus, although the methods used by RMAL were based on these various EPA documents, the actual details of each method were implemented by RMAL as explained in more detail below. The various documents which were used to establish RMAL's approach are listed in a bibliography. The discussion below references method numbers in SW-846. However, it should be noted that several different versions of these methods are cited in the various EPA documents. In addition to the documents listed in the bibliography, RMAL has continued a dialogue through phone conversations and meetings with EPA/OSW to ensure that this approach is in line with the Agency's expectations. Much of RMAL's approach is being incorporated in pending Agency promulgations.

Total Metals

Metals were determined using inductively coupled plasma-atomic emission spectroscopy (ICP) for barium, beryllium, cadmium, chromium, cobalt, lead, nickel, silver, vanadium and zinc (Method 6010). Graphite furnace atomic absorption (AA) spectroscopy was used for the determinations of antimony (Method 7041), arsenic (Method 7060), selenium (Method 7740) and thallium (Method 7841). Cold vapor atomic absorption spectroscopy was used to determine mercury (Method 7470). Prior to analysis, the samples were prepared using Method 3050.

The ICP was preprogrammed to perform off peak background correction on both the high and low wavelength sides of the analytical peaks of interest as appropriate. One hundred interelemental corrections were also automatically applied to the analysis. A matrix spike is analyzed as a quality control check for the ICP analyses. Every sample analyzed by graphite furnace AA was spiked with the metal of interest and reanalyzed to check for possible interferences.

Volatile Organics

Volatile organic compounds were determined by purge and trap gas chromatography/mass spectrometry (GC/MS) using Method 8240 with the appropriate sample introduction procedure. The appropriate procedure was determined using a screening procedure consisting of a liquid-liquid extraction with hexadecane followed by direct injection of an aliquot of the extract into a gas chromatograph with flame ionization detection (GC/FID). All volatile samples were screened in this way before GC/MS analysis. The GC/FID screening results were evaluated to determine the amount of sample to use that provides the lowest detection limits possible without overloading the GC/MS system. Samples containing low levels of organics were analyzed using a modification developed by EPA Region X and EMSL/Cincinnati for soil and sediment samples containing low levels of volatile organics. The procedure is quite similar to Method 624 except that a water slurry of the solid material is purged. This procedure is used by the EPA in their contract lab program for Superfund analyses. Samples containing higher levels of organic species were analyzed using the sample introduction technique described in Method 8240. This procedure was used as written except that tetraglyme (tetraethylene glycol dimethyl ether) was used instead of polyethylene glycol as the extracting agent before the purge and trap procedure, as recommended in the July, 1985 Refinery Guidance Manual.

Semivolatile Organics

Semivolatile organics were determined by capillary column GC/MS using SW-846 Method 8270. Soil samples were extracted using SW-846 Sonication Method 3550. After extraction, the samples were subjected to Method 3530 to separate the extract into acidic and basic fractions. The basic fraction was then cleaned up using Method 3570 to generate aliphatic and aromatic fractions. GC/MS analyses were then performed on the acidic and aromatic fractions.

Identification and quantitation of the target compounds determined by GC/MS were performed according to the process described in Methods 8240 and 8270. In summary, this process has the following features:

- Multipoint calibration for each compound to establish instrument response using multiple internal standards,
- Identification of compounds using a computerized reverse search with selected key fragment ions, and
- Quantitation using the previously determined response factors.

QUALITY CONTROL

For refinery waste sample analyses quality control analyses consist of the following activities:

- o multipoint standard calibration,
- o analysis of blanks,
- o analysis of spiked and duplicate samples,
- o analysis of a standard reference materials,
- o daily calibration, including mass spectrometer tuning checks (BFB and DFTPP), where appropriate, and
- o addition of surrogate spikes into each sample for GC/MS analyses.

More specific information about these activities is presented in Table 2. The relevant quality control data generated on this project are presented in the enclosed QC tables.

TABLE 2. SUMMARY OF QC ACTIVITIES PERFORMED FOR REFINERY SAMPLES

for

GeoScience Consultants

Parameter Group	QC Activity	Frequency
Metals and Inorganic parameters	Duplicate Sample	5%
Metals and Inorganic parameters	Spike Sample	5%
Volatile Organics	Surrogate Spikes	Each sample
Volatile Organics	Blank Analysis	Daily
Base/Neutral Organics	Surrogate Spikes	Each sample
Base/Neutral Organics	Duplicate Analysis	10%
Base/Neutral Organics	Blank Analysis	10%
Acid Organics	Surrogate Spikes	Each sample
Acid Organics	Duplicate Analysis	10%
Acid Organics	Blank Analysis	10%
Volatile Aromatics	Duplicate Analyses	10%

V. BIBLIOGRAPHY

A. Documents Pertaining to Appendix VIII Constituents

1) January, 1984 letter form Myles Morse pertaining to delisting petitions as well as land treatment demonstrations, including sampling procedures and data requirements.

2) March, 1984 letter to delisting petitioners from Barbara Bush revising target parameters.

3) April, 1984 memo from John Skinner to Permit Branch Chiefs concerning land treatment containing target parameters and analytical methods.

4) May, 1984 memo from John Skinner clarifying previous memo.

5) September, 1984 letter to Petitioners from Barbara Bush distributing Refinery Handbook.

6) November, 1984 letter from Eileen Claussen to all delisting petitioners describing new RCRA requirements.

7) May 3, 1985 RMAL Memo.

8) January 8, 1985 RMAL letter to Eileen Claussen, EPA-OSW.

B. Documents Pertaining to Analytical Methods

1) "Handbook for the Analysis of Petroleum Refinery Residuals and Waste", October, 1984 - prepared by Radian Corporation for EPA/OSW.

2) "Evaluation of the Applicability of the SW-846 Manual To Support All RCRA Subtitle C Testing", December 20, 1984 - prepared by Rocky Mountain Analytical Laboratory for API.

3) "Comments on the 'Handbook for the Analysis of Petroleum Refinery Residuals and Waste, October, 1984'", December 12, 1984 - prepared by Rocky Mountain Analytical Laboratory for API.

4) "Comments on the 'Handbook for the Analysis of Petroleum Refinery Residuals and Waste, April 2, 1984", August 15, 1984 - prepared by Rocky Mountain Analytical Laboratory for API.

5) "Handbook for the Analysis of Petroleum Refinery Residuals and Waste", April 2, 1984 - prepared by S-Cubed for EPA/OSW.

6) EPA document "Guidance for the Analysis of Refinery Wastes", July 5, 1985.

7) "Recovery and Detection Limits of Organic Compounds in Petroleum Refinery Wastes", January 25, 1985.

8) SW-846 - "Test Methods for Evaluating Solid Waste, Physical Chemical Methods" USEPA, 2nd Edition, 1982.

9) 40CFR136 - "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act."

Report of Chemical Analysis

Consulting Geotechnical, Materials and Environmental Engineers
Geologists, Scientists and Chemists

Raba-Kistner
Consultants, Inc.
P.O. Box 690287, San Antonio, TX 78269-0287
12821 W. Golden Lane, San Antonio, TX 78249
(512) 699-9090

To: Geoscience Consultants, Ltd.
500 Copper Avenue N.W., Suite 325
Albuquerque, New Mexico 87102

Attn: Mr. Trent A. Thomas

Project No: 686-036
Date Received: 6/06/86
Date Reported: 7/18/86
Submitted By: Mr. Thomas, GCL

Sample Description/Code: 8606041715, Bottom Sludge, Pond No. 1, Navajo Refinery, R-KCI 6-10143-1

SUMMARY OF ANALYSIS

Determination	Analytical Method	Results	Miscellaneous
Volatile Organics	EPA 624[1]	See Attached	Aqueous Phase
Acid Extractables	EPA 625[1]	See Attached	Aqueous Phase
Solids Content	EPA 160.3[2]	86.8 % wt	
Arsenic	EPA 7060[3]	11.2 mg/kg	Total[4]
Barium	EPA 7080	52.0 mg/kg	Total
Beryllium	EPA 7090	0.46 mg/kg	Total
Cadmium	EPA 7130	0.46 mg/kg	Total
Chromium	EPA 7190	636 mg/kg	Total

Special Comments:

1. Federal Register, Vol. 49, October, 1984.
2. EPA 600/4-79-020, March, 1983.
3. EPA SW-846, April, 1984.
4. The metal contents are on dry weight basis of the sludge sample.

Raba-Kistner Consultants, Inc.
by Francis Y. Huang
Francis Y. Huang, Ph.D., CPC

Report of Chemical Analysis

Consulting Geotechnical, Materials and Environmental Engineers
Geologists, Scientists and Chemists

Raba-Kistner
Consultants, Inc.
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(512) 699-9090

To: Geoscience Consultants, Ltd.
500 Copper Avenue N.W., Suite 325
Albuquerque, New Mexico 87102

Attn: Mr. Trent A. Thomas

Project No: 686-036
Date Received: 6/06/86
Date Reported: 7/18/86
Submitted By: Mr. Thomas, GCL

Sample Description/Code: 8606041715, Bottom Sludge, Pond No. 1, Navajo Refinery, R-KCI 6-10143-1

SUMMARY OF ANALYSIS

Determination	Analytical Method	Results	Miscellaneous
Lead	EPA 7420	37.0 mg/kg	Total
Mercury	EPA 7471	0.06 mg/kg	Total
Silver	EPA 7760	0.70 mg/kg	Total
Zinc	EPA 7950	22.9 mg/kg	Total

Special Comments:

Raba-Kistner Consultants, Inc.
by Francis Y. Huang
Francis Y. Huang, Ph.D., CPC

Project No. 686-036
R-KCI Lab No. 6-10143-1

(PURGEABLES)
(EPA Method 624)

Compound	Concentration (ug/L)	Method Detection Limits (ug/L)
Chloromethane	N.D.	5.0
Bromomethane	N.D.	5.0
Vinyl Chloride	N.D.	10.0
Chloroethane	N.D.	5.0
Methylene Chloride	N.D.	2.8
Trichlorofluoromethane	N.D.	5.0
1,1-Dichloroethene	N.D	2.8
1,1-Dichloroethane	N.D.	4.7
Trans-1,2-Dichloroethene	N.D.	1.6
Chloroform	N.D.	1.6
1,2-Dichloroethane	N.D.	2.8
1,1,1-Trichloroethane	N.D.	3.8
Carbon Tetrachloride	N.D.	2.8
Bromodichloromethane	N.D.	2.2
1,2-Dichloropropane	N.D.	6.0
Trans-1,3-Dichloropropene	N.D.	5.0
Trichloroethene	N.D	1.9
Dibromochloromethane	N.D.	3.1
1,1,2-Trichloroethane	N.D	5.0
cis-1,3-Dichloropropene	N.D.	5.0
Benzene	11.8	4.4
2-Chloroethylvinyl Ether	N.D.	5.0
Bromoform	N.D.	4.7
1,1,2,2-Tetrachloroethane	N.D.	6.9
Tetrachloroethene	N.D	4.1
Toluene	72.4	6.0
Chlorobenzene	N.D.	6.0
Ethylbenzene	N.D.	7.2
Xylenes	N.D.	5.0

N.D. = Not Detected

Note: Aliphate hydrocarbons were found in the sample.

Raba-Kistner Consultants, Inc.
by Francis Y. Huang
Francis Y. Huang, Ph.D., CPC

Project No. 686-036
R-KCI Lab No. 6-10143-1

ACID EXTRACTABLES
(EPA METHOD 625)

Compound	Concentration (ug/L)	Method Detection Limits (ug/L)
4-Chloro-3-Methylphenol.....	N.D.	3.0
2-Chlorophenol.....	N.D.	3.3
2,4-Dichlorophenol.....	N.D.	2.7
2,4-Dimethylphenol.....	N.D.	2.7
2,4-Dinitrophenol.....	N.D.	20.0
2-Methyl-4,6-Dinitrophenol.....	N.D.	10.0
2-Nitrophenol.....	N.D.	3.6
4-Nitrophenol.....	N.D.	2.4
Pentachlorophenol.....	N.D.	3.6
Phenol.....	N.D.	1.5
2,4,6-Trichlorophenol.....	N.D.	2.7

N.D. = Not Detected

Rabe-Kistner Consultants, Inc.
by Francis Y. Huang
Francis Y. Huang, Ph.D., CPC

RADIAN CORPORATION

Page 3 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121400 FRACTION 01A TEST CODE EPA602 NAME EPA method 602
Point 87-12 Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST CL
INSTRMT D INJECTED 03/18/87 FILE # UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	ND	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	96% recovery

CODES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703121400 FRACTION Q1A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/12/87 Category

otherwise noted.

RADIAN CORPORATION

Page 5 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121400 FRACTION 01A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/18/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	ND@	0.1

SURROGATES

98-08-8 a,a,a-Trifluorotoluene 96% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
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N\A = not available

RADIAN CORPORATION

Page 6 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121425 FRACTION 02A TEST CODE EPA602 NAME EPA method 602
87-13 Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST CL
INSTRMT D INJECTED 03/18/87 FILE # UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	ND	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	104% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703121425 FRACTION 02A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/12/87 Category

otherwise noted.

RADIAN CORPORATION

Page 8 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121425 FRACTION 02A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/18/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	1.6	0.2
95-47-6	o-Xylene	ND	0.2

SURROGATES

98-08-8 a,a,a-Trifluorotoluene 104% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
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N\A = not available

RADIAN CORPORATION

Page 9 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121445 FRACTION 03A TEST CODE EPA602 NAME EPA method 602
87-14 Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE # UNITS ug/L
TRTMT D INJECTED 03/18/87

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	2.2	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	114% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703121445 FRACTION 03A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/12/87 Category

otherwise noted.

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703121445 FRACTION 03A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #
INSTRMT D INJECTD 03/18/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	0.3*	0.1
108-38-3	m-Xylene	1.4	0.2
95-47-6	o-Xylene	1.6	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	114% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
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N\A = not available

RADIAN CORPORATION

Page 12 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121500 FRACTION 04A TEST CODE EPA602 NAME EPA method 602
87-17 Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #
INSTRMT D INJECTED 03/18/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	ND	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	110% recovery

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DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703121500 FRACTION 04A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/12/87 Category

otherwise noted.

RADIAN CORPORATION

Page 14 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121500 FRACTION 04A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #
INSTRMT D INJECTD 03/18/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	ND	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	110% recovery

CODES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

Page 15 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121530 FRACTION 05A TEST CODE EPA602 NAME EPA method 602
87-15 Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #
INSTRMT D INJECTED 03/18/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	ND	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	116% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703121530 FRACTION 05A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/12/87 Category

otherwise noted.

RADIAN CORPORATION

Page 17 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121530 FRACTION 05A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #
INSTRMT D INJECTD 03/18/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	1.5	0.1
108-38-3	m-Xylene	210	0.2
95-47-6	o-Xylene	ND	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	116% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

Page 18 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121515 FRACTION 06A TEST CODE EPA602 NAME EPA method 602
87-16 Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE # UNITS ug/L
INSTRMT D INJECTED 03/18/87

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	ND	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	109% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703121515 FRACTION 06A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/12/87 Category

otherwise noted.

RADIAN CORPORATION

Page 20 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121515 FRACTION 06A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #
INSTRMT D INJECTD 03/18/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	2.7	0.2
95-47-6	o-Xylene	ND	0.1

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	109% recovery

CODES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

Page 21 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703121610 FRACTION 07A TEST CODE EPA602 NAME EPA method 602
87-19 Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE # UNITS ug/L
INSTRMT D INJECTED 03/18/87

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	1.8	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	109% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703121610 FRACTION 07A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/12/87 Category

otherwise noted.

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703121610 FRACTION 07A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #
DILSTRMT D INJECTD 03/18/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	5.1	0.1
108-38-3	m-Xylene	330	0.2
95-47-6	o-Xylene	7.4	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	109% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703121635 FRACTION 08A TEST CODE EPA602 NAME EPA method 602
87-1 Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #
DILUTION D INJECTED 03/18/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	ND	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	106% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample Continued From Above

SAMPLE ID 8703121635 FRACTION 08A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/12/87 Category

otherwise noted.

RADIAN CORPORATION

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SAMPLE ID 8703121635 FRACTION 08A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #
DILSTRMT D INJECTD 03/18/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	ND	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	106% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703121655 FRACTION 09A TEST CODE EPA602 NAME EPA method 602

87-2 Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #

INSTRMT D INJECTED 03/18/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	2.0	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	122**% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.

DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703121655 FRACTION 09A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/12/87 Category

otherwise noted.

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SAMPLE ID 8703121655 FRACTION 09A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST AD FILE #
METRMT D INJECTD 03/18/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	3.1	0.1
108-38-3	m-Xylene	450	0.2
95-47-6	o-Xylene	ND	0.2

SURROGATES

98-08-8 a,a,a-Trifluorotoluene 122**% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

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SAMPLE ID 8703121720 FRACTION 10A TEST CODE EPA602 NAME EPA method 602
87-10 Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST CL FILE # UNITS ug/L
INSTRMT D INJECTED 03/19/87

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	1.1	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	104% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703121720 FRACTION 10A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/12/87 Category

otherwise noted.

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SAMPLE ID 8703121720 FRACTION 10A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/12/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/19/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	0.3*	0.1
108-38-3	m-Xylene	1.3	0.2
95-47-6	o-Xylene	1.6,Q	0.2

SURROGATES

98-08-8 a,a,a-Trifluorotoluene 104% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

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SAMPLE ID 8703130755 FRACTION 11A TEST CODE EPA602 NAME EPA method 602
87-11 Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTED 03/19/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	2.5	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	105% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703130755 FRACTION 11A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130755 FRACTION 11A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/19/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	0.2*	0.1
108-38-3	m-Xylene	0.4*	0.2
95-47-6	o-Xylene	1.5,Q	0.2

SURROGATES

98-08-8 a,a,a-Trifluorotoluene 105% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130815 FRACTION 12A TEST CODE EPA602 NAME EPA method 602
87-3 Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTED 03/19/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	1.0*	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	99% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703130815 FRACTION 12A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

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SAMPLE ID 8703130815 FRACTION 12A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/19/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	0.4*,Q	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	99% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130840 FRACTION 13A TEST CODE EPA602 NAME EPA method 602
87-5 Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTED 03/19/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	ND	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	105% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703130840 FRACTION 13A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130840 FRACTION 13A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/19/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	ND,Q	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	105% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130900 FRACTION 14A TEST CODE EPA602 NAME EPA method 602

87-8 Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #

INSTRMT D INJECTED 03/19/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	1.1	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	94% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.

DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703130900 FRACTION 14A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130900 FRACTION 14A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/19/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	0.3*	0.1
108-38-3	m-Xylene	0.9*	0.2
95-47-6	o-Xylene	0.5*,Q	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	94% recovery

CODES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

 RAS - Austin REPORT Work Order # 87-03-088

Received: 03/18/87 Results by Sample

SAMPLE ID 8703130915 FRACTION 15A TEST CODE EPA602 NAME EPA method 602

87-9 Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST AD FILE #

INSTRMT D INJECTED 03/19/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	7.3	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	124**% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.

DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703130915 FRACTION 15A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130915 FRACTION 15A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST AD FILE #
INSTRMT D INJECTD 03/19/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	ND,Q	0.2

SURROGATES

98-08-8 a,a,a-Trifluorotoluene 124**% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130930 FRACTION 16A TEST CODE EPA602 NAME EPA method 602
87-9E Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST AD FILE #
INSTRMT D INJECTED 03/19/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	0.9*	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	117% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703130930 FRACTION 16A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130930 FRACTION 16A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST AD FILE #
INSTRMT D INJECTD 03/19/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	ND, Q	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	117% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130950 FRACTION 17A TEST CODE EPA602 NAME EPA method 602
87-7 Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST DMV FILE #
INSTRMT D INJECTED 03/20/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	3.8	0.2
100-41-4	Ethylbenzene	0.5*	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	97% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703130950 FRACTION 17A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703130950 FRACTION 17A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST DMV FILE #
INSTRMT D INJECTD 03/20/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	0.6*	0.1
108-38-3	m-Xylene	1.4	0.2
95-47-6	o-Xylene	1.3,Q	0.2

SURROGATES

98-08-8 a,a,a-Trifluorotoluene 97% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703131005 FRACTION 18A TEST CODE EPA602 NAME EPA method 602

87-6

Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL
INSTRMT D INJECTED 03/20/87 FILE # UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	0.6*	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	96% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703131005 FRACTION 18A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

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Received: 03/18/87 Results by Sample

SAMPLE ID 8703131005 FRACTION 18A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/20/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	ND,Q	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	96% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

Page 57 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703131020 FRACTION 19A TEST CODE EPA602 NAME EPA method 602
87-4 Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST FILE #
INSTRMT INJECTED UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	9.7	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	95% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703131020 FRACTION 19A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

Page 59 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703131020 FRACTION 19A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/20/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	ND,Q	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	95% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

Page 60 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703131200 FRACTION 20A TEST CODE EPA602 NAME EPA method 602
HP-3 Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTED 03/20/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	0.8*	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	90% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703131200 FRACTION 20A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

Page 62 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703131200 FRACTION 20A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/20/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	ND, Q	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	90% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

Page 63 RAS - Austin REPORT Work Order # 87-03-088
Received: 03/18/87 Results by Sample

SAMPLE ID 8703131220 FRACTION 21A TEST CODE EPA602 NAME EPA method 602
HP-2 Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTED 03/20/87 UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	ND	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	90% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID 8703131220 FRACTION 21A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected 03/13/87 Category

otherwise noted.

RADIAN CORPORATION

Received: 03/18/87
Results by Sample

SAMPLE ID 8703131220 FRACTION 21A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected 03/13/87 Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/20/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	0.2*	0.2
95-47-6	o-Xylene	ND,Q	0.2
	SURROGATES		
98-08-8	a,a,a-Trifluorotoluene	90% recovery	

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

RADIAN CORPORATION

RAS - Austin REPORT Work Order # 87-03-088

Received: 03/18/87

Results by Sample

SAMPLE ID reagent blank FRACTION 22A TEST CODE EPA602 NAME EPA method 602

Date & Time Collected not specified Category

VERIFIED CL

ANALYST CL
INSTRMT D

FILE #

INJECTED 03/18/87

UNITS ug/L

CAS#	COMPOUND	RESULT	DET LIMIT
71-43-2	Benzene	ND	0.2
108-88-3	Toluene	ND	0.2
100-41-4	Ethylbenzene	ND	0.3
108-90-7	Chlorobenzene-A	ND	0.3
106-46-7	1,4-Dichlorobenzene	ND	0.3
541-73-1	1,3-Dichlorobenzene	ND	0.4
95-50-1	1,2-Dichlorobenzene	ND	0.4

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	N/A% recovery

NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available
A-Chlorobenzene and m-xylene co-elute.
Quantitated as chlorobenzene unless

SAMPLE ID reagent blank FRACTION 22A TEST CODE EPA602 NAME EPA method 602
Date & Time Collected not specified Category

otherwise noted.

SAMPLE ID reagent blank FRACTION 22A TEST CODE XYLENE NAME Xylenes, EPA 602
Date & Time Collected not specified Category

VERIFIED CL

ANALYST CL FILE #
INSTRMT D INJECTD 03/18/87 UNITS ug/L

CAS #	COMPOUND	RESULT	DET LIMIT
106-42-3	p-Xylene	ND	0.1
108-38-3	m-Xylene	ND	0.2
95-47-6	o-Xylene	ND	0.2

SURROGATES

98-08-8	a,a,a-Trifluorotoluene	N/A% recovery

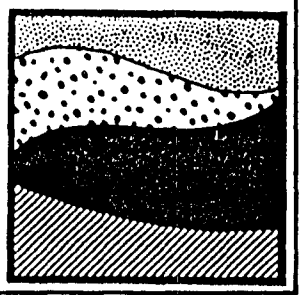
NOTES AND DEFINITIONS FOR THIS REPORT.
DET LIMIT = DETECTION LIMIT
ND = not detected at detection limit
NA = not analyzed
* = less than 5 times the detection limit
N\A = not available

APPENDIX C

APPENDIX C

MW SERIES WELL LITHOLOGIC LOGS AND COMPLETION DIAGRAMS

GCL



WELL LOGGING FORM

Client NAVAJO REFINERY Well Number MW-1

__1/4__1/4__1/4__1/4 S 12 T 17S R 26E State NEW MEXICO

County EDDY Contractor LARRY'S DRILLING

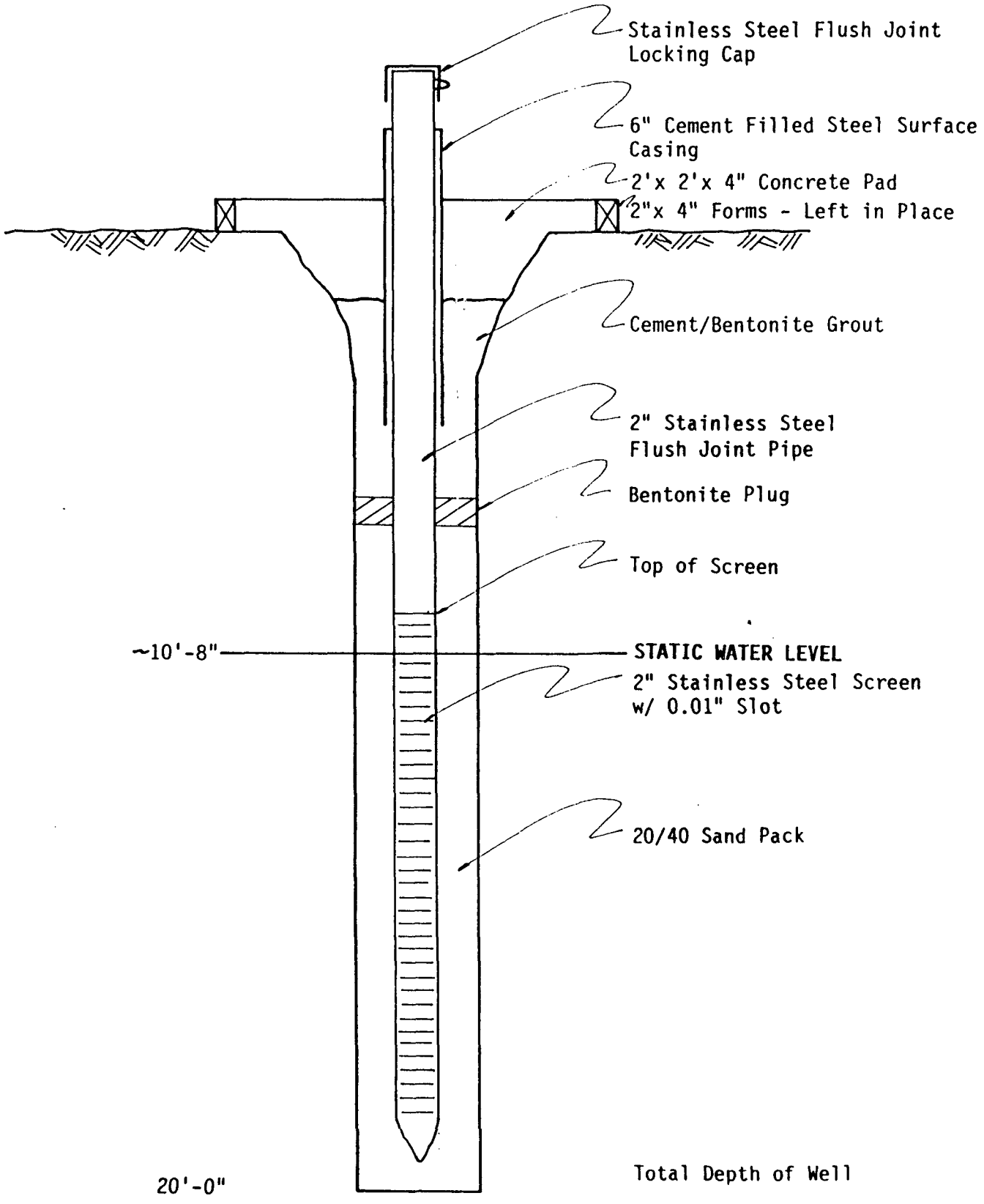
Spud Date 6-18-86 Completion Date 6-18-86

Logs Run LITHOLOGY Logged By SELKE

Elevation _____ Spud In (Fm.) _____

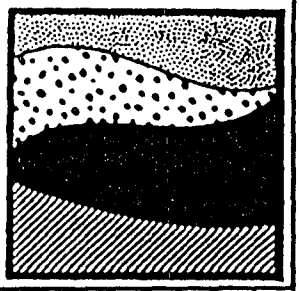
Remarks Steam cleaned rig and tools prior to drilling- drill w/ air rotary and temp. casing

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							0-20' v.fn.gr., brown silty clay v. tight formation- drilled borehole to 40'- 1hr. to recover
Sand							
5							
Silt							
10							
Clay							
15							
Silty Clay							
20							
Clayey Silt							
25							
Gravel							
30							
35							
40							
45							



WELL COMPLETION DIAGRAM
FOR MW-1

GCL



WELL LOGGING FORM

Client NAVAJO REFINERY Well Number MW- 2

1/4 1/4 1/4 1/4 S T R State NEW MEXICO

County EDDY Contractor LARRY'S DRILLING

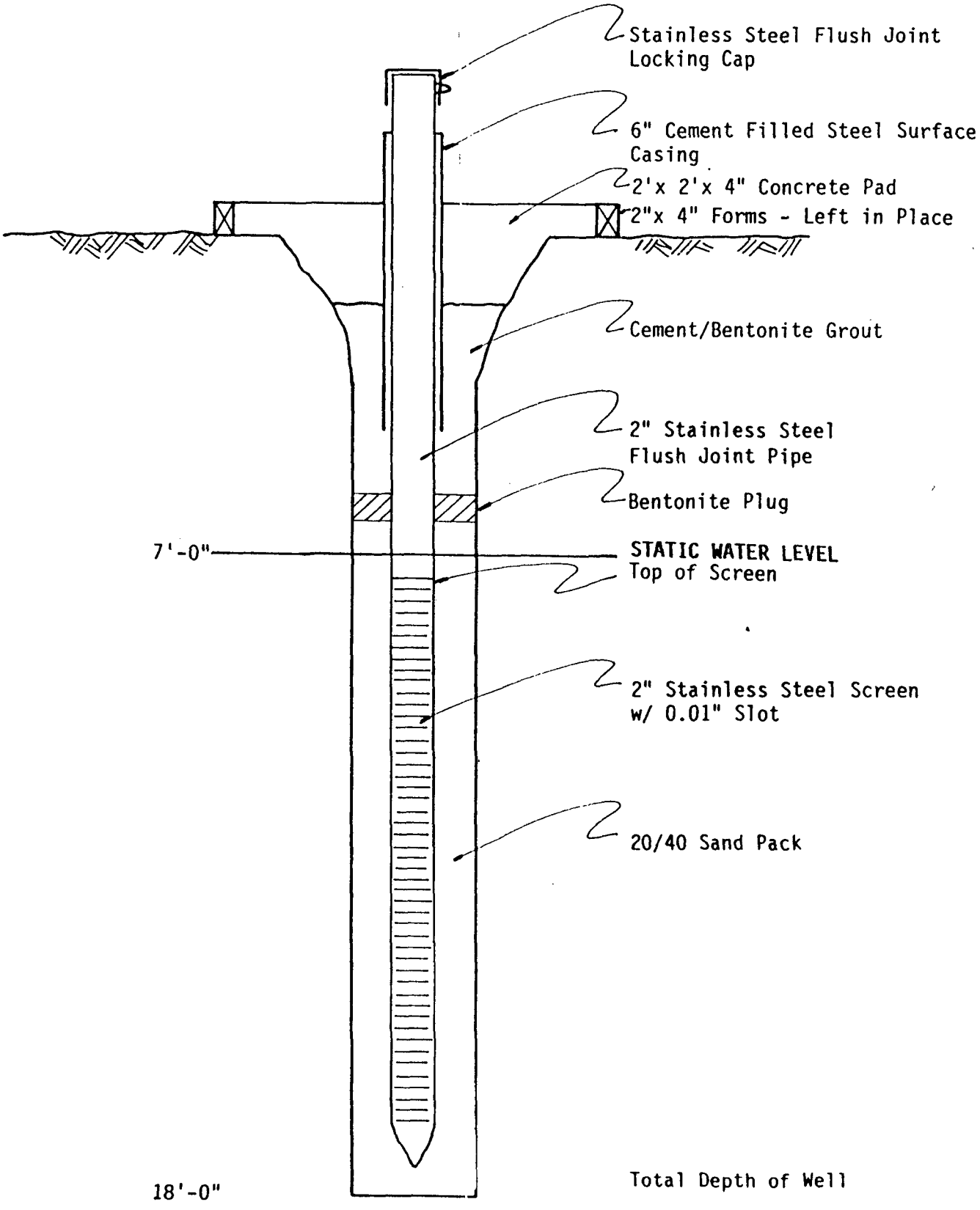
Spud Date 6-18-86 Completion Date 6-18-86

Logs Run LITHOLOGY Logged By SELKE

Elevation Spud In (Fm.)

Remarks Steam cleaned rig and tools prior to drilling-
drilled with air rotary and temp. casing

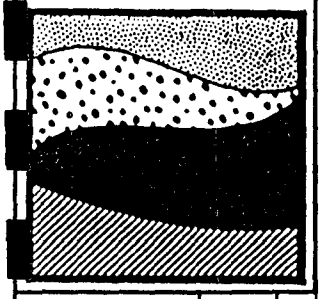
DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							0-18' very fine gr., brown, clayey silt and silty clay
Sand							
5							
Silt							
10							
Clay							
15							
Silty Clay							
20							
Clayey Silt							
25							
Gravel							
30							
35							
40							
45							



WELL COMPLETION DIAGRAM

FOR MW-2

GCL



WELL LOGGING FORM

Client NAVAJO REFINERY Well Number MW-3

1/4 1/4 1/4 1/4 S 12 T 17S R 26E State NEW MEXICO

County EDDY Contractor LARRY'S DRILLING

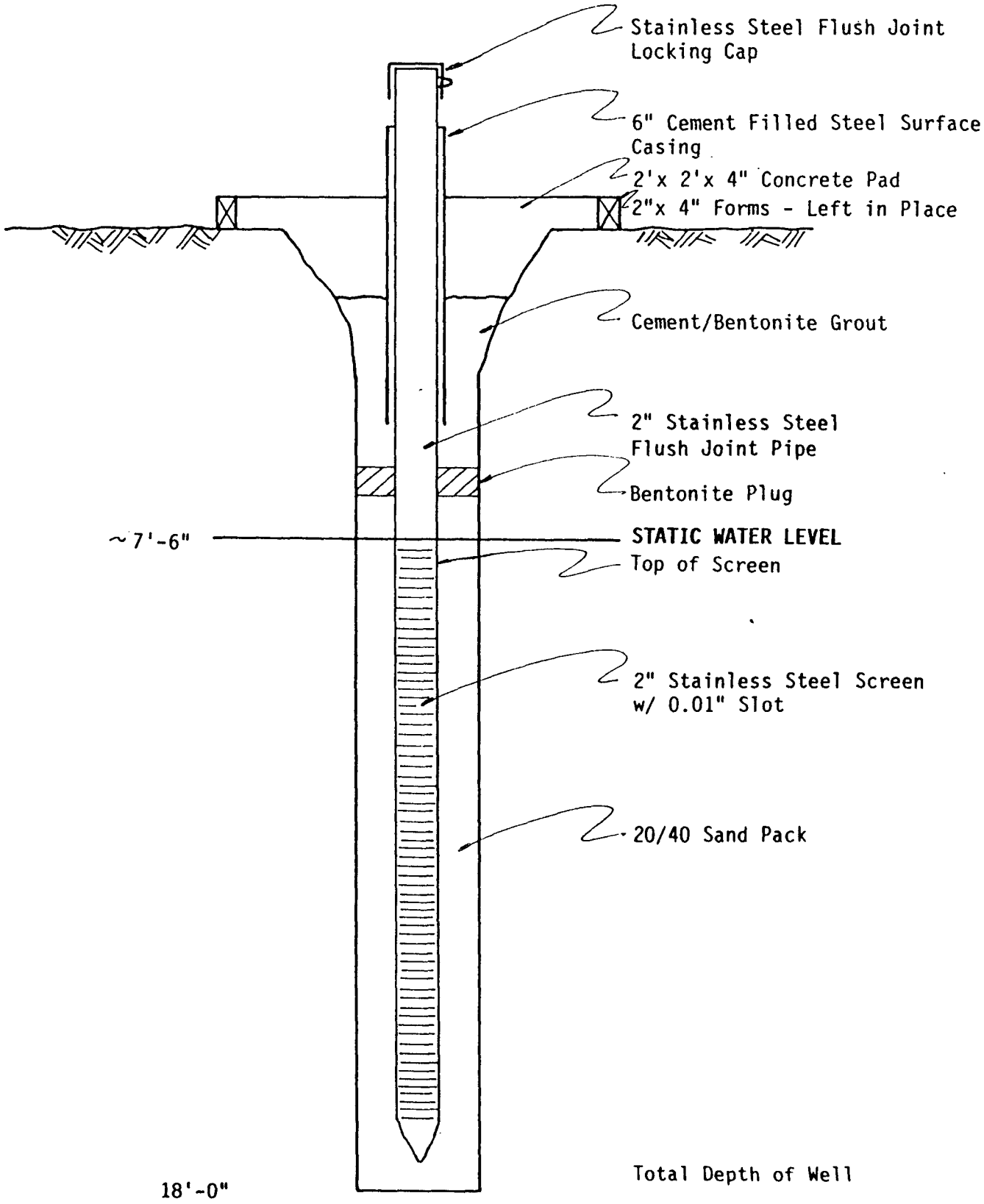
Spud Date 6-17-86 Completion Date 6-17-86

Logs Run LITHOLOGY Logged By SELKE

Elevation _____ Spud In (Fm.) _____

Remarks I/R TH-60 Drill Rig and all tools steam cleaned prior to drilling-drill w/ air rotary and temp. casing
2" stainless steel well casing-.010" slot 20/40 sand pack

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							0-17' v.fn.gr.,clayey silt, brown
and							
5							
Silt							
10							
Clay							
15							
lty Clay							
20							
Clayey Silt							
25							
ravel							
30							
35							
40							



WELL COMPLETION DIAGRAM

FOR MW-3

GCL

WELL LOGGING FORM

Client NAVAJO REFINERY Well Number MW- 4

__1/4__1/4__1/4__1/4 S 12 T17S R26E State NEW MEXICO

County EDDY Contractor LARRY'S DRILLING

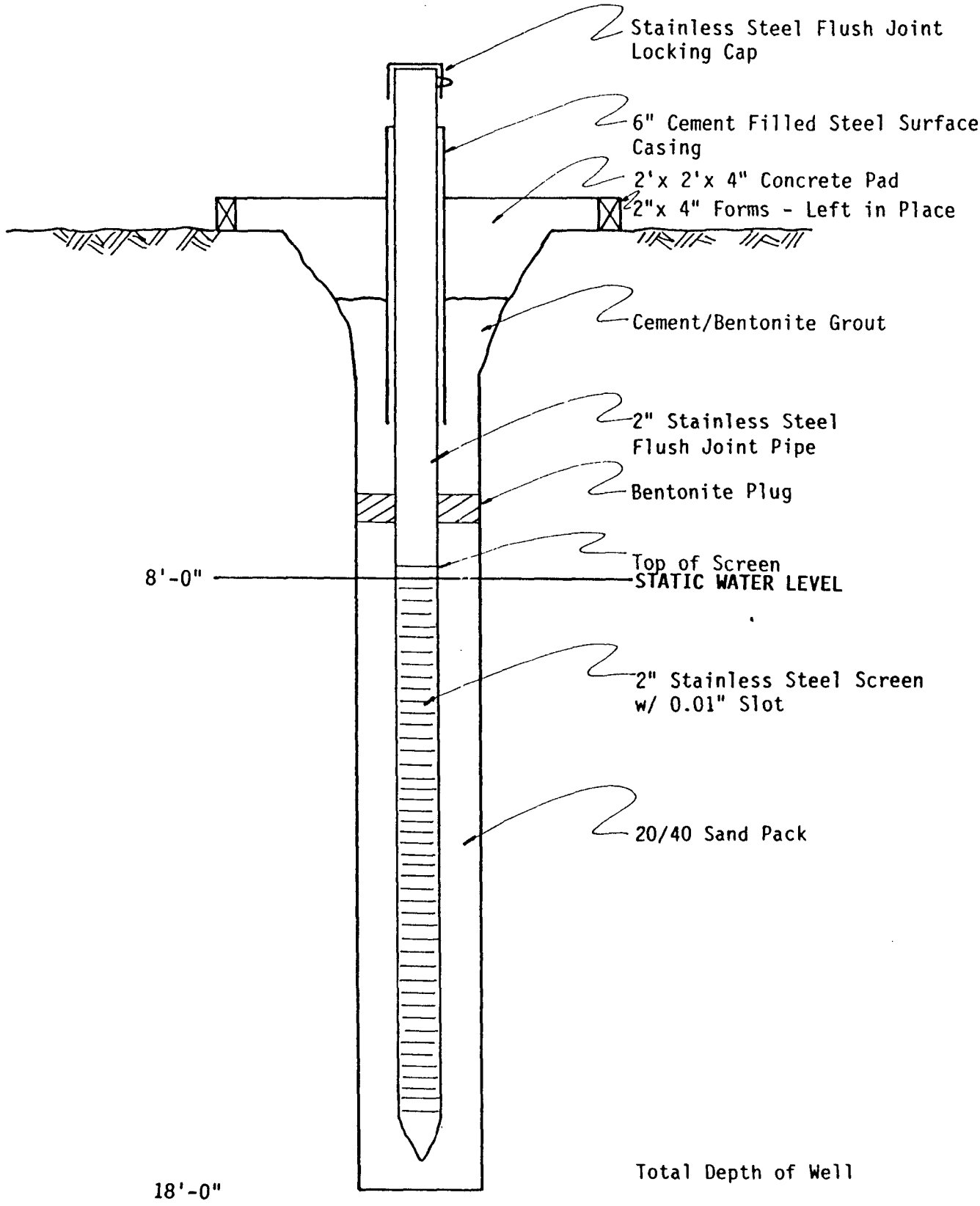
Spud Date 6-17-86 Completion Date 6-17-86

Logs Run LITHOLOGY Logged By SELKE

Elevation _____ Spud In (Fm.) _____

Remarks Steam cleaned rig and tools prior to setting up drill with air rotary and temp. casing

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							0-18' v.fn.gr.,brown, clayey silt
Sand							
5							
Silt							
10							
Clay							
15							
ilty Clay							
20							
layey Silt							
25							
ravel							
30							
35							
40							
45							



WELL COMPLETION DIAGRAM

FOR MW-4

GCL

WELL LOGGING FORM

Client NAVAJO REFINERY Well Number MW-5

__1/4 __1/4 __1/4 __1/4 S __T __R State NEW MEXICO

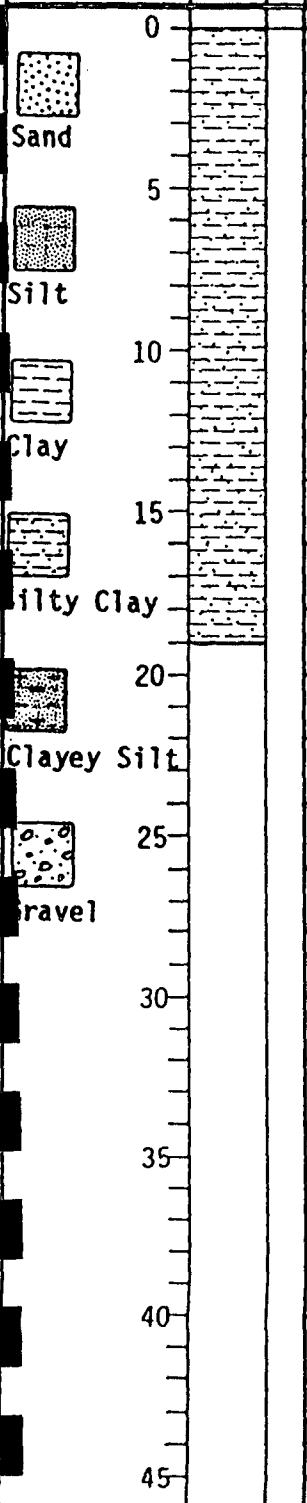
County EDDY Contractor LARRY'S DRILLING

Spud Date 6-19-86 Completion Date 6-19-86

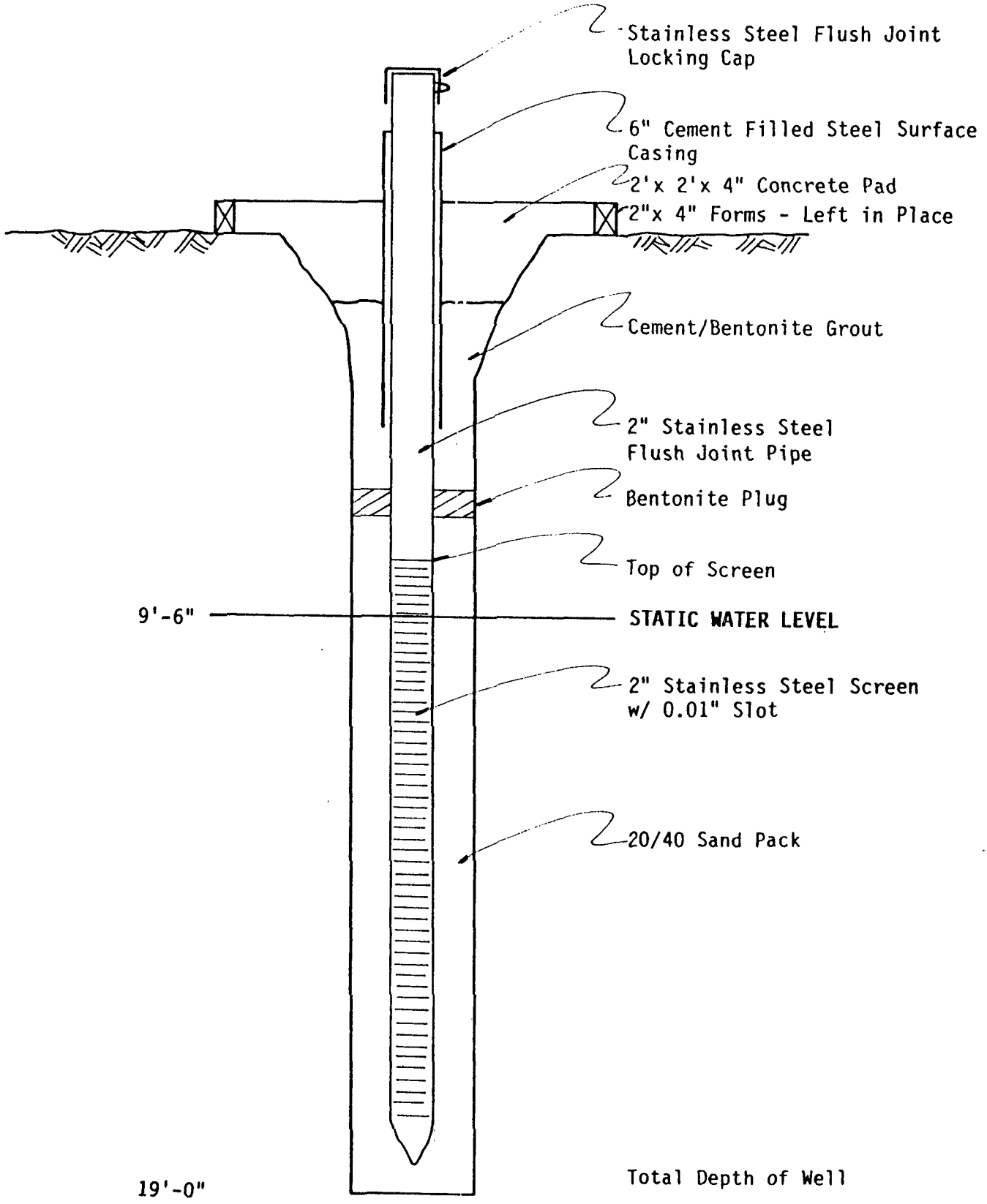
Logs Run LITHOLOGY Logged By SELKE

Elevation _____ Spud In (Fm.) _____

Remarks Steam cleaned rig and tools prior to drilling-drilled with air rotary- no temporary casing



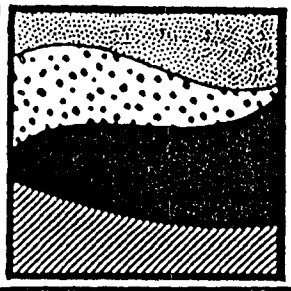
RUN	FROM	TO	SAMPLE DEPTH	REMARKS
				0-19' v.fn.gr., brown silty clay, very strong petroliferous odor soils are discolored black beginning at approx. 13'



WELL COMPLETION DIAGRAM

FOR MW-5

GCL



WELL LOGGING FORM

Client NAVAJO REFINERY Well Number MW- 6

1/4 1/4 1/4 1/4 S T R State NEW MEXICO

County EDDY Contractor LARRY'S DRILLING

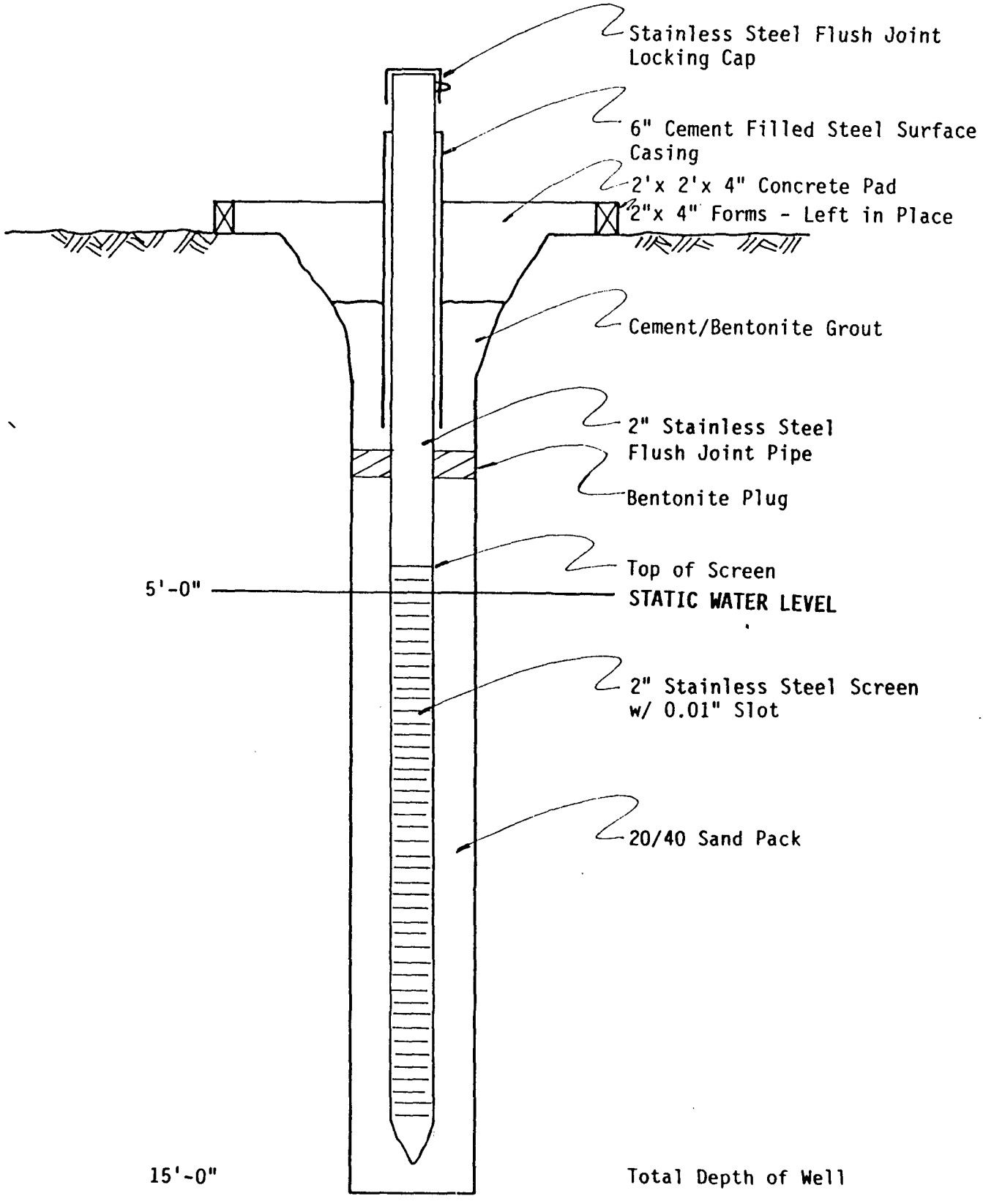
Spud Date 6-19-86 Completion Date 6-19-86

Logs Run LITHOLOGY Logged By SELKE

Elevation Spud In (Fm.)

Remarks Steam cleaned rig and tools prior to drilling- drilled with air rotary

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							0-15' brown, v.fn.gr., silty clay and clayey silt
Sand							
5							at approx. 14' the clay is colored black, green, gray and is extremely petroliferous
Silt							
10							
Clay							
15							
Silty Clay							
20							
Clayey Silt							
25							
Gravel							
30							
35							
40							
45							



WELL COMPLETION DIAGRAM

FOR MW-6

GCL

WELL LOGGING FORM

Client NAVAJO REFINERY Well Number MW-7

1/4 1/4 1/4 1/4 S T R State NEW MEXICO

County EDDY Contractor LARRY'S DRILLING

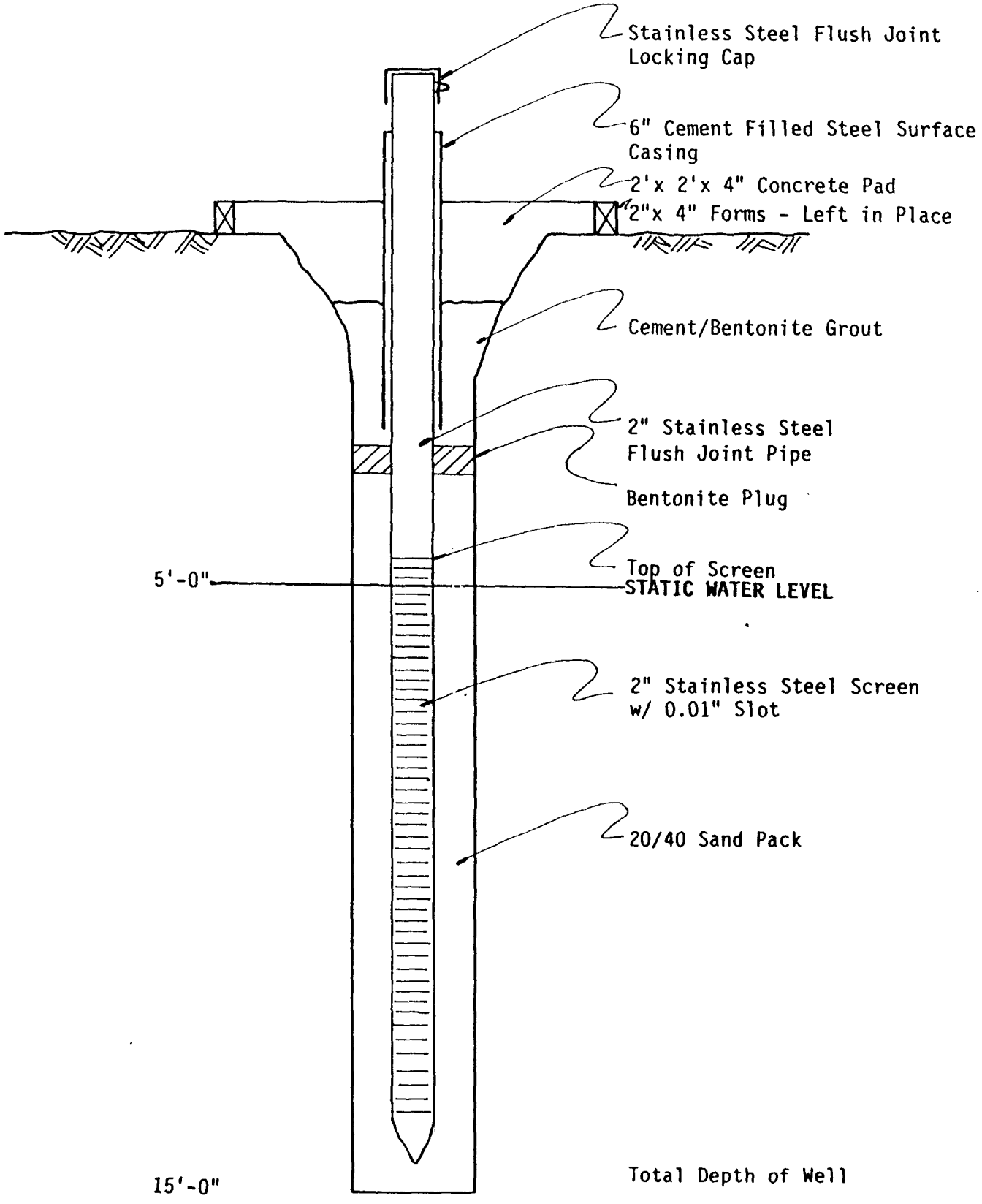
Spud Date 6-19-86 Completion Date 6-19-86

Logs Run LITHOLOGY Logged By SELKE

Elevation Spud In (Fm.)

Remarks Steam cleaned rig and tools prior to drilling-drilled with air rotary- no temp casing necessary

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							0-12' v.stiff, brown clay
Sand							
5							at 7' clay is slightly moist and plastic
Silt							
10							12-20' v. fn. gr., brown clayey silt petroliferous odor
Clay							
15							
Silty Clay							
20							
Clayey Silt							
25							
Gravel							
30							
35							
40							
45							



WELL COMPLETION DIAGRAM

FOR MW-7

GCL

WELL LOGGING FORM

Client NAVAJO REFINERY Well Number MW- 8

1/4 1/4 1/4 1/4 S T R State NEW MEXICO

County EDDY Contractor LARRY'S DRILLING

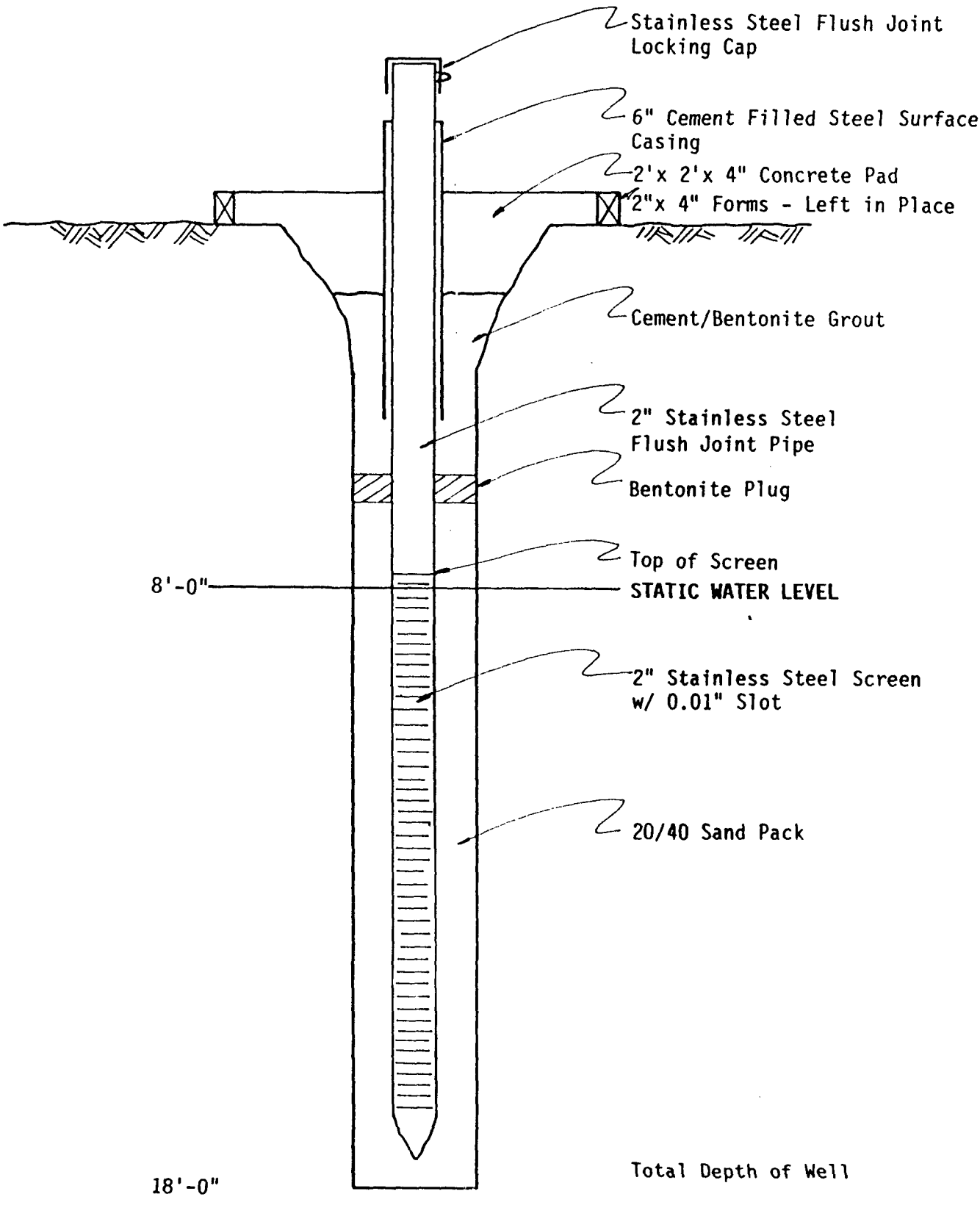
Spud Date 6-20-86 Completion Date 6-20-86

Logs Run LITHOLOGY Logged By SELKE

Elevation Spud In (Fm.)

Remarks Steam cleaned rig and tools prior to drilling - drilled with air rotary

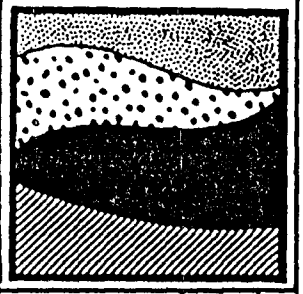
DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							0-8' Brown, silty sandy clay moist at approx. 8'
Sand							
5							
Silt							8-13' white to gray, sandy clay with moderate amounts of gravel(pea size)
10							
Clay							13-20' lt. brown clayey sand (abund. clay) v. minor gravel at top w/ moderate
15							to abundant gravel at bottom
Silty Clay							
20							
Clayey Silt							
25							
Gravel							
30							
35							
40							
45							



WELL COMPLETION DIAGRAM

FOR MW-8

GCL



WELL LOGGING FORM

Client NAVAJO REFINERY Well Number MW- 9

1/4 1/4 1/4 1/4 S T R State NEW MEXICO

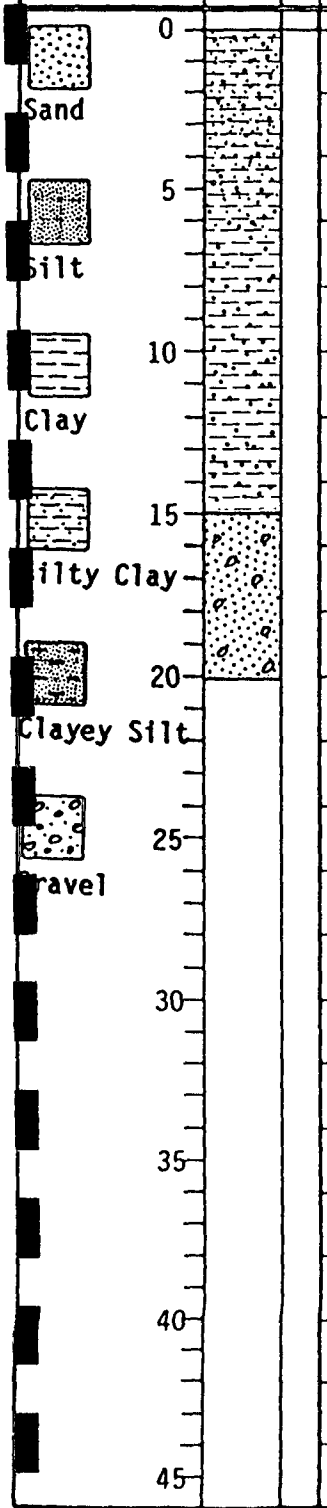
County EDDY Contractor LARRY'S DRILLING

Spud Date 6-20-86 Completion Date 6-20-86

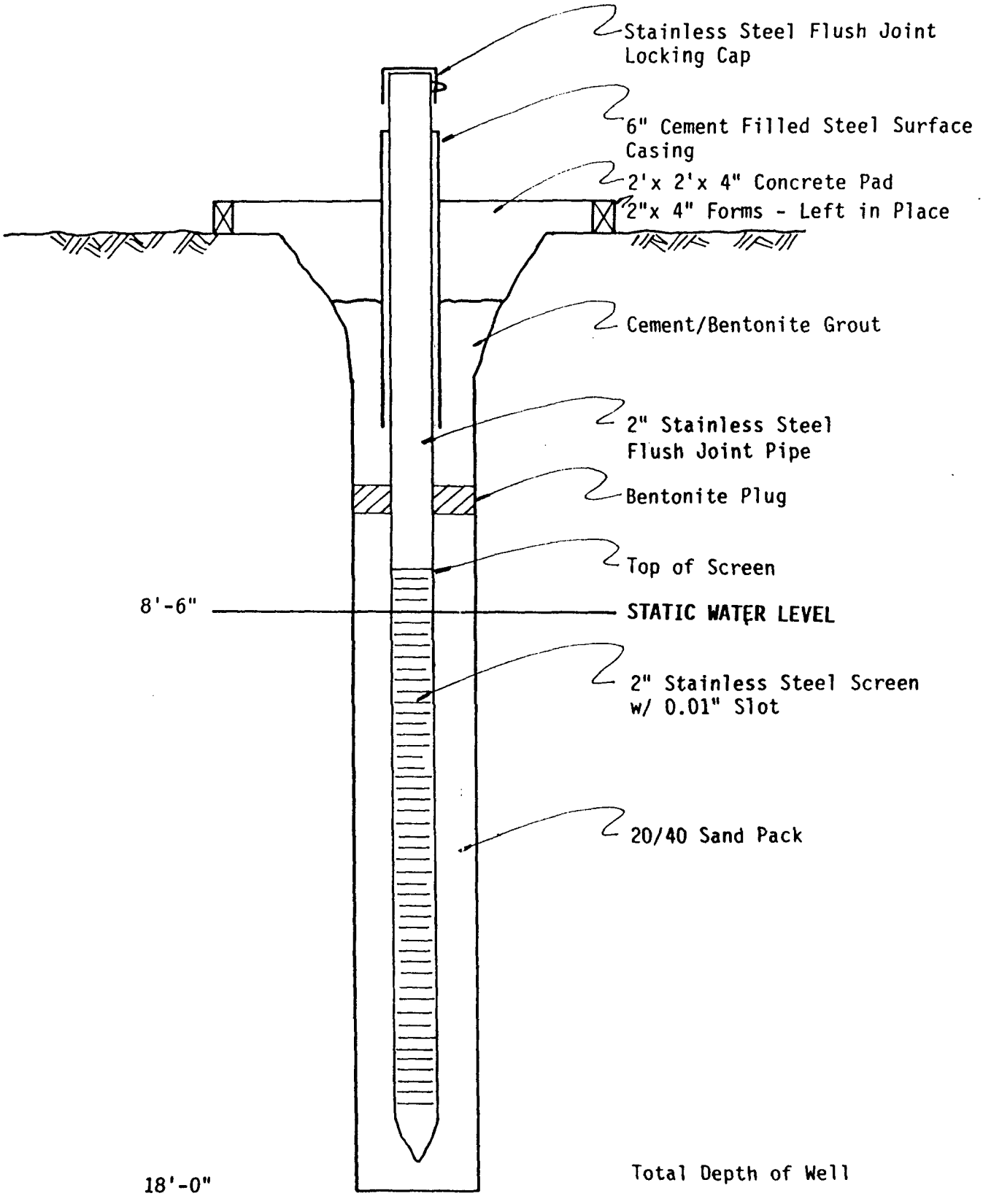
Logs Run LITHOLOGY Logged By SELKE

Elevation Spud In (Fm.)

Remarks Steam cleaned rig and tools prior to drilling- drilled with air rotary- no temporary casing



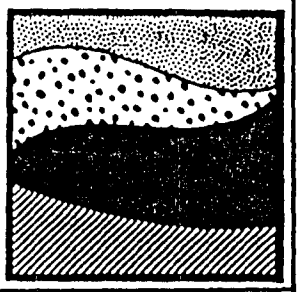
RUN	FROM	TO	SAMPLE DEPTH	REMARKS
				0-approx. 5' brown, silty , sandy clay
				approx. 5'-approx. 15' white to gray, sandy clay
				15-20' lt. brown, clayey sand w/ moderate amounts of fine grain gravel



WELL COMPETION DIAGRAM

FOR MW-9

GCL



WELL LOGGING FORM

Client NAVAJO REFINERY Well Number Pumptest Well

___1/4___1/4___1/4___1/4 S___T___R___ State NEW MEXICO

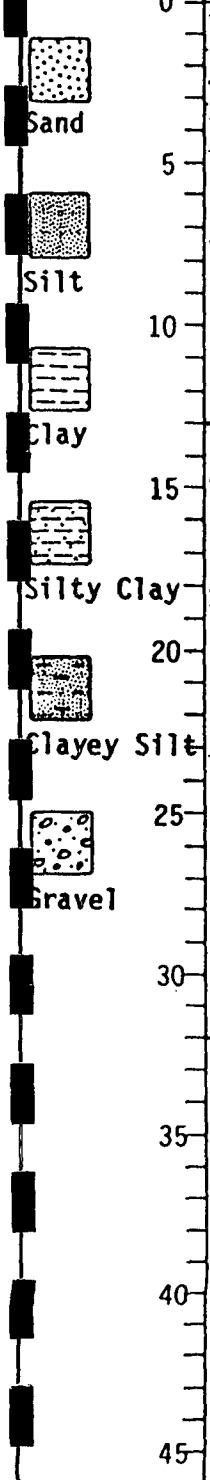
County EDDY Contractor LARRY'S DRILLING

Spud Date 6-20-86 Completion Date 6-20-86

Logs Run LITHOLOGY Logged By SELKE

Elevation _____ Spud In (Fm.) _____

Remarks Steam cleaned rig and tools prior to drilling- drilled w/ air rotary- 4" PVC well casing-.010" slot 12/20 sand pack



RUN	FROM	TO	SAMPLE DEPTH	REMARKS
				0-13' brown, fn. gr.clayey silt and silty clay
				13-32' blackish, v.fn.gr. silt and sand

APPENDIX D

APPENDIX D

DATA SHEET FOR RECORDING PUMP TEST DATA

12,020
1,461
10,559 gal

Meter
14,611 ~~12,020~~ = ~~106,409~~ gal

DATA SHEET FOR RECORDING PUMP TEST DATA

$\bar{Q} = 6.5$ gpm

County: _____ Observation well no. #

Location: Navajo Pumped well no. V

Average Q 6.5 gpm r = 0 ft. r^2 = _____

Date	Hour	t (min)	log t/t' (min)	Δt t/t'	Depth to water	s (unadjusted)	~~adjustment~~ Δs	s' (adjusted)	Q (gpm)	Remarks
9/17	0830				6.96				9.5	static
	0836 ~~0856~~	0								start
	0842	6	.78	6	9.45	2.49	-2.49			
	0853	17	1.23	11	9.61	2.65	-.16		9.6	
	0900	24	1.38	7	9.65	2.69	-.04			
	0914	38	1.58	14	9.74	2.78	-.09			
	0930	54	1.73	16	9.80	2.84	-.06			
	1100	144	2.16	90	9.875	2.92	-.08		7.0	Added 50' hose
	1158	202	2.31	58	8.25	1.29	+1.63		7.0	for better discharge control
	1258	262	2.42	60	8.876	1.92	-0.63			
	1357	321	2.51	59	8.89	1.93	-.01			
	~~1456~~	440	2.64	119	8.95	1.99	-.06			
	1850	554	2.74	114	9.00	2.04	-.05			
	2100	744	2.87	190	9.08	2.12	-.08			
9/18	2400	924			9.15	2.19				
	0330	1134			9.17	2.21				
	0640	1324			9.23	2.26				
	0915	1479			9.23	2.26				
	1140	1624			9.26	2.29				
	1145				9.26					Pump off
	1146				8.125					Recovery
	1150				7.45					
	1152				7.39					
	1156				7.35					
	1200				7.31					

27 hrs 9 min
= 1629 min
$\Rightarrow \bar{Q} = 6.5$ gpm

DATA SHEET FOR RECORDING PUMP TEST DATA

County : _____ Observation well no. 4A

Location: _____ Pumped well no. 1

Average Q _____ gpm r = _____ ft. r^2 = _____

Date	Hour	t (min)	Δt / t' (min)	t/t'	Depth to water	s (unadjusted)	Adjustment Δs	s' (adjusted)	Q (gpm)	Remarks
7/18	1205				7.28					
	1210		5		7.275					
	1215		5		7.26					
	1220		5		7.25					
	1235		15		7.22					
	1250		15		7.21					
	1305		15		7.19					
	1345				7.16					
	1530				7.13					
	1820				7.11					
7/19	0720				7.19					

DATA SHEET FOR RECORDING PUMP TEST DATA

County : _____ Observation well no. #1

Location: Navajo Pumped well no. _____

Average Q _____ gpm r = 15.5' ft. r^2 = 240.25 $\log r^2$ = 2.38

Date	Hour	t (min)	t' (min)	t/t'	Depth to water	s (unadjusted)	Adjustment Δs	s' (adjusted)	Q (gpm)	Remarks
7/17	0830				7.075				9.5	static
	0836	0			~~7.95~~	0				start
	0837				7.075					
	0857	1			7.075					
	0840	4			7.075					
	0849	13			7.075					
	0901	25			7.075					
	0913	37			7.075					
	0931	55			7.080	.005				
	1102	146			7.09	.015				added 50' hose
	1159	203			7.10	.025				
	1259	263			7.10	.025				
	1358	322			7.11	.035				
	1557	441			7.11	.035				
	1756	560			7.125	.05				
	2100	744			7.13	.055				
7/18	2400	924			7.15	.075				
	0332	1134			7.175	.10				
	0640	1324			7.20	.125				
	0915	1479			7.20	.125				
	1140	1624			7.21	.135				
	1147				7.21					Rec
	1163				7.21					
	1157				7.21					

Static = 7.075 Smax = 7.210 = .135

DATA SHEET FOR RECORDING PUMP TEST DATA

County : _____ Observation well no. 1

location: _____ Pumped well no. _____

Average Q _____ gpm r = _____ ft. r^2 = _____

Date	Hour	t (min)	t' (min)	t/t'	Depth to water	s (unadjusted)	Adjustment Δs	s' (adjusted)	Q (gpm)	Remarks
7/10	1206				7.21					
	1211				7.21					
	1216				7.21					
	1221				7.21					
	1236				7.21					
	1251				7.21					
	1316				7.21					
	1346				7.21					
	1531				7.23					
	1920				7.24					
7/19	0720				7.31					

DATA SHEET FOR RECORDING PUMP TEST DATA

County: _____ Observation well no. 2

Location: _____ Pumped well no. _____

Average Q _____ gpm r = 23.2' ft. r^2 = 538.24 log r^2 = 2.73

Date	Hour	t (min)	Δt' (min)	Log t/t'	Depth to water	s (unadjusted)	Adjustment As	s' (adjusted)	Q (gpm)	Remarks
	0830	0			6.21		As			Static
	0836	0			6.21					Start
	0841	5		1	6.21	0				
	0855	19	1	2	6.275	.07	-.07			
	0902	26		1	6.30	.09	-.02			
	0914	38			6.32	.11	-.02			
	0931	55			6.33	.12	-.01			
	1103	142			6.375	.17	-.05			
	1200	204			6.36	.15	+.02			
	1300	264			6.375	.17	-.02			
	1400	324			6.38	.17	0			
	1558	442			6.39	.18	-.01			
	1255	559			6.41	.20	-.02			
	2100	744			6.46	.25	-.05			
7/18	2400	924			6.50	.29	-.04			
	0330	1134			6.53	.32	-.03			
	0640	1324			6.55	.34	-.02			
	0915	1479			6.57	.36	-.02			
	1140	1624			6.58	.37				
	1148				6.58					Rec
	1154				6.57					
	1158				6.56					

Static = 6.210 Swell = 6.580 = .37'

DATA SHEET FOR RECORDING PUMP TEST DATA

County : _____ Observation well no. 2

Location: _____ Pumped well no. _____

Average Q _____ gpm r = _____ ft. r^2 = _____

Date	Hour	t (min)	t' (min)	t/t'	Depth to water	s (unadjusted)	Adjustment Δs	s' (adjusted)	Q (gpm)	Remarks
	1209				6.54					
	1212				6.52					
	1217				6.51					
	1222				6.51					
	1237				6.50					
	1252				6.49					
	1307				6.48					
	1347				6.47					
	1532				6.44					
	1820				6.425					
9/19	0920				6.45					

DATA SHEET FOR RECORDING PUMP TEST DATA

County: _____ Observation well no. 3

Location: _____ Pumped well no. _____

Average Q _____ gpm r = 48.2' ft. r^2 = 2323.24 $\log r^2$ = 3.37

Date	Hour	t (min)	t' (min)	t/t'	Depth to water	s (unadjusted)	Adjustment Δs	s' (adjusted)	Q (gpm)	Remarks
5/10	0830		log t		6.43	S	ΔS			static
	0857	21	1.43	27	6.48	.05	.005			
	0903	27	1.54	6	6.49	.06	.01			
	0915	39	1.65	12	6.50	.07	.01			
	0932	56	1.79	17	6.50	.07	0			
	1103	147	2.18	91	6.52	.09	.02			
	1200	204	2.32	57	6.52	.09	0			
	1301	265	2.43	61	6.525	.095	.005			
	1401	325	2.52	60	6.525	.095	0			
	1600	444	2.65	119	6.525	.095	0			
	1756	560	2.75	116	6.525	.095	0			
	2100	744	2.88	184	6.540	.11	.02			
5/11	2400	924			6.56	.13	.02			
	0330	1134			6.60	.17	.04			
	0640	1324			6.61	.18	.01			
	0915	1479			6.62	.19	.01			
	1140	1624			6.625	.195				
	1149				6.625					Rec Pump off @ 1145
	1155				6.61					
	1159				6.60					

Static = 6.430
Smax = 6.625
= .195

DATA SHEET FOR RECORDING PUMP TEST DATA

County : _____ Observation well no. 3

Location: _____ Pumped well no. _____

Average Q _____ gpm r = _____ ft. r^2 = _____

Date	Hour	t (min)	t' (min)	t/t'	Depth to water	s (unadjusted)	Adjustment Δs	s' (adjusted)	Q (gpm)	Remarks
	1208				6.59					
	1213				6.59					
	1218				6.58					
	1223				6.58					
	1228				6.58					
	1253				6.57					
	1308				6.57					
	1348				6.57					
	1532				6.57					
	1820				6.56					
7/19	0720				6.64					

Calculation of Transmissivity and Specific Yield

$$T = \frac{2.30Q \log\left(\frac{r_2}{r_1}\right)}{2(3.1416)\,(S_1' - S_2')}$$

Where:

T = transmissivity
Q = discharge
r = distance from pumped well to observation well

$$S' = S - (S^2/2m)$$

Where:

S = drawdown
m = effective aquifer thickness

Using Data from time = 1624 minutes:

r_1 = 23.2 ft
r_2 = 48.2 ft
s_1 = 0.37 ft
s_2 = 0.195 ft
s_1' = 0.369 ft
s_2' = 0.195 ft
Q = 0.0145 ft^3/second

$$T = \frac{2.3\,(0.0145)\,\log\left(\frac{48.2}{23.2}\right)}{2(3.1416)\,(.396 - .195)}$$

T = 0.0097 ft^2/second

$$0.0097\ ft^2/\text{second} \times 6.46 \times 10^5\ \frac{\text{gallons/d/ft}^2}{ft^2/\text{ sec}}$$

= 6243 gallons/day/$foot^2$

Specific yield is determined as follows:

$$\text{from } \frac{r_e^2 S}{4Tt} = e^{-0.5772} = 0.562$$

$$\text{then } S = (4)(.562)\frac{Tt}{r_e^2}$$

Where:

S = ~~specific yield~~ = storage coefficient not specific yield
T = transmissivity
t = time
r_e = effective radius of the cone of depression

All of these terms are known except for r_e. This is determined from the accompanying graph of s' versus r. , Note that r_e is read from the graph where the line connecting s_1 and s_2 intersects the s' = 0 line. This gives an r_e value of:

$$r_e = 105 \text{ feet.}$$

Converting 1624 minutes to seconds:
1624 x 60 = 97,440 seconds

$$S = \frac{(4)(.562)(0.0097)(97,440)}{(105)^2}$$

$$S = 0.1927$$

or, S = 0.2

APPENDIX E

APPENDIX E

CHEMICAL ANALYSES OF GROUND WATER SAMPLES

Rocky Mountain Analytical Laboratory
4955 Yarrow Street, Arvada, CO 80002 (303) 421-6611

A DIVISION OF
ENSECO
INCORPORATED

September 19, 1986

Trent Thomas
Geoscience Consultants, Ltd.
500 Copper N.W., Suite 325
Albuquerque, NM 87102

Dear Trent:

Enclosed are the results for the analysis of the 13 groundwater samples (Navajo Refinery) received August 12, 1986. An ion balance was performed on relevant samples and all had a percent difference of less than five percent. The ion balance results are also enclosed.

We experienced some difficulty with organic acid surrogate spike recoveries. Samples MW-9, MW-2, MW-3, MW-1 and Well Pit #2 all had more than one acid surrogate spike recovery below our QC limits. Repreparation and analysis was performed on these five samples and all still had low acid surrogate spike recoveries except for Well Pit #2, which had acceptable recoveries. Limited sample was available for the repreparation of Well Pit #2 (260 mLs vs. 1000 mLs). This suggests that there was a matrix effect on the recovery of the acid surrogate compounds when the sample was at full strength (1000 mLs).

Please do not hesitate to call if you have any questions.

Sincerely,

Brian J. Rahn
Project Coordinator
Inorganic Chemistry

Approved by:

Jerry L. Parr
Technical Director

BJR/JLP/bj
Enclosures

RMAL #61882

SAMPLE DESCRIPTION INFORMATION

for

Geoscience Consultants, Ltd.

RMA Sample No.	Sample Description	Sample Type	Date Sampled	Date Received
61882-01	MW-8 ✓	Water	08/06/86	08/12/86
61882-02	MW-9 ✓	Water	08/06/86	08/12/86
61882-03	MW-2 ✓	Water	08/06/86	08/12/86
61882-04	MW-6 ✓	Water	08/07/86	08/12/86
61882-05	MW-3 ✓	Water	08/07/86	08/12/86
61882-06	Equip Blank ✓	Water	08/07/86	08/12/86
61882-07	Field Blank ✓	Water	08/07/86	08/12/86
61882-08	MW-7 ✓	Water	08/07/86	08/12/86
61882-09	MW-5 ✓	Water	08/07/86	08/12/86
61882-10	MW-1 ✓	Water	08/07/86	08/12/86
61882-11	MW-4 ✓	Water	08/07/86	08/12/86
61882-12	#13 ✓	Water	08/07/86	08/12/86
61882-13	Well Pt #2 ✓	Water	08/07/86	08/12/86

September 19, 1986

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

INORGANIC PARAMETERS

Parameter	Units	61882-01		61882-02 mw9		61882-03 mw2		61882-04 mw6	
Total Dissolved Solids	mg/L	7420	(10)	NR	-	21600	(10)	10100	(10)
Fluoride	mg/L	2.0	(0.1)	NR	-	NR	-	5.5	(0.1)
Chloride	mg/L	904	(3)	NR	-	NR	-	3080	(3)
Nitrate + Nitrite as N	mg/L	1.7	(0.1)	NR	-	NR	-	2.1	(0.1)
Sulfate	mg/L	3430	(5)	NR	-	NR	-	3000	(5)
Dissolved Sulfide	mg/L	ND	(0.05)	ND	(0.05)	NR	-	ND	(0.05)
Carb. Alk. as CaCO3 at pH 8.3	mg/L	ND	(5)	NR	-	NR	-	ND	(5)
Bicarb. Alk as CaCO3 at pH 4.5	mg/L	384	(5)	NR	-	NR	-	483	(5)
Total Kjeldahl Nitrogen as N	mg/L	0.9	(0.1)	NR	-	NR	-	5.2	(0.1)

Parameter	Units	61882-05		61882-08		61882-09 mw5		61882-10 mw1	
Total Dissolved Solids	mg/L	8080	(10)	10500	(10)	27300	(10)	14900	(10)
Fluoride	mg/L	2.9	(0.1)	NR	-	NR	-	1.0	(0.1)
Chloride	mg/L	1210	(3)	NR	-	NR	-	4250	(3)
Nitrate + Nitrite as N	mg/L	ND	(0.1)	NR	-	NR	-	ND	(0.1)
Sulfate	mg/L	2760	(5)	NR	-	NR	-	3080	(5)
Dissolved Sulfide	mg/L	ND	(0.05)	NR	-	NR	-	0.07	(0.05)
Carb. Alk. as CaCO3 at pH 8.3	mg/L	ND	(5)	NR	-	NR	-	ND	(5)
Bicarb. Alk as CaCO3 at pH 4.5	mg/L	1280	(5)	NR	-	NR	-	391	(5)
Total Kjeldahl Nitrogen as N	mg/L	0.3	(0.1)	NR	-	NR	-	2.6	(0.1)

ND = Not detected. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

INORGANIC PARAMETERS

Parameter	Units	61882-11		61882-12		61882-13	
Total Dissolved Solids	mg/L	13000	(10)	1200	(10)	5100	(10)
Fluoride	mg/L	NR	-	2.1	(0.1)	NR	-
Chloride	mg/L	NR	-	202	(3)	NR	-
Nitrate + Nitrite as N	mg/L	NR	-	ND	(0.1)	NR	-
Sulfate	mg/L	NR	-	257	(5)	NR	-
Dissolved Sulfide	mg/L	NR	-	0.29	(0.05)	NR	-
Carb. Alk. as CaCO3 at pH 8.3	mg/L	NR	-	ND	(5)	NR	-
Bicarb. Alk as CaCO3 at pH 4.5	mg/L	NR	-	184	(5)	NR	-
Total Kjeldahl Nitrogen as N	mg/L	NR	-	7.2	(0.1)	NR	-

ND = Not detected. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT METALS

Parameter	Units	61882-01 mw8		61882-02 mw9		61882-04 mw6		61882-05 mw3	
Antimony	mg/L	0.006	(0.002)	ND	(0.002)	0.007	(0.002)	0.003	(0.002)
Arsenic	mg/L	0.012	(0.002)	0.020	(0.002)	0.092	(0.002)	0.084	(0.002)
Barium	mg/L	0.049	(0.01)	0.020	(0.01)	0.040	(0.01)	0.22	(0.01)
Beryllium	mg/L	ND	(0.002)	ND	(0.002)	ND	(0.002)	ND	(0.002)
Cadmium	mg/L	ND	(0.008)	ND	(0.008)	ND	(0.008)	ND	(0.008)
Chromium	mg/L	ND	(0.01)	ND	(0.01)	0.019	(0.01)	0.02	(0.01)
Cobalt	mg/L	0.018	(0.06)	0.012	(0.06)	ND	(0.06)	0.007	(0.06)
Copper	mg/L	ND	(0.03)	ND	(0.03)	ND	(0.03)	ND	(0.03)
Lead	mg/L	ND	(0.04)	ND	(0.04)	ND	(0.04)	ND	(0.04)
Mercury	mg/L	ND	(0.0001)	ND	(0.0001)	ND	(0.0001)	ND	(0.0001)
Nickel	mg/L	0.039	(0.02)	0.048	(0.02)	ND	(0.02)	0.02	(0.02)
Selenium	mg/L	ND	(0.04)	ND	(0.04)	ND	(0.04)	ND	(0.04)
Silver	mg/L	ND	(0.006)	ND	(0.006)	ND	(0.006)	ND	(0.006)
Thallium	mg/L	ND	(0.04)	ND	(0.04)	ND	(0.04)	ND	(0.04)
Vanadium	mg/L	0.053	(0.004)	0.048	(0.004)	0.005	(0.004)	0.014	(0.004)
Zinc	mg/L	ND	(0.02)	ND	(0.02)	ND	(0.02)	ND	(0.02)

DISSOLVED MAJOR CATIONS

Parameter	Units	61882-01		61882-02		61882-04		61882-05	
Calcium	mg/L	635	(0.2)	NR	-	986	(0.2)	703	(0.2)
Iron	mg/L	1.7	(0.1)	NR	-	19	(0.1)	7.5	(0.1)
Magnesium	mg/L	451	(0.2)	NR	-	248	(0.2)	296	(0.2)
Potassium	mg/L	2.6	(0.6)	NR	-	9.0	(0.6)	7.2	(0.6)
Sodium	mg/L	637	(1)	NR	-	1990	(1)	1220	(1)

ND = Not detected. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT METALS

Parameter	Units	61882-10 mw1		61882-12 mw4	
Arsenic	mg/L	ND	(0.002)	0.064	(0.002)
Antimony	mg/L	0.004	(0.002)	0.006	(0.002)
Barium	mg/L	0.030	(0.025)	0.22	(0.05)
Beryllium	mg/L	ND	(0.005)	ND	(0.001)
Cadmium	mg/L	ND	(0.02)	ND	(0.004)
Chromium	mg/L	ND	(0.025)	0.007	(0.005)
Cobalt	mg/L	ND	(0.015)	ND	(0.003)
Copper	mg/L	ND	(0.03)	ND	(0.03)
Lead	mg/L	ND	(0.1)	ND	(0.02)
Mercury	mg/L	ND	(0.0001)	ND	(0.0001)
Nickel	mg/L	0.10	(0.05)	ND	(0.01)
Selenium	mg/L	ND	(0.04)	ND	(0.004)
Silver	mg/L	ND	(0.015)	ND	(0.003)
Thallium	mg/L	ND	(0.04)	ND	(0.004)
Vanadium	mg/L	ND	(0.01)	0.011	(0.002
Zinc	mg/L	ND	(0.02)	ND	(0.02)

DISSOLVED MAJOR CATIONS

Parameter	Units	61882-10		61882-12	
Calcium	mg/L	900	(0.2)	143	(0.1)
Iron	mg/L	1.3	(0.1)	2.7	(0.05)
Magnesium	mg/L	601	(0.2)	27	(0.1)
Potassium	mg/L	9.1	(0.6)	9.3	(0.3)
Sodium	mg/L	2020	(1)	150	(0.5)

ND = Not detected. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT BASE/NEUTRAL ORGANICS

Parameter	Units	61882-01 mw8		61882-02 mw9		61882-03 mw2		61882-04 mw6	
Acenaphthene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Acenaphthylene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Anthracene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Benzidine	ug/L	BDL	(20)	BDL	(20)	NR	-	BDL	(20)
Benzo(a)anthracene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Benzo(a)pyrene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
3,4-Benzofluoranthene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Benzo(g,h,i)perylene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Benzo(k)fluoranthene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Bis(2-chloroethoxy)methane	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Bis(2-chloroethyl)ether	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Bis(2-chloroisopropyl)ether	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Bis(2-ethylhexyl)phthalate	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
4-Bromophenyl phenyl ether	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Butylbenzyl phthalate	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
2-Chloronaphthalene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
4-Chlorophenyl phenyl ether	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Chrysene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Dibenzo(a,h)anthracene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Dibenzofuran	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
2-Methylnaphthalene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,2-Dichlorobenzene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,3-Dichlorobenzene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,4-Dichlorobenzene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
3,3'-Dichlorobenzidine	ug/L	BDL	(20)	BDL	(20)	NR	-	BDL	(20)
Diethyl phthalate	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Dimethyl phthalate	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Di-n-butyl phthalate	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
2,4-Dinitrotoluene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
2,6-Dinitrotoluene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORTIY POLLUTANT BASE/NEUTRAL ORGANICS (Cont.)

Parameter	Units	61882-01 mw8		61882-02 mw9		61882-03 mw2		61882-04 mw6	
Di-n-octyl phthalate	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
,2-Diphenylhydrazine*	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Fluoranthene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Fluorene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Hexachlorobenzene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Hexachlorobutadiene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Hexachlorocyclopentadiene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Hexachloroethane	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
ndeno(1,2,3-cd)pyrene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
sophorone	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Naphthalene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Nitrobenzene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
N-Nitrosodimethylamine	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
N-Nitrosodi-n-propylamine	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
N-Nitrosodiphenylamine*	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Phenanthrene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Pyrene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
,2,4-Trichlorobenzene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT ACID ORGANICS

Parameter	Units	61882-01 mw8		61882-02 mw9		61882-03 mw2		61882-04 mw6	
2-Chlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
2,4-Dichlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
2,4-Dimethylphenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
4,6-Dinitro-o-cresol	ug/L	BDL	(10)	BDL	(10)	BDL	(5)	BDL	(5)
2,4-Dinitrophenol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)	BDL	(10)
2-Methylphenol	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
4-Methylphenol	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
2-Nitrophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
4-Nitrophenol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)	BDL	(10)
p-Chloro-m-cresol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
Pentachlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
Phenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
2,4,6-Trichlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT VOLATILE ORGANICS

Parameter	Units	61882-01 MW8		61882-02 MW3		61882-03 MW2		61882-04 MW6	
Acetone	ug/L	BDL	(10)	BDL	(10)	NR	-	74	(10)
Acrolein	ug/L	BDL	(100)	BDL	(100)	NR	-	BDL	(100)
Acrylonitrile	ug/L	BDL	(100)	BDL	(100)	NR	-	BDL	(100)
Benzene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Bromoform	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Carbon tetrachloride	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Chlorobenzene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Chlorodibromomethane	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Chloroethane	ug/L	BDL	(10)	BDL	(10)	NR	-	BDL	(10)
2-Chloroethylvinyl ether	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Chloroform	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Dichlorobromomethane	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,1-Dichloroethane	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,2-Dichloroethane	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,1-Dichloroethylene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,2-Dichloropropane	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,3-Dichloropropylene (c&t)	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Ethylbenzene	ug/L	BDL	(5)	BDL	(5)	NR	-	12	(5)
Methylbromide	ug/L	BDL	(10)	BDL	(10)	NR	-	BDL	(10)
Methylchloride	ug/L	BDL	(10)	BDL	(10)	NR	-	BDL	(10)
Methylene chloride	ug/L	BDL	(10)	BDL	(10)	NR	-	BDL	(10)
1,1,2,2-Tetrachloroethane	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Tetrachloroethylene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Toluene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,2-trans-Dichloroethylene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,1,1-Trichloroethane	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
1,1,2-Trichloroethane	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Trichloroethylene	ug/L	BDL	(5)	BDL	(5)	NR	-	BDL	(5)
Vinyl chloride	ug/L	BDL	(10)	BDL	(10)	NR	-	BDL	(10)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT BASE/NEUTRAL ORGANICS

Parameter	Units	61882-05		61882-08		61882-09		61882-10	
Acenaphthene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Acenaphthylene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Anthracene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Benzidine	ug/L	BDL	(20)	NR	-	NR	-	BDL	(20)
Benzo(a)anthracene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Benzo(a)pyrene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
3,4-Benzofluoranthene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Benzo(g,h,i)perylene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Benzo(k)fluoranthene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Bis(2-chloroethoxy)methane	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Bis(2-chloroethyl)ether	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Bis(2-chloroisopropyl)ether	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Bis(2-ethylhexyl)phthalate	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
4-Bromophenyl phenyl ether	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Butylbenzyl phthalate	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
2-Chloronaphthalene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
4-Chlorophenyl phenyl ether	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Chrysene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Dibenzo(a,h)anthracene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Dibenzofuran	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,2-Dichlorobenzene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,3-Dichlorobenzene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,4-Dichlorobenzene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
3,3'-Dichlorobenzidine	ug/L	BDL	(20)	NR	-	NR	-	BDL	(20)
Diethyl phthalate	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Dimethyl phthalate	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Di-n-butyl phthalate	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
2,4-Dinitrotoluene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
2,6-Dinitrotoluene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT BASE/NEUTRAL ORGANICS (Cont.)

Parameter	Units	61882-05 mw3		61882-08 mw7		61882-09 mw5		61882-10 mw1	
Di-n-octyl phthalate	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,2-Diphenylhydrazine*	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Fluoranthene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Fluorene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Hexachlorobenzene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Hexachlorobutadiene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Hexachlorocyclopentadiene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Hexachloroethane	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Indeno(1,2,3-cd)pyrene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Isophorone	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
2-Methylnaphthalene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Naphthalene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Nitrobenzene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
N-Nitrosodimethylamine	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
N-Nitrosodi-n-propylamine	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
N-Nitrosodiphenylamine*	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Phenanthrene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Pyrene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,2,4-Trichlorobenzene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT ACID ORGANICS

Parameter	Units	61882-05 mw3		61882-08 mw7		61882-09 mw 5		61882-10 mw1	
2-Chlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
2,4-Dichlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
2,4-Dimethylphenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
4,6-Dinitro-o-cresol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)	BDL	(10)
2,4-Dinitrophenol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)	BDL	(10)
2-Methylphenol	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
4-Methylphenol	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
2-Nitrophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
4-Nitrophenol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)	BDL	(10)
p-Chloro-m-cresol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
Pentachlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
Phenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)
2,4,6-Trichlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)	BDL	(5)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT VOLATILE ORGANICS

Parameter	Units	61882-05 mw3		61882-08 mw 7		61882-09 mw 5		61882-10 mw1	
Acetone	ug/L	BDL	(10)	NR	-	NR	-	BDL	(10)
Acrolein	ug/L	BDL	(100)	NR	-	NR	-	BDL	(100)
Acrylonitrile	ug/L	BDL	(100)	NR	-	NR	-	BDL	(100)
Benzene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Bromoform	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Carbon tetrachloride	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Chlorobenzene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Chlorodibromomethane	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Chloroethane	ug/L	BDL	(10)	NR	-	NR	-	BDL	(10)
2-Chloroethylvinyl ether	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Chloroform	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Dichlorobromomethane	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,1-Dichloroethane	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,2-Dichloroethane	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,1-Dichloroethylene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,2-Dichloropropane	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,3-Dichloropropylene (c&t)	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Ethylbenzene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Methylbromide	ug/L	BDL	(10)	NR	-	NR	-	BDL	(10)
Methylchloride	ug/L	BDL	(10)	NR	-	NR	-	BDL	(10)
Methylene chloride	ug/L	BDL	(10)	NR	-	NR	-	BDL	(10)
1,1,2,2-Tetrachloroethane	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Tetrachloroethylene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Toluene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,2-trans-Dichloroethylene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,1,1-Trichloroethane	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
1,1,2-Trichloroethane	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Trichloroethylene	ug/L	BDL	(5)	NR	-	NR	-	BDL	(5)
Vinyl chloride	ug/L	BDL	(10)	NR	-	NR	-	BDL	(10)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT BASE/NEUTRAL ORGANICS

Parameter	Units	61882-11 mw4		61882-12	
Acenaphthene	ug/L	NR	-	BDL	(5)
Acenaphthylene	ug/L	NR	-	BDL	(5)
Anthracene	ug/L	NR	-	BDL	(5)
Benzidine	ug/L	NR	-	BDL	(20)
Benzo(a)anthracene	ug/L	NR	-	BDL	(5)
Benzo(a)pyrene	ug/L	NR	-	BDL	(5)
3,4-Benzofluoranthene	ug/L	NR	-	BDL	(5)
Benzo(g,h,i)perylene	ug/L	NR	-	BDL	(5)
Benzo(k)fluoranthene	ug/L	NR	-	BDL	(5)
Bis(2-chloroethoxy)methane	ug/L	NR	-	BDL	(5)
Bis(2-chloroethyl)ether	ug/L	NR	-	BDL	(5)
Bis(2-chloroisopropyl)ether	ug/L	NR	-	BDL	(5)
Bis(2-ethylhexyl)phthalate	ug/L	NR	-	BDL	(5)
4-Bromophenyl phenyl ether	ug/L	NR	-	BDL	(5)
Butylbenzyl phthalate	ug/L	NR	-	BDL	(5)
2-Chloronaphthalene	ug/L	NR	-	BDL	(5)
4-Chlorophenyl phenyl ether	ug/L	NR	-	BDL	(5)
Chrysene	ug/L	NR	-	BDL	(5)
Dibenzo(a,h)anthracene	ug/L	NR	-	BDL	(5)
Dibenzofuran	ug/L	NR	-	BDL	(5)
1,2-Dichlorobenzene	ug/L	NR	-	BDL	(5)
1,3-Dichlorobenzene	ug/L	NR	-	BDL	(5)
1,4-Dichlorobenzene	ug/L	NR	-	BDL	(5)
3,3'-Dichlorobenzidine	ug/L	NR	-	BDL	(20)
Diethyl phthalate	ug/L	NR	-	BDL	(5)
Dimethyl phthalate	ug/L	NR	-	BDL	(5)
Di-n-butyl phthalate	ug/L	NR	-	BDL	(5)
2,4-Dinitrotoluene	ug/L	NR	-	BDL	(5)
2,6-Dinitrotoluene	ug/L	NR	-	BDL	(5)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT BASE/NEUTRAL ORGANICS (Cont.)

Parameter	Units	61882-11 mw4		61882-12	
Di-n-octyl phthalate	ug/L	NR	-	BDL	(5)
1,2-Diphenylhydrazine*	ug/L	NR	-	BDL	(5)
Fluoranthene	ug/L	NR	-	BDL	(5)
Fluorene	ug/L	NR	-	BDL	(5)
Hexachlorobenzene	ug/L	NR	-	BDL	(5)
Hexachlorobutadiene	ug/L	NR	-	BDL	(5)
Hexachlorocyclopentadiene	ug/L	NR	-	BDL	(5)
Hexachloroethane	ug/L	NR	-	BDL	(5)
Indeno(1,2,3-cd)pyrene	ug/L	NR	-	BDL	(5)
Isophorone	ug/L	NR	-	BDL	(5)
2-Methylnaphthalene	ug/L	NR	-	BDL	(5)
Naphthalene	ug/L	NR	-	BDL	(5)
Nitrobenzene	ug/L	NR	-	BDL	(5)
N-Nitrosodimethylamine	ug/L	NR	-	BDL	(5)
N-Nitrosodi-n-propylamine	ug/L	NR	-	BDL	(5)
N-Nitrosodiphenylamine*	ug/L	NR	-	BDL	(5)
Phenanthrene	ug/L	NR	-	BDL	(5)
Pyrene	ug/L	NR	-	BDL	(5)
1,2,4-Trichlorobenzene	ug/L	NR	-	BDL	(5)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT ACID ORGANICS

Parameter	Units	61882-11 mw4		61882-12		61882-13	
-Chlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
,4-Dichlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
,4-Dimethylphenol	ug/L	BDL	(5)	19	(5)	BDL	(5)
,6-Dinitro-o-cresol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)
,4-Dinitrophenol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)
-Methylphenol	ug/L	NR	-	BDL	(5)	NR	-
-Methylphenol	ug/L	NR	-	BDL	(5)	NR	-
-Nitrophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
-Nitrophenol	ug/L	BDL	(10)	BDL	(10)	BDL	(10)
-Chloro-m-cresol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Pentachlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
Phenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)
,4,6-Trichlorophenol	ug/L	BDL	(5)	BDL	(5)	BDL	(5)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PRIORITY POLLUTANT VOLATILE ORGANICS

Parameter	Units	61882-11 mw4		61882-12	
Acetone	ug/L	NR	-	BDL	(10)
Acrolein	ug/L	NR	-	BDL	(100)
Acrylonitrile	ug/L	NR	-	BDL	(100)
Benzene	ug/L	NR	-	BDL	(5)
Bromoform	ug/L	NR	-	BDL	(5)
Carbon tetrachloride	ug/L	NR	-	BDL	(5)
Chlorobenzene	ug/L	NR	-	BDL	(5)
Chlorodibromomethane	ug/L	NR	-	BDL	(5)
Chloroethane	ug/L	NR	-	BDL	(10)
2-Chloroethylvinyl ether	ug/L	NR	-	BDL	(5)
Chloroform	ug/L	NR	-	BDL	(5)
Dichlorobromomethane	ug/L	NR	-	BDL	(5)
1,1-Dichloroethane	ug/L	NR	-	BDL	(5)
1,2-Dichloroethane	ug/L	NR	-	BDL	(5)
1,1-Dichloroethylene	ug/L	NR	-	BDL	(5)
1,2-Dichloropropane	ug/L	NR	-	BDL	(5)
1,3-Dichloropropylene (c&t)	ug/L	NR	-	BDL	(5)
Ethylbenzene	ug/L	NR	-	5	(5)
Methylbromide	ug/L	NR	-	BDL	(10)
Methylchloride	ug/L	NR	-	BDL	(10)
Methylene chloride	ug/L	NR	-	BDL	(10)
1,1,2,2-Tetrachloroethane	ug/L	NR	-	BDL	(5)
Tetrachloroethylene	ug/L	NR	-	BDL	(5)
Toluene	ug/L	NR	-	BDL	(5)
1,2-trans-Dichloroethylene	ug/L	NR	-	BDL	(5)
1,1,1-Trichloroethane	ug/L	NR	-	BDL	(5)
1,1,2-Trichloroethane	ug/L	NR	-	BDL	(5)
Trichloroethylene	ug/L	NR	-	BDL	(5)
Vinyl chloride	ug/L	NR	-	BDL	(10)

BDL = Below detection limits. NR = Not requested. Detection limits in parentheses.

ANALYTICAL RESULTS

for

Geoscience Consultants, Ltd.

PURGEABLE ORGANICS - METHOD 602

Parameter	Units	61882-03 MW2		61882-06 BLANK		61882-07 BLANK		61882-08 MW7	
Benzene	ug/L	ND	(0.5)	ND	(0.5)	ND	(0.5)	ND	(0.5)
Chlorobenzene	ug/L	ND	(1)	ND	(1)	ND	(1)	ND	(1)
Ethylbenzene	ug/L	ND	(1)	ND	(1)	ND	(1)	ND	(1)
Toluene	ug/L	6.4	(1)	ND	(1)	ND	(1)	7.2	(1)
1,2-Dichlorobenzene	ug/L	ND	(2)	ND	(2)	ND	(2)	ND	(2)
1,3-Dichlorobenzene	ug/L	ND	(2)	ND	(2)	ND	(2)	ND	(2)
1,4-Dichlorobenzene	ug/L	ND	(2)	ND	(2)	ND	(2)	ND	(2)

Parameter	Units	61882-09 MW5		61882-11 MW4		61882-13 WP2	
Benzene	ug/L	ND	(5)	ND	(5)	ND	(5)
Chlorobenzene	ug/L	ND	(10)	ND	(10)	ND	(10)
Ethylbenzene	ug/L	ND	(10)	39	(10)	ND	(10)
Toluene	ug/L	58	(10)	140	(10)	70	(10)
1,2-Dichlorobenzene	ug/L	ND	(20)	ND	(20)	ND	(20)
1,3-Dichlorobenzene	ug/L	ND	(20)	ND	(20)	ND	(20)
1,4-Dichlorobenzene	ug/L	ND	(20)	ND	(20)	ND	(20)

ND = Not detected. Detection limits in parentheses.

ION BALANCE RESULTS
for sample #61882-01

CATION ANALYSIS

ELEMENT	mg/L	meq/L
Ca	635.000	31.6865
Fe+2	1.700	0.0153
Fe+3	ND	0.0000
Mg	451.000	37.1173
K	2.600	0.0666
Na	637.000	27.7095
NH4	ND	0.0000
TOTAL	1727.300	96.5952

ANION ANALYSIS

ELEMENT	mg/L	meq/L
Cl	904.000	25.4928
F	2.000	0.0512
SO4	3430.000	71.3440
Alk	230.400	7.6800
NO2+NO3	1.700	0.1214
TOTAL	4568.100	104.6894

SUMMARY

% DIFFERENCE =-4.021
CATIONS + ANIONS (mg/L) =6295.400
TDS =%7420.000
HARDNESS =3436.600
CALCULATED THEORETICAL CONDUCTIVITY =%13244.0527
MEASURED CONDUCTIVITY = 1.0000
THEORETICAL/MEASURED CONDUCTIVITY RATIO =%13244.053
MEASURED CONDUCTIVITY/TDS RATIO = 0.000

ND - Not Detected

ION BALANCE RESULTS
for sample #61882-04

CATION ANALYSIS

ELEMENT	mg/L	meq/L
Ca	986.000	49.2014
Fe+2	19.000	0.1710
Fe+3	ND	0.0000
Mg	248.000	20.4104
K	9.000	0.2304
Na	1990.000	86.5650
NH4	ND	0.0000
TOTAL	3252.000	156.5782

ANION ANALYSIS

ELEMENT	mg/L	meq/L
Cl	3080.000	86.8560
F	5.500	0.1408
SO4	3000.000	62.4000
Alk	289.800	9.6600
NO2+NO3	2.100	0.1499
TOTAL	6377.400	159.2067

SUMMARY

% DIFFERENCE =-0.832
CATIONS + ANIONS (mg/L) =9629.400
TDS =%10100.000
HARDNESS =3481.800
CALCULATED THEORETICAL CONDUCTIVITY =%20425.8847
MEASURED CONDUCTIVITY = 1.0000
THEORETICAL/MEASURED CONDUCTIVITY RATIO =%20425.885
MEASURED CONDUCTIVITY/TDS RATIO = 0.000

ND - Not Detected

ION BALANCE RESULTS
for sample #61882-05

CATION ANALYSIS

ELEMENT	mg/L	meq/L
Ca	703.000	35.0797
Fe+2	7.500	0.0675
Fe+3	ND	0.0000
Mg	296.000	24.3608
K	7.200	0.1843
Na	1220.000	53.0700
NH4	ND	0.0000
TOTAL	2233.700	112.7623

ANION ANALYSIS

ELEMENT	mg/L	meq/L
Cl	1210.000	34.1220
F	2.900	0.0742
SO4	2760.000	57.4080
Alk	768.000	25.6000
NO2+NO3	ND	0.0000
TOTAL	4740.900	117.2042

SUMMARY

% DIFFERENCE =-1.932
CATIONS + ANIONS (mg/L) =6974.600
TDS =%8080.000
HARDNESS =2971.100
CALCULATED THEORETICAL CONDUCTIVITY =%14385.3307
MEASURED CONDUCTIVITY = 1.0000
THEORETICAL/MEASURED CONDUCTIVITY RATIO =%14385.331
MEASURED CONDUCTIVITY/TDS RATIO = 0.000

ND - Not Detected

ION BALANCE RESULTS
for sample #61882-10

CATION ANALYSIS

ELEMENT	mg/L	meq/L
Ca	900.000	44.9100
Fe+2	1.300	0.0117
Fe+3	ND	0.0000
Mg	601.000	49.4623
K	9.100	0.2330
Na	2020.000	87.8700
NH4	ND	0.0000
TOTAL	3531.400	182.4870

ANION ANALYSIS

ELEMENT	mg/L	meq/L
Cl	4250.000	119.8500
F	1.000	0.0256
SO4	3080.000	64.0640
Alk	234.600	7.8200
NO2+NO3	ND	0.0000
TOTAL	7565.600	191.7596

SUMMARY

% DIFFERENCE =-2.478
CATIONS + ANIONS (mg/L) =%11097.000
TDS =%14900.000
HARDNESS =4714.100
CALCULATED THEORETICAL CONDUCTIVITY =%24321.3227
MEASURED CONDUCTIVITY = 1.0000
THEORETICAL/MEASURED CONDUCTIVITY RATIO =%24321.323
MEASURED CONDUCTIVITY/TDS RATIO = 0.000

ND - Not Detected

ION BALANCE RESULTS
for sample #61882-12

CATION ANALYSIS

ELEMENT	mg/L	meq/L
Ca	143.000	7.1357
Fe+2	2.700	0.0243
Fe+3	ND	0.0000
Mg	27.000	2.2221
K	9.300	0.2381
Na	150.000	6.5250
NH4	ND	0.0000
TOTAL	332.000	16.1452

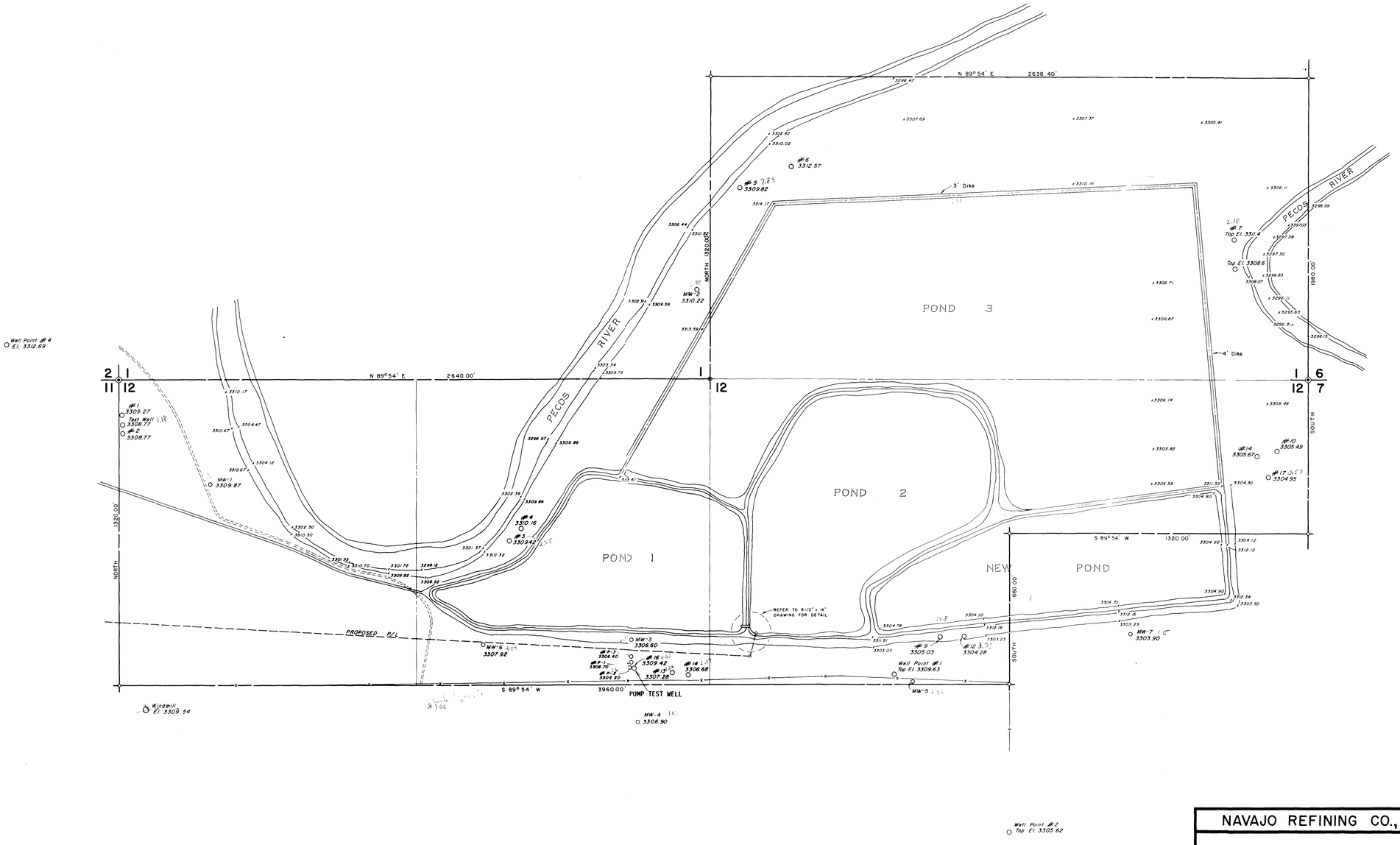
ANION ANALYSIS

ELEMENT	mg/L	meq/L
Cl	202.000	5.6964
F	2.100	0.0538
SO4	257.000	5.3456
Alk	110.400	3.6800
NO2+NO3	ND	0.0000
TOTAL	571.500	14.7758

SUMMARY

% DIFFERENCE = 4.429
CATIONS + ANIONS (mg/L) = 903.500
TDS =%1200.000
HARDNESS = 468.200
CALCULATED THEORETICAL CONDUCTIVITY =1918.0087
MEASURED CONDUCTIVITY = 1.0000
THEORETICAL/MEASURED CONDUCTIVITY RATIO =%1918.009
MEASURED CONDUCTIVITY/TDS RATIO = 0.001

ND - Not Detected



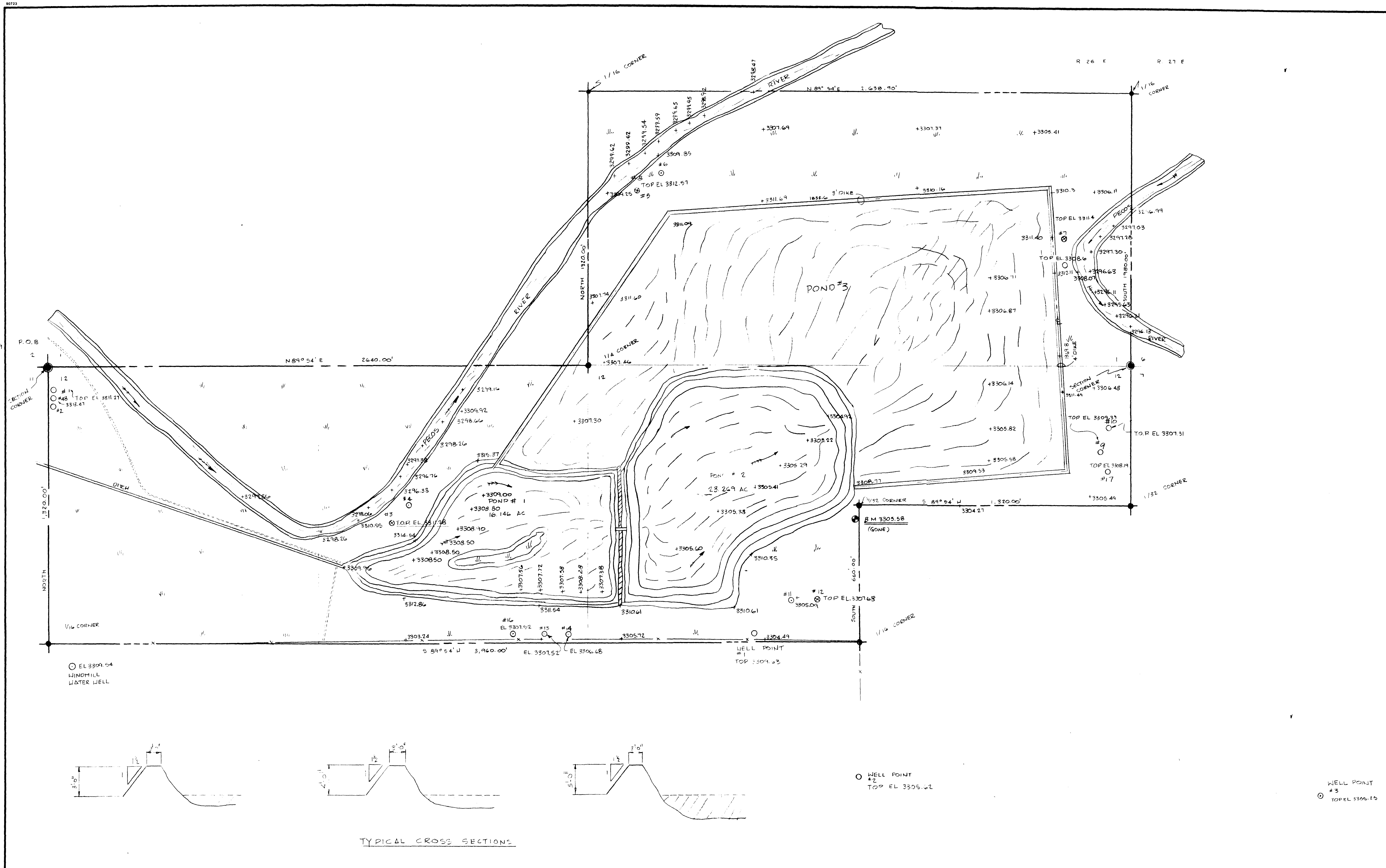
NAVAJO REFINING CO., INC.

NAVAJO PONDS
SITUATE WITHIN
SECTIONS 1 & 12, T 17 S, R 26 E, N.M.P.M.,
EDDY COUNTY, NEW MEXICO

JOHN WEST ENGINEERING CO.
CONSULTANTS
HOBBS NEW MEXICO

Surveyed By J. Love	Drawn By M. Mitchell	Last Rev. Date	Drawing Number
Date Begin	Date 7/19/86	File No.	
Date End 7/17/86	Checked By	Sheet 1 Of 1	

LA 6493



NOTES	REFERENCE DRAWINGS	NO.	REVISIONS	BY	CHK.	DATE	APPR.	APPR.	NO.	REVISIONS	BY	CHK.	DATE	APPR.	APPR.

DRAWING TITLE: NAVAJO PONDS
WELL LOCATIONS

PLATE 3

NAVAJO REFINING COMPANY
ENGINEERING DEPARTMENT
ARTESIA, NEW MEXICO

DRAWN BY	CHK'D BY	SCALE	
GLS		1" = 200'	
DATE	DATE	DRAWING NO.	REV.
5-30-83		102 - 09 - D	0

(Well numbers are SEO application numbers)

Base maps are USGS Artesia and Spring Lake Quadrangles

B

1380

3262

3225

3282

1440

602

4922

6550

7180

3368

Navajo Refinery Grounds

2698

1414

768

6612

307

3195

2749

2723

4196

3353

A

CITY

1090

2368

2155

1749

B'

A'

4438

2649

FAULT

(approx. 100')

Wells projected onto north-south (B-B') cross section

PLATE 6

Geoscience Consultants, Ltd.

TOPOGRAPHIC MAP OF NAVAJO REFINERY AREA SHOWING WATER WELL AND GEOLOGIC CROSS SECTION LOCATIONS

CLIENT: NAVAJO REFINERY CO.

DATE: 11/5/84

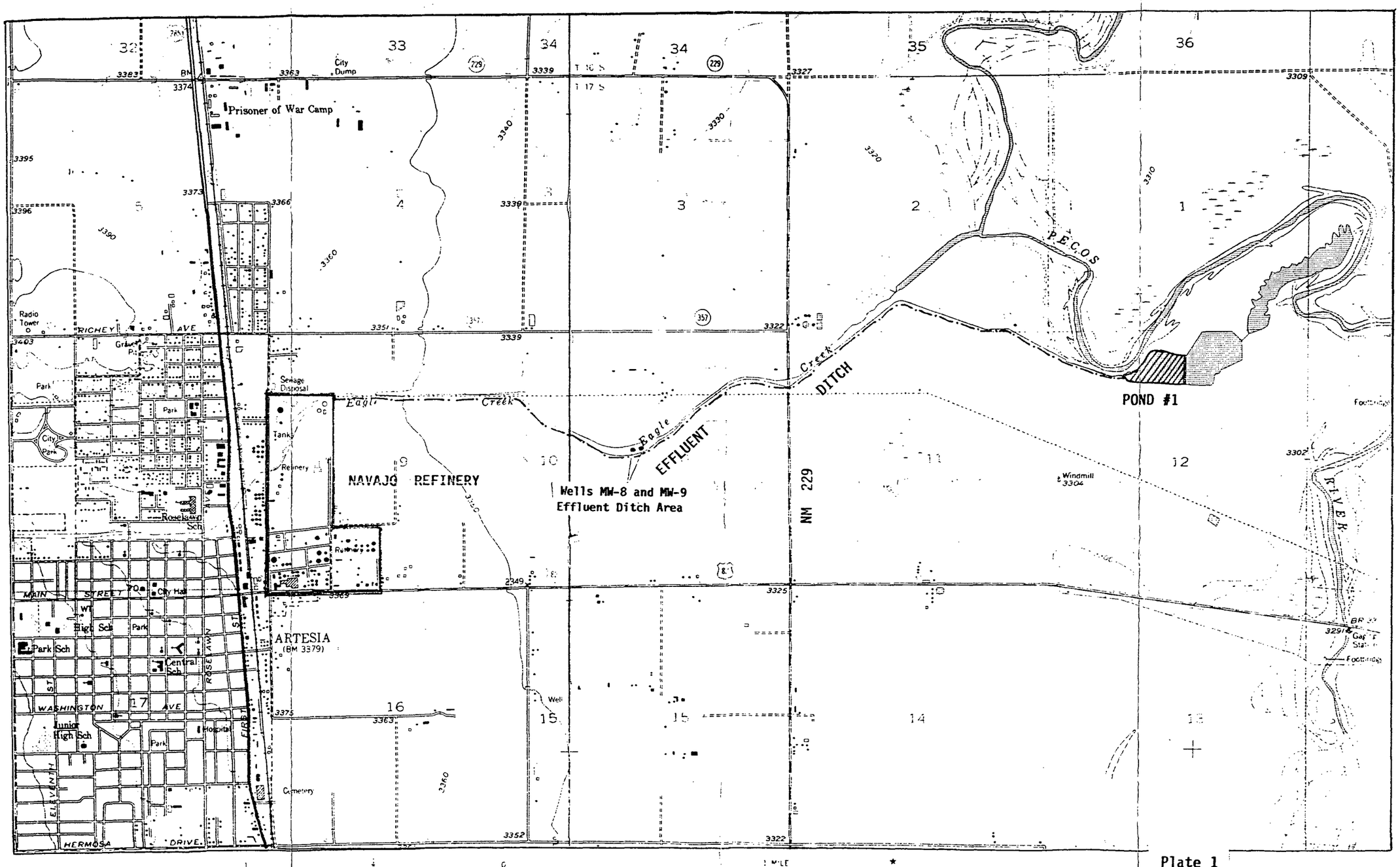
DRAWN BY: Anita Larson

CHECKED BY: James Hunter

REVISED:

SCALE: 1:24,000

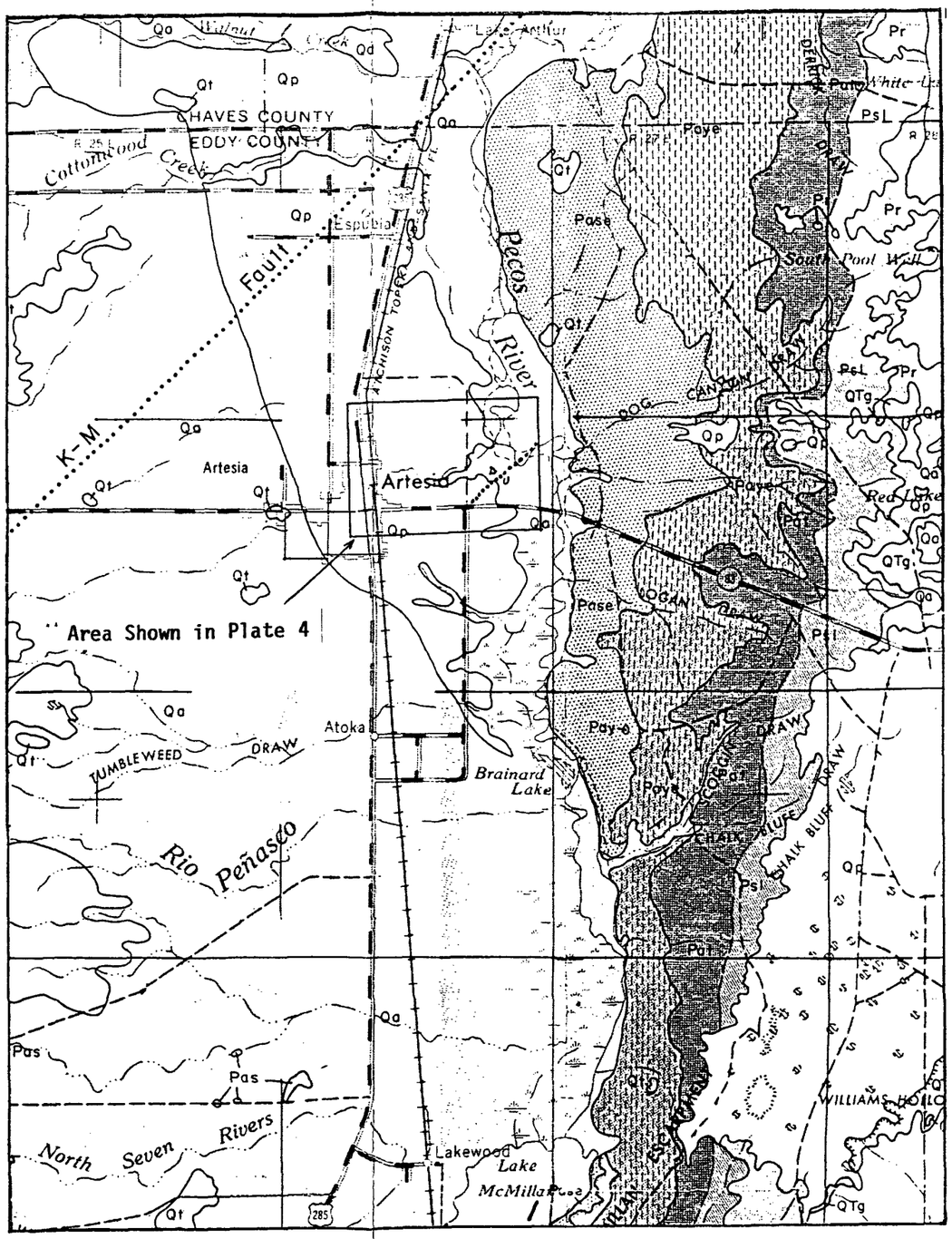
AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS CERTIFICATE NUMBER 6421 AIPG ALBERTO A. GUTIERREZ CERTIFIED PROFESSIONAL GEOLOGIST



CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Plate 1

Location Map of Navajo Refinery Area
Showing Refinery, Ditch and Ponds



SEDIMENTARY ROCKS

Surficial Deposits
Qa, alluvium of stream and valley bottoms; Qs, caliche soil; Qe, blow sand and dunes; Ql, landslides; Qd, disturbed gravel, etc. affected by collapse; Qtr, travertine spring deposits; Qt, terrace gravel; Qp, pediment gravel; Qc, caliche

Gatuna Formation — QTg
Red, tan, and buff sand, gravel, and mudstone

Cub Mountain Formation — TKc
Purplish mudstone and buff, conglomeratic sandstone

Mesaverde Group — Kmv
Olive-drab to black shale, grayish sandstone, and coal

Mancos Shale — Km
Black shale, local sandstone, and limestone

Dakota Sandstone — Kd
Gray to white sandstone, local shale, and conglomerate

Chinle Formation — Tr
Reddish-brown mudstone

Santa Rosa Formation — Trs
Brown, buff, and red sandstone; local conglomerate

Dewey Lake Formation — Pd
Tan-brown, clean sandstone

Rustler Formation — Pr (Pru, Prl)
Dolomite, gypsum, and reddish sandstone; Pru, upper member; Prl, lower member

Salado Formation — Psl
Gypsum, dolomite, mudstone, and orange-red, collapsed, recrystallized, residual breccia

Castile Formation — Pc (Pcu, Pcl)
Gypsum, anhydrite and limestone; Pcu, upper member; Pcl, lower member

CRETACEOUS | TERTIARY | QUATERNARY | TRIASSIC | PERMIAN | PRECAMBRIAN | TERTIARY

EXPLANATION

Artesia Group

Tansill Formation — Pat
Dolomite intertonguing northward into gypsum

Yates Formation — Pay / Paye
Pay, limestone, sandstone, and dolomite southward
Paye, gypsum, dolomite, and siltstone northward

Seven Rivers Formation — Pas / Pase
Pas, limestone and dolomite southward
Pase, gypsum, mudstone and then dolomite northward

Queen and Grayburg Formations — Paq / Pag / Paqg
Paq, Queen Formation; dolomite and sandstone southward; gypsum and mudstone northward
Pag, Grayburg Formation; sandstone and dolomite southward; gypsum, red sandstone, and local dolomite northward
Paqg, Queen and Grayburg Formations undivided in north and locally elsewhere

Pac — Capitan Limestone

Bell Canyon Formation — Pbc
Basin-facies limestone and sandstone

Goat Seep Formation — Pgs
Massive dolomite

San Andres Formation — Psf / Psb / Psbr / Psg
Psf, Fourmile Draw Member; Psb, Bonney Canyon Member; Psr, Rio Bonito Member; Psg, Glorieta Sandstone

Yeso Formation — Py
Tan, yellow and rusty sandstone, red mudstone, dolomite, and gypsum

Precambrian rocks, undivided — Pc
Granite, syenite, and gneiss

IGNEOUS ROCKS

Sierra Blanca Volcanic Group — Tsb
Andesitic to rhyolitic breccia, tuff, and flows

Dikes, sills, stocks, and laccoliths — Ti / Tis / Tig / Tir / Tim / Tid
Ti, not identified; Tis, syenite or latite; Tig, granite or aplite; Tir, rhyolite; Tim, monzonite; Tid, diorite or diabase

PLATE 4 Geologic Map of Artesia Area

EXPLANATION

QUATERNARY

Qal — Alluvium
Silt, sand, gravel and clay. Stippled area indicates granular or gravelly deposits.

Qe — Eolian deposits
Wind-blown sand

Qc — Caliche deposits
Medium to hard, nodular, caliche; locally having a well-cemented caprock

Qab — Alluvium and bolson deposits
Sand, silt and clay deposited in lowlands; rarely having local incrustations of soft nodular caliche

Qcg — Caliche and gravel
Caliche-capped limestone gravel, sand, silt and clay underlain locally by deposits of lime-cemented conglomerate

Qgt — Gatuña Formation
Well indurated sand, gravel, silt and clay derived from the Ogallala formation

PERMIAN

Pr — Rustler Formation
Anhydrite, gypsum, interbedded red and green sandy clay, and some beds of dolomite

Psl — Salado Formation
Residual material derived from the solution of halite, anhydrite, polyhalite and other potassium salts and red sandy shale

Pt — Tansill Formation
Light olive-gray to very pale orange, fine-grained, laminated dolomite, and rare, thin beds of very pale orange, fine-grained quartz sandstone or siltstone

Pya — Yates Formation
Very pale orange to yellowish-gray, fine-grained, laminated dolomite, alternating with grayish-orange to pale yellowish-orange, calcareous quartz siltstone or very fine-grained sandstone

Psr — Seven Rivers Formation
Gray to white dolomitic limestone, white and red gypsum, orange-red siltstone and shale

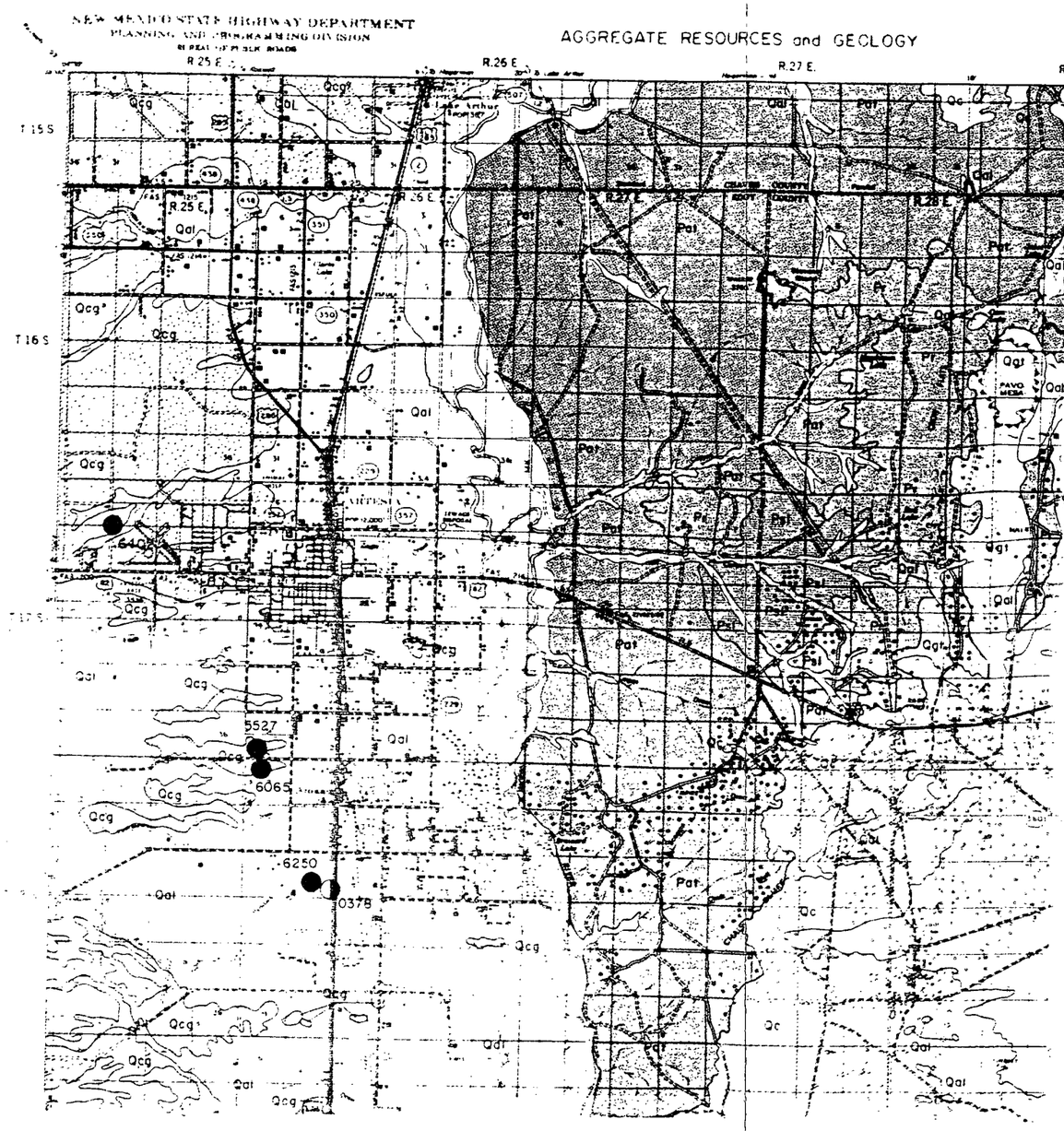
Pq — Queen Formation
Red to white gypsum, interbedded sandstone, siltstone and dolomite. Surface exposures are primarily evaporite.

Pat — Artesia group undivided
Primarily red to white gypsum with some interbeds of dolomite, sandstone and siltstone. This essentially represents a lateral facies change where the Seven Rivers, Queen, Yates and Tansil formations become indistinguishable as separate units.

- Developed pit or quarry
- Prospect pit or quarry
- * Selected exploration sites

NEW MEXICO STATE HIGHWAY DEPARTMENT
PLANNING AND PROGRAMMING DIVISION
BUREAU OF PUBLIC ROADS

AGGREGATE RESOURCES and GEOLOGY



Surficial Geology of Artesia Area

PLATE 5

EDDY AREA, NEW MEXICO — SHEET NUMBER 6

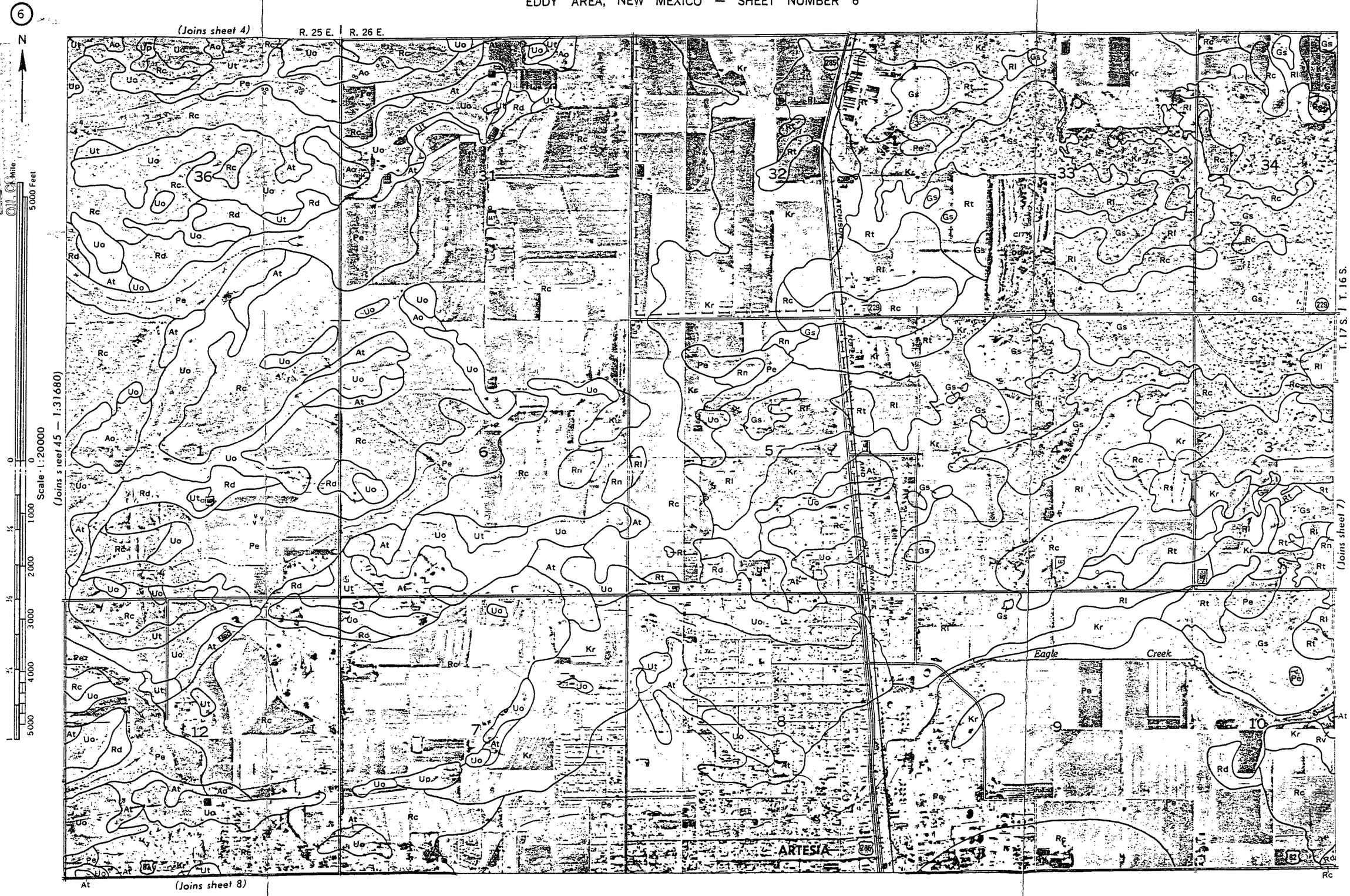
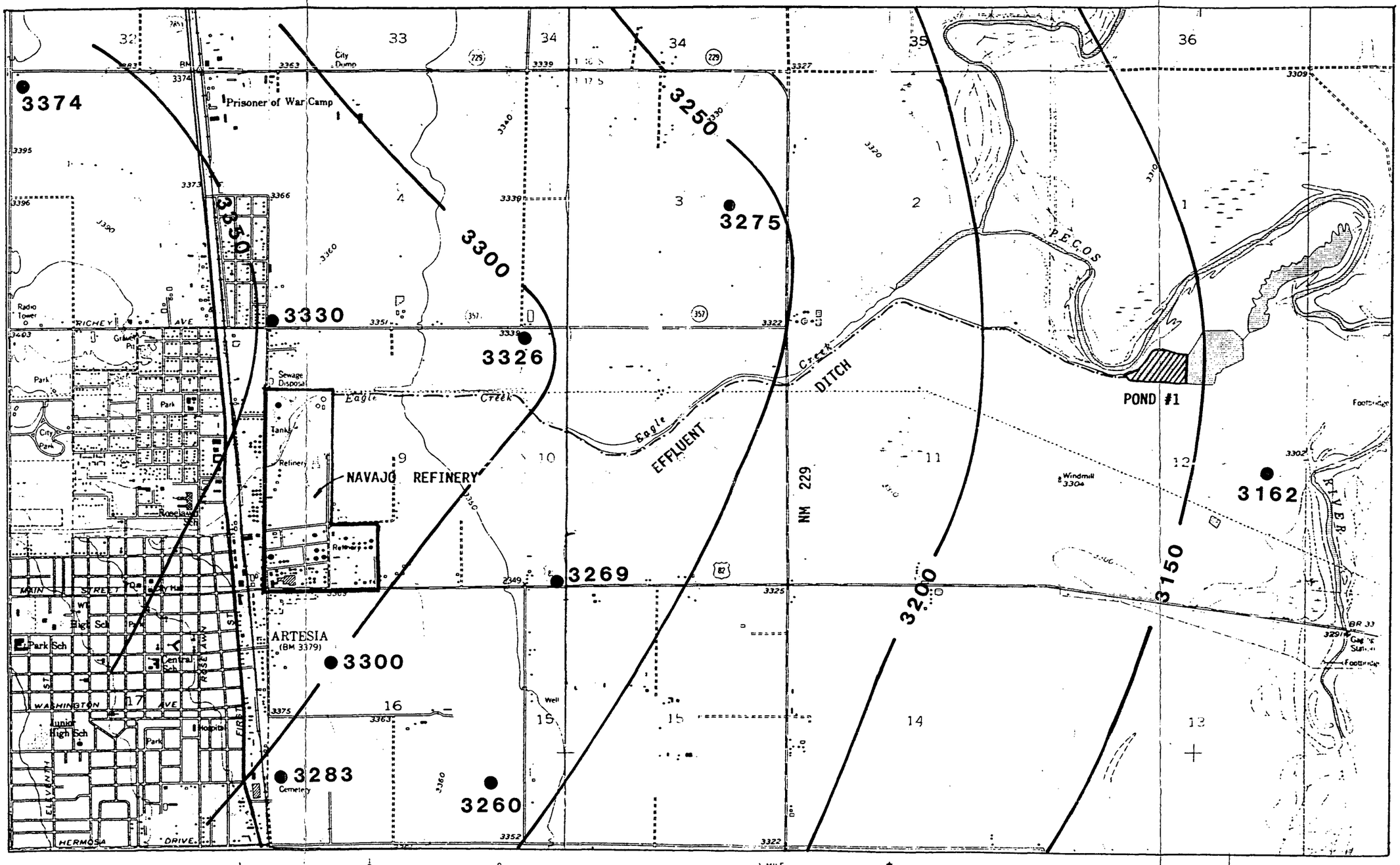


PLATE 7

EDDY AREA, NEW MEXICO — SHEET NUMBER 7

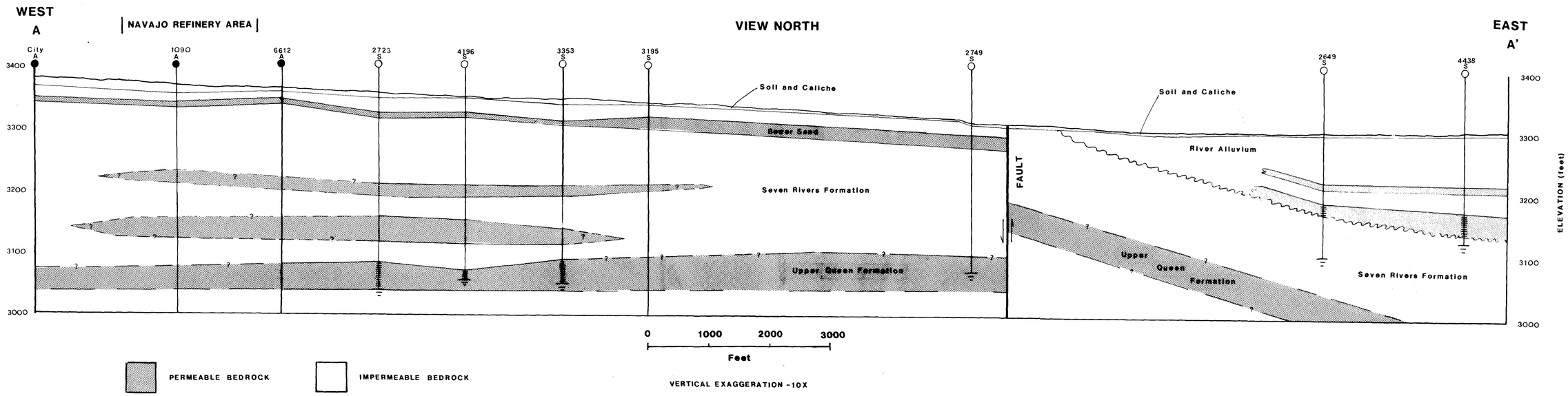
PLATE 8

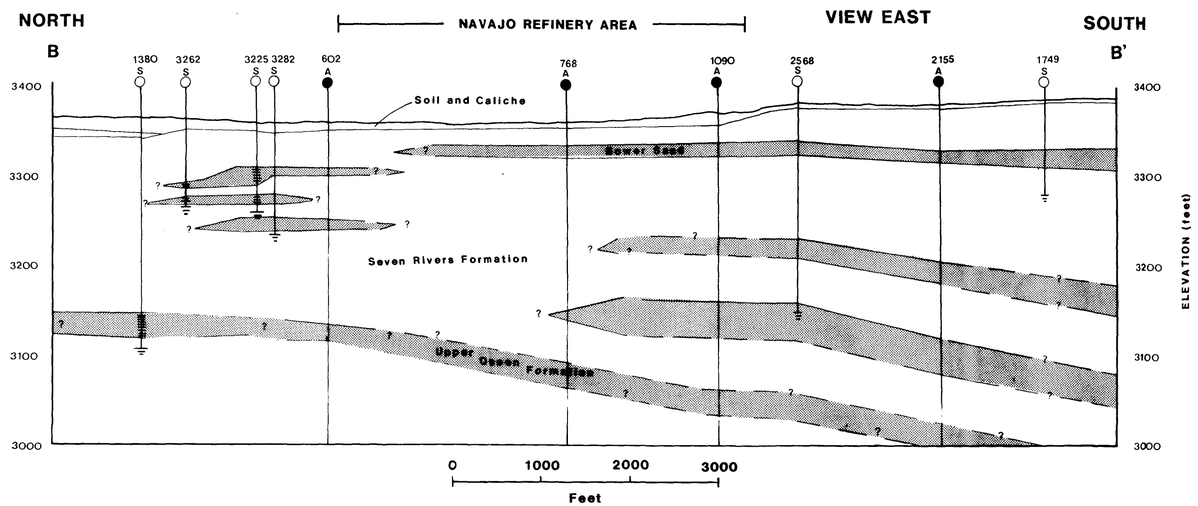


CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

POTENTIOMETRIC SURFACE
QUEEN AQUIFER

PLATE 10



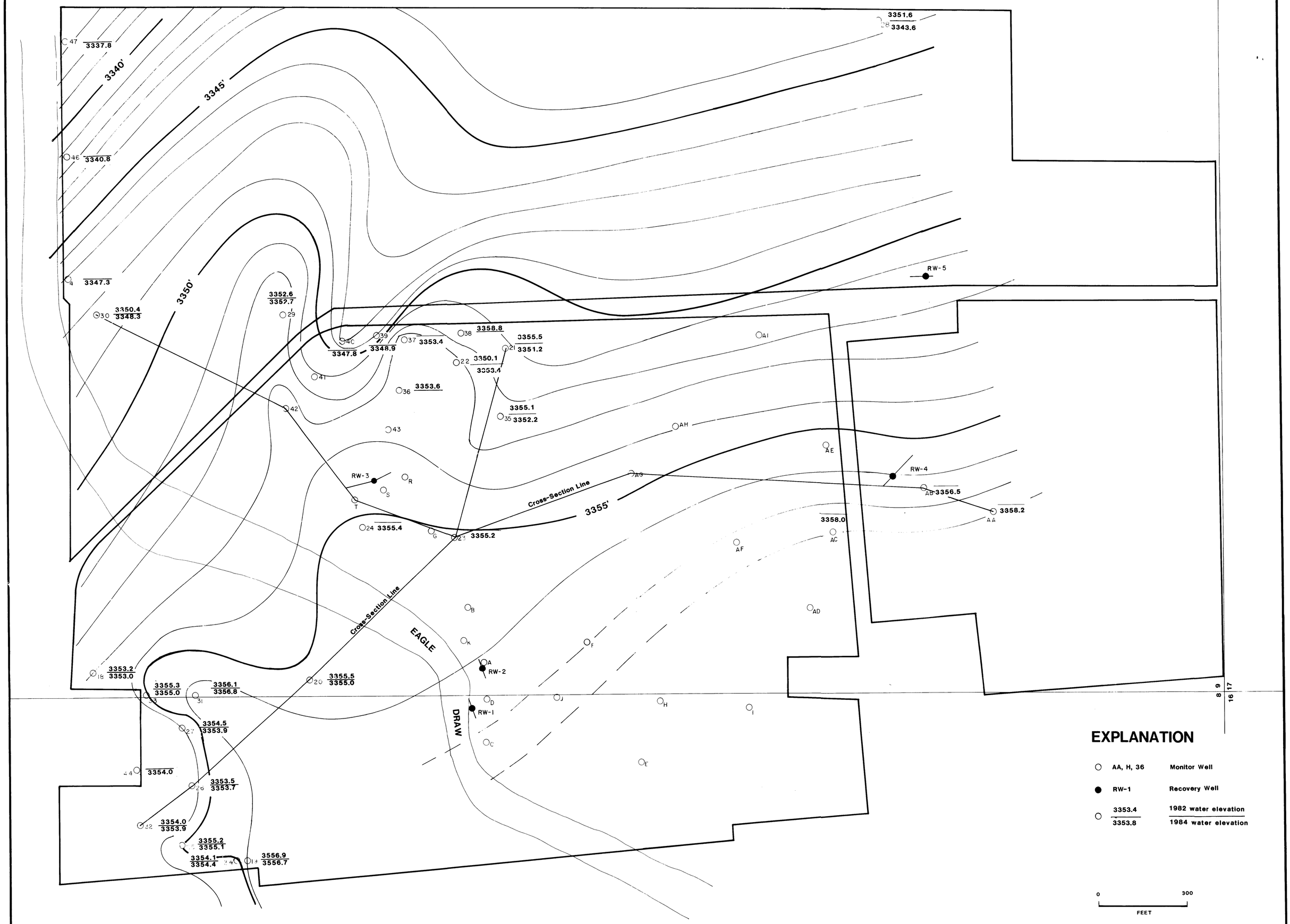


Geoscience Consultants, Ltd.

PLATE 9

CROSS SECTIONS NAVAJO REFINING COMPANY AND ARTESIA , NEW MEXICO AREA

CLIENT:	NAVAJO REFINING CO.
DATE:	10/11/84
DRAWN BY:	Anita Larson
CHECKED BY:	Randy Hicks
REVISED:	
SCALE:	1:22,000(H) 1:1200(V)



Geoscience Consultants, Ltd.

PLATE 11

POTENTIOMETRIC SURFACE

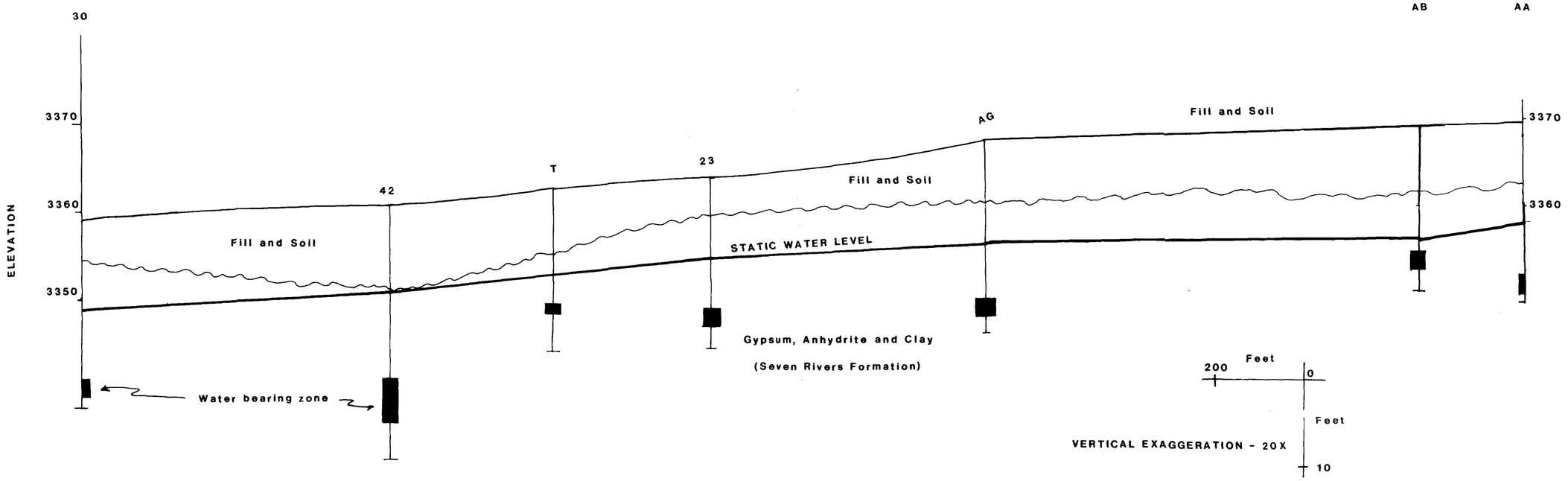
SHALLOW PERCHED AQUIFER

NAVAJO REFINING COMPANY ARTESIA , NEW MEXICO

CLIENT:	NAVAJO REFINING COMPANY
DATE:	November 9, 1984
DRAWN BY:	James Hunter
CHECKED BY:	
REVISED:	
SCALE:	1 inch equals 150 feet

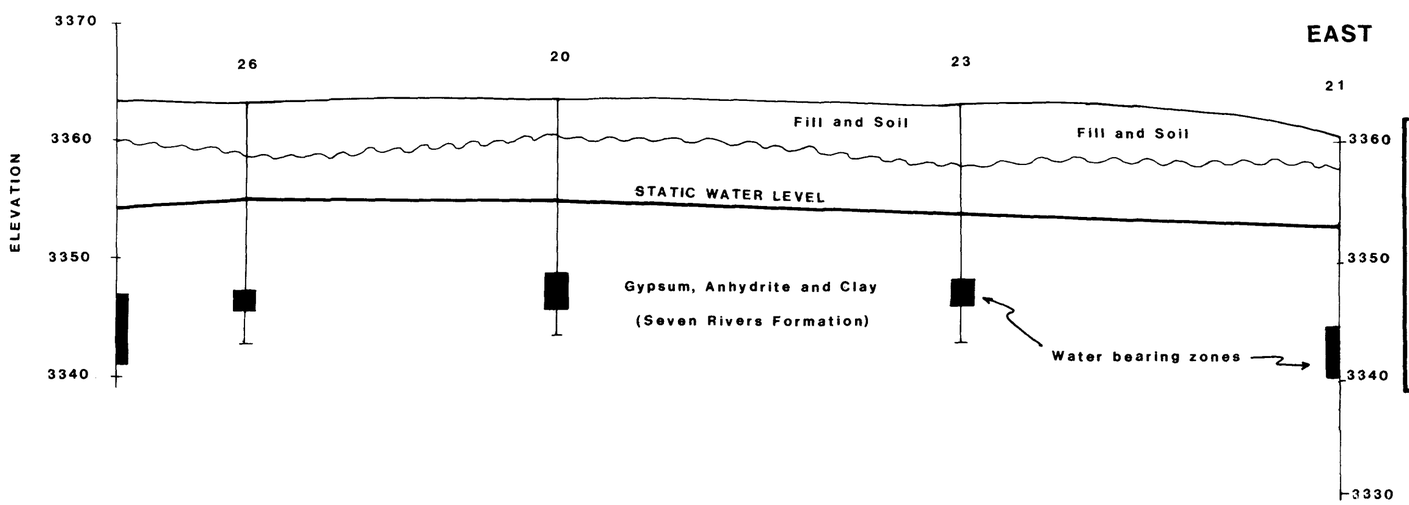
View East

NORTH — SOUTH



View North

WEST — EAST

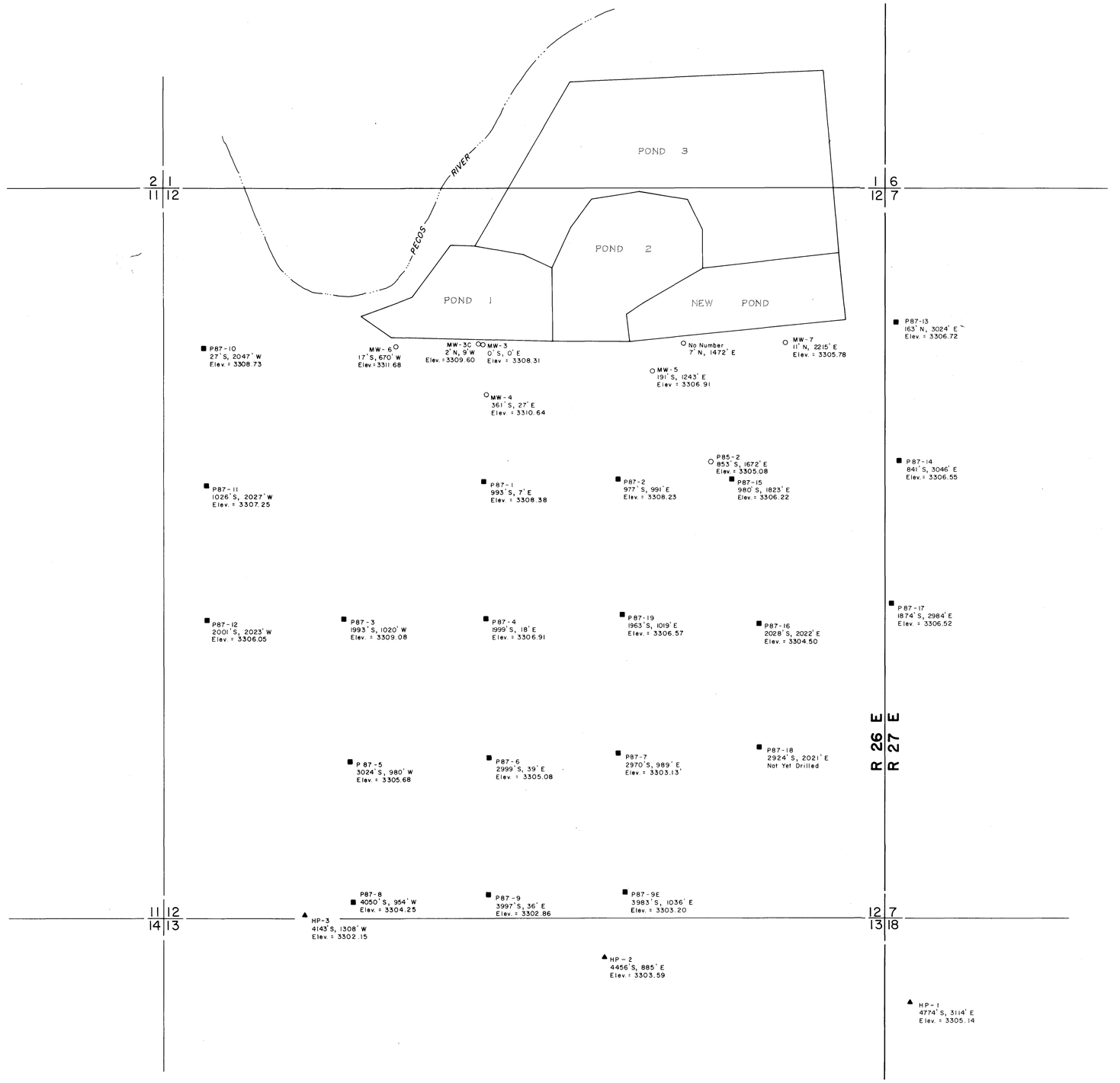


Geoscience Consultants, Ltd.

PLATE 12

HYDROGEOLOGIC CROSS SECTION OF REFINERY SITE AREA

CLIENT:	NAVAJO REFINING CO.
DATE:	11/5/84
DRAWN BY:	Anita Larson
CHECKED BY:	James Hunter
REVISED:	
SCALE:	



SCALE : 1" = 400'

- ○ MONITOR WELL
- ■ POINT INSTALLED IN THIS STUDY (1987)
- ○ POINT INSTALLED IN EARLIER STUDY (1985)
- ▲ POINT INSTALLED BY UNKNOWN AGENCY

NOTE: Coordinate origin is well MW-3
All elevations are to the top of well pipe.

I hereby certify that this plat was made from notes taken in the field in a bona fide survey made under my supervision, and that the same is true and correct to the best of my knowledge and belief.

John W. West, N.M. P.E. & L.S. No. 676

JUN - 2 1987

OIL CONSERVATION DIVISION

PLATE 13

GEO SCIENCE CONSULTANTS

LOCATION OF MONITOR WELLS SITUATE WITHIN SECTIONS 12 & 13, T 17 S, R 26 E, AND IN SECTIONS 7 & 18, T 17 S, R 27 E, ALL N.M.P.M., EDDY COUNTY, NEW MEXICO.

JOHN WEST ENGINEERING CO.
CONSULTANTS
HOBBS NEW MEXICO

Surveyed By T. Asel	Drawn By M. Mitchell	Last Rev. Date	Drawing Number
Date Begin 3/11/87	Date 3/17/87	File No.	
Date End 3/12/87	Checked By	Sheet 1 Of 1	

31952

LA 6493