GW - 1

REPORTS

YEAR(S):

1986

Bloomfield Refining Company
A Gary Energy Corporation Subsidiary

June 2, 1986

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. R. L. Stamets
Director
Energy & Minerals Department
Oil Conservation Division
State of New Mexico
State Land Office Building
P. O. Box 2088
Santa Fe, NM 87501

Dear Mr. Stamets:

In response to your letter of March 4, 1986, to Mr. Chris Hawley, we have had our consultant, Engineering Science, prepare the enclosed "Report on Subsurface Hydrocarbon Data at the Bloomfield Refinery" for OCD's review. Also enclosed are final analytical results for the April 22, 1986, Hammond Ditch samples (taken within 24 hours of the start of the irrigation season), and a subsequent set of Hammond Ditch samples taken on April 28, 1986. You will note that the results for the second set of samples show that the small amounts of hydrocarbons found in the initial samples are no longer present.

We are using this information to develop a plan for installation of recovery wells. As requested in your letter, this plan will be submitted to OCD no later than July 1, 1986.

Sincerely,

David J. Younggren
Vice President Finance
and Administration

enclosures

DJY:dam

115 Inverness Drive East • Englewood, Colorado 80112-5116 • 303/799-3800 • TWX 910-935-0791

June 1986

REPORT ON SUBSURFACE HYDROCARBON DATA AT THE BLOOMFIELD REFINERY

PREAPARED FOR

BLOOMFIELD REFINING COMPANY

PREPARED BY

ENGINEERING-SCIENCE
AUSTIN, TEXAS 78722 - 512/477-9901
ES

SECTION 1

INTRODUCTION

This report has been developed in response to a March 4, 1986, letter from the New Mexico Oil Conservation Division (NMOCD) requesting information on subsurfacce hydrocarbons at the Bloomfield Refinery in Bloomfield, New Mexico. The refinery is currently conducting an investigation of the subsurface hydrocarbons under a Consent Agreement. Data developed as a part of this investigation which are responsive to NMOCD's request are summarized in this report.

Additional historic data were summarized previously in a seprate document entitled "A Review of Subsurface Petroleum Hydrocarbons at the Bloomfield Refinery" issued in January 1985. These data are not repeated in this submittal. The reader should refer to this report if additional information is needed.

Following this introduction, the data are organized into the following sections: Electrical Resistivity Data, Section 2; Monitoring Well Data, Section 3.

SECTION 2

ELECTRICAL RESISTIVITY SURVEY

INTRODUCTION

An electrical resistivity (ER) survey was conducted at the Bloomfield Refining Company's refinery in Bloomfield, New Mexico, during the period from January 27 to February 7, 1986. The objectives of this investigation were as follows:

(1) To locate, identify the source of, and track the extent of any subsurface hydrocarbon plumes.

(2) To determine if an east-west depression is present in the Nacimiento Formation.

(3) To recommend locational changes for groundwater monitoring wells.

METHODOLOGY

The ER survey was conducted with a Bison Earth Resistivity Model 2350B meter which uses an electrical current to measure the relative electrical resistance of the earth in ohms (Bison, 1975). Varying subsurface conditions resulted in a range of observed values during the survey. Relatively high values are believed to indicate dry unconsoldated sediments, sandstone, and/or assumed unimpacted groundwater, whereas relatively low values are believed to indicate a shale in a predominantly sandstone sequence, weathered or fractured sandstone, and/or subsurface hydrocarbons. In this survey, both vertical (soundings) and horizontal (profiles) measurements were taken.

Soundings (vertical resistivity measurements) were conducted at various depths at individual ground surface locations. The method used at the Bloomfield Refinery was the "Modified Wenner" Electrode Array (Carrington and Watson, 1981). In this method, the current electrodes, which are those farthest away from the center of the array, remain stationary while the potential electrodes, which are closest to the center of the array, are moved away from the center at equally spaced intervals. In using the

"Modified Wenner" Electrode Array, the distance between the potential electrodes closely approximates the depth of the subsurface investigation. Figure 2.1 illustrates the resistivity electrode array used for the soundings.

Profiles (horizontal resistivity measurements) were conducted at one depth zone at many ground surface locations. The profile method used at the Bloomfield Refinery was the Wenner Array. In using this method, the approximate depth of investigation is a zone of the subsurface which equals three-fourths to one times the electrode spacing (USGS, 1977). For example, an electrode spacing of 30 feet in the Wenner Array would cover a zone of the subsurface between 23 and 30 feet deep. Figure 2.2 illustrates the resistivity electrode array used for the profiles. Shallow profiles conducted at the Bloomfield Refinery consisted of zone depths of 10 and 20 feet. The 30- and 40-foot profile depths were used to evaluate the top of the Nacimiento Formation, while the 60- 80-, and 100-foot depths were used to investigate the Nacimiento Formation.

ELECTRICAL RESISTIVITY SOUNDINGS

The soundings were used to assist in the evaluation of the subsurface hydrology and geology underlying the refinery. The sounding data obtained during the survey are tabulated in Tables 2.1 through 2.6. Some of the features that were interpreted from the soundings obtained were the depth of fill material, water table, cobble zones, top of bedrock and shaly or weathered-fractured zones within the subsurface.

Six soundings, located in Figure 2.3, were conducted at the Bloomfield Refinery. The location of sounding 1 (Figure 2.4) was near monitoring well MW-6. The unconsolidated sediment zone, which consists of sand, silt, clay, cobbles, and pebbles, extends from the ground surface to approximately 46 feet at which depth the Nacimiento Formation is believed to subcrop. A shaly zone of the Nacimiento may exist from a 67- to 90-foot depth.

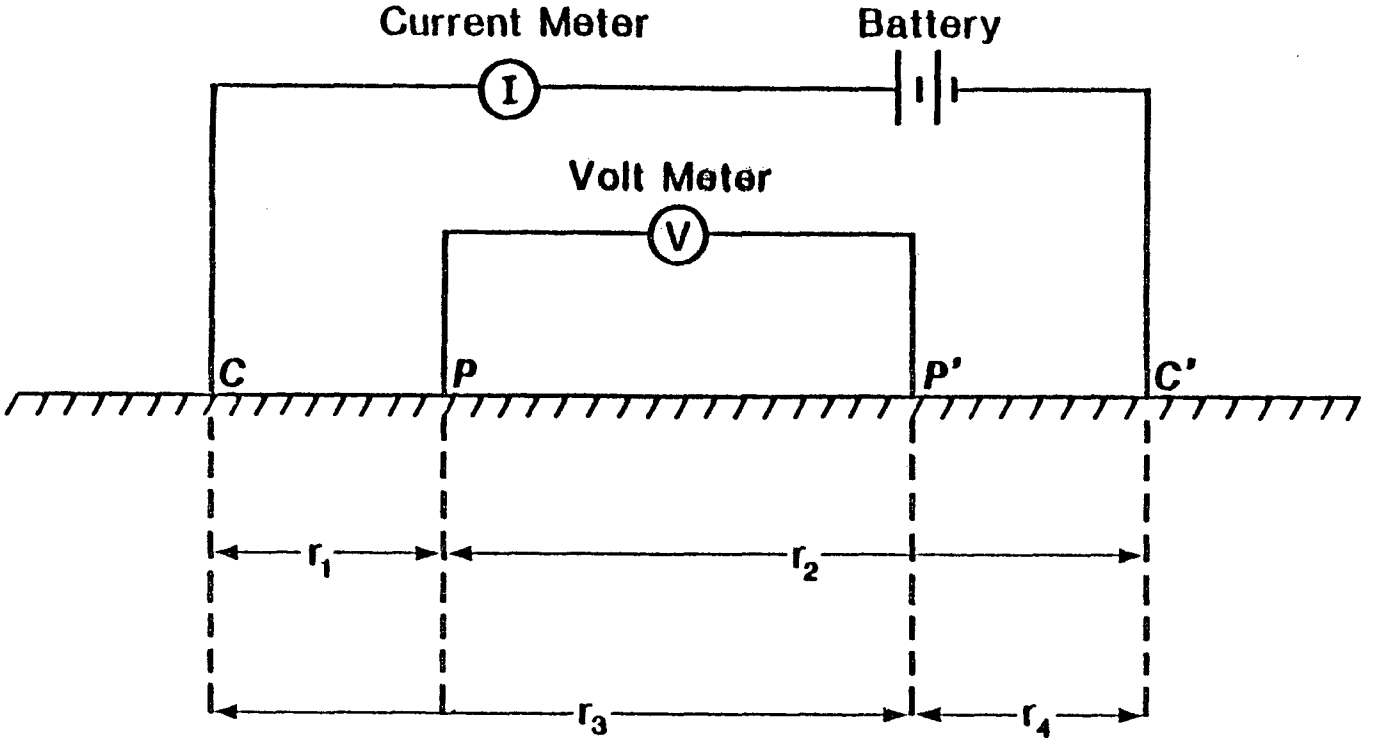
Sounding 2 (Figure 2.5) was conducted near monitoring well MW-1. The top of the Nacimiento Formation is believed to begin at a depth of 24 feet. A possible perched water table may exist at a 10-feet depth.

FIGURE 2.1

"MODIFIED WENNER" ARRAY
DIAGRAM OF ELECTRODE SPACING

Formula for Apparent Resistivity

$$\rho = (2\pi R)\left[\frac{1}{1/r_1 - 1/r_2 - 1/r_3 + 1/r_4}\right]$$



SOURCE: Carrington & Watson, 1981

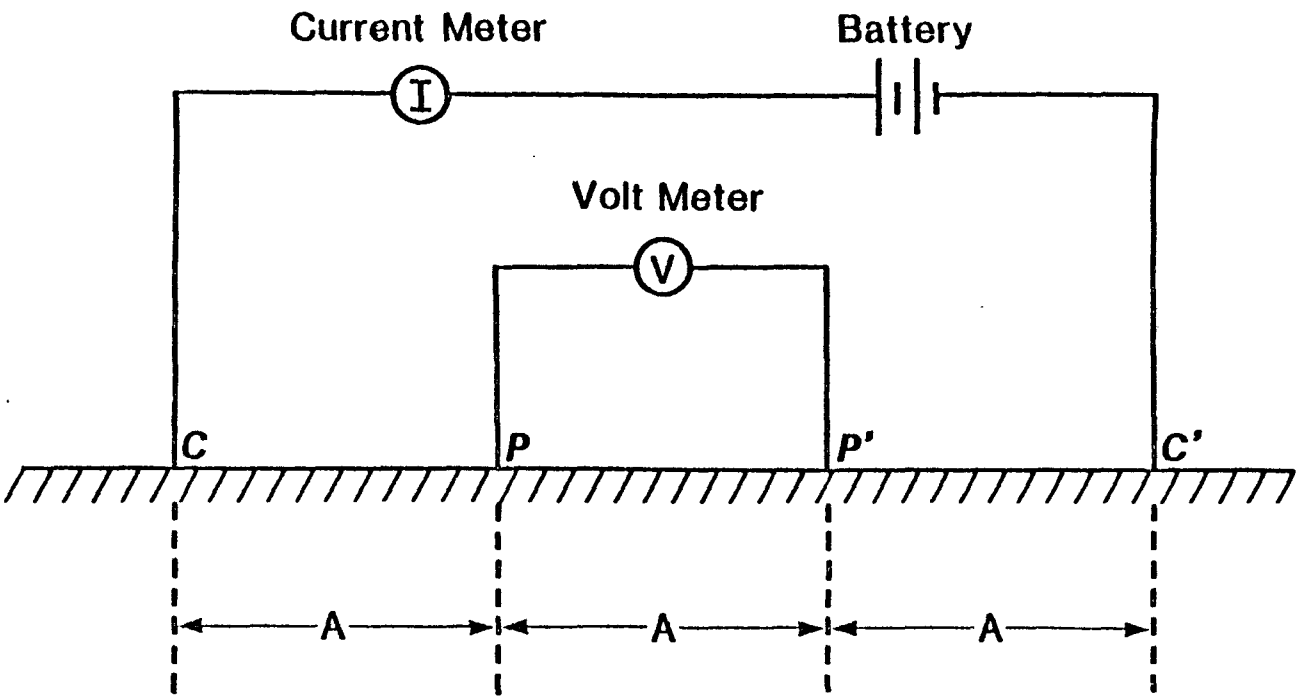
FIGURE 2.2

WENNER ARRAY

DIAGRAM OF ELECTRODE SPACING

Formula for Apparent Resistivity

$$\rho = A(2\pi\frac{V}{I})$$



SOURCE: Bison, 1975

TABLE 2.1

SOUNDING 1 BLOOMFIELD REFINING CO.
BLOOMFIELD, NEW MEXICO

p-p1 spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	*K (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.00	4.00	0.010	0.0400	2499.80	99.99	99.99
4.00	7.00	0.010	0.0700	1249.50	87.47	187.46
6.00	10.50	0.010	0.1050	832.60	87.42	274.88
8.00	17.00	0.010	0.1700	624.00	106.08	380.96
10.00	20.00	0.010	0.2000	498.80	99.76	480.72
12.00	23.50	0.010	0.2350	415.20	97.57	578.29
14.00	25.00	0.010	0.2500	355.40	88.85	667.14
16.00	28.00	0.010	0.2800	310.50	86.94	754.08
18.00	33.00	0.010	0.3300	275.50	90.92	845.00
20.00	37.00	0.010	0.3700	247.50	91.58	936.57
22.00	38.00	0.010	0.3800	224.50	85.31	1021.88
24.00	42.50	0.010	0.4250	205.30	87.25	1109.13
26.00	44.50	0.010	0.4450	189.10	84.15	1193.28
28.00	49.00	0.010	0.4900	175.10	85.80	1279.08
30.00	54.50	0.010	0.5450	162.90	88.78	1367.86
32.00	58.00	0.010	0.5800	152.30	88.33	1456.20
34.00	61.00	0.010	0.6100	142.80	87.11	1543.31
36.00	61.00	0.010	0.6100	134.40	81.98	1625.29
38.00	70.00	0.010	0.7000	126.80	88.76	1714.05
40.00	71.50	0.010	0.7150	120.00	85.80	1799.85
42.00	76.00	0.010	0.7600	113.80	86.49	1886.34
44.00	81.00	0.010	0.8100	108.10	87.56	1973.90
46.00	84.00	0.010	0.8400	102.90	86.44	2060.33
48.00	88.50	0.010	0.8850	98.20	86.91	2147.24
50.00	93.00	0.010	0.9300	93.80	87.23	2234.48
52.00	98.00	0.010	0.9800	89.70	87.91	2322.38
54.00	100.00	0.010	1.0000	85.80	85.80	2408.18
56.00	102.50	0.010	1.0250	82.30	84.36	2492.54
58.00	107.00	0.010	1.0700	79.00	84.53	2577.07
60.00	108.50	0.010	1.0850	75.80	82.24	2659.31
62.00	111.50	0.010	1.1150	72.90	81.28	2740.60
64.00	117.00	0.010	1.1700	70.10	82.02	2822.61
66.00	119.00	0.010	1.1900	67.50	80.33	2902.94
68.00	124.50	0.010	1.2450	65.00	80.93	2983.86
70.00	126.50	0.010	1.2650	62.70	79.32	3063.18
72.00	129.00	0.010	1.2900	60.40	77.92	3141.09
74.00	129.00	0.010	1.2900	58.30	75.21	3216.30
76.00	133.00	0.010	1.3300	56.30	74.88	3291.18
78.00	140.00	0.010	1.4000	54.40	76.16	3367.34
80.00	144.00	0.010	1.4400	52.50	75.60	3442.94
82.00	150.00	0.010	1.5000	50.70	76.05	3518.99
84.00	156.00	0.010	1.5600	49.00	76.44	3595.43
86.00	160.00	0.010	1.6000	47.40	75.84	3671.27
88.00	167.00	0.010	1.6700	45.80	76.49	3747.76
90.00	176.00	0.010	1.7600	44.30	77.97	3825.72
92.00	182.00	0.010	1.8200	42.80	77.90	3903.62
94.00	192.00	0.010	1.9200	41.40	79.49	3983.11
96.00	203.00	0.010	2.0300	40.10	81.40	4064.51
98.00	209.50	0.010	2.0950	38.80	81.29	4145.80
100.00	212.00	0.010	2.1200	37.50	79.50	4225.30

*APPARENT RESISTIVITY = (2iiR) [1/1/r1-1/r2-1/r3+1/r4] where K=[]

TABLE 2.2

SOUNDING 2 BLOOMFIELD REFINING CO.
BLOOMFIELD, NEW MEXICO

p-p1 spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	*k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.00	10.50	0.010	0.1050	2499.80	262.48	262.48
4.00	20.50	0.010	0.2050	1249.50	256.15	518.63
6.00	30.50	0.010	0.3050	832.60	253.94	772.57
8.00	38.50	0.010	0.3850	624.00	240.24	1012.81
10.00	47.00	0.010	0.4700	498.80	234.44	1247.25
12.00	59.50	0.010	0.5950	415.20	247.04	1494.29
14.00	70.00	0.010	0.7000	355.40	248.78	1743.07
16.00	81.50	0.010	0.8150	310.50	253.06	1996.13
18.00	93.00	0.010	0.9300	275.50	256.22	2252.34
20.00	101.50	0.010	1.0150	247.50	251.21	2503.55
22.00	112.50	0.010	1.1250	224.50	252.56	2756.12
24.00	121.50	0.010	1.2150	205.30	249.44	3005.56
26.00	132.50	0.010	1.3250	189.10	250.56	3256.11
28.00	145.00	0.010	1.4500	175.10	253.90	3510.01
30.00	155.00	0.010	1.5500	162.90	252.50	3762.50
32.00	167.50	0.010	1.6750	152.30	255.10	4017.61
34.00	180.50	0.010	1.8050	142.80	257.75	4275.36
36.00	191.50	0.010	1.9150	134.40	257.38	4532.74
38.00	203.50	0.010	2.0350	126.80	258.04	4790.77
40.00	218.00	0.010	2.1800	120.00	261.60	5052.37
42.00	229.50	0.010	2.2950	113.80	261.17	5313.55
44.00	243.50	0.010	2.4350	108.10	263.22	5576.77
46.00	256.50	0.010	2.5650	102.90	263.94	5840.71
48.00	271.50	0.010	2.7150	98.20	266.61	6107.32
50.00	285.50	0.010	2.8550	93.80	267.80	6375.12
52.00	299.50	0.010	2.9950	89.70	268.65	6643.77
54.00	316.00	0.010	3.1600	85.80	271.13	6914.90
56.00	330.00	0.010	3.3000	82.30	271.59	7186.49
58.00	345.00	0.010	3.4500	79.00	272.55	7459.04
60.00	361.50	0.010	3.6150	75.80	274.02	7733.06
62.00	379.00	0.010	3.7900	72.90	276.29	8009.35
64.00	397.00	0.010	3.9700	70.10	278.30	8287.64
66.00	412.50	0.010	4.1250	67.50	278.44	8566.08
68.00	426.00	0.010	4.2600	65.00	276.90	8842.98
70.00	442.50	0.010	4.4250	62.70	277.45	9120.43
72.00	458.00	0.010	4.5800	60.40	276.63	9397.06
74.00	476.00	0.010	4.7600	58.30	277.51	9674.57
76.00	496.00	0.010	4.9600	56.30	279.25	9953.82
78.00	516.50	0.010	5.1650	54.40	280.98	10234.79
80.00	541.00	0.010	5.4100	52.50	284.03	10518.82
82.00	561.50	0.010	5.6150	50.70	284.68	10803.50
84.00	582.50	0.010	5.8250	49.00	285.43	11088.92
86.00	605.00	0.010	6.0500	47.40	286.77	11375.69
88.00	627.50	0.010	6.2750	45.80	287.40	11663.09
90.00	653.50	0.010	6.5350	44.30	289.50	11952.59
92.00	679.00	0.010	6.7900	42.80	290.61	12243.20
94.00	704.50	0.010	7.0450	41.40	291.66	12534.86
96.00	732.00	0.010	7.3200	40.10	293.53	12828.40
98.00	757.50	0.010	7.5750	38.80	293.91	13122.31
100.00	791.00	0.010	7.9100	37.50	296.63	13418.93

*APPARENT RESISTIVITY = (2iiR) [1/1/r1-1/r2-1/r3+1/r4] where K=[]

TABLE 2.3

SOUNDING 3 BLOOMFIELD REFINING CO.
BLOOMFIELD, NEW MEXICO

p-p1 spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	*k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.00	5.50	0.010	0.0550	2499.80	137.49	137.49
4.00	1.50	0.010	0.0150	1249.50	18.74	156.23
6.00	4.50	0.010	0.0450	832.60	37.47	193.70
8.00	11.50	0.010	0.1150	624.00	71.76	265.46
10.00	8.00	0.010	0.0800	498.80	39.90	305.36
12.00	6.00	0.010	0.0600	415.20	24.91	330.27
14.00	10.00	0.010	0.1000	355.40	35.54	365.81
16.00	10.50	0.010	0.1050	310.50	32.60	398.42
18.00	17.50	0.010	0.1750	275.50	48.21	446.63
20.00	14.50	0.010	0.1450	247.50	35.89	482.52
22.00	13.50	0.010	0.1350	224.50	30.31	512.82
24.00	16.50	0.010	0.1650	205.30	33.87	546.70
26.00	18.00	0.010	0.1800	189.10	34.04	580.74
28.00	21.00	0.010	0.2100	175.10	36.77	617.51
30.00	22.00	0.010	0.2200	162.90	35.84	653.35
32.00	22.50	0.010	0.2250	152.30	34.27	687.61
34.00	24.00	0.010	0.2400	142.80	34.27	721.89
36.00	26.00	0.010	0.2600	134.40	34.94	756.83
38.00	26.00	0.010	0.2600	126.80	32.97	789.80
40.00	32.00	0.010	0.3200	120.00	38.40	828.20
42.00	30.00	0.010	0.3000	113.80	34.14	862.34
44.00	36.00	0.010	0.3600	108.10	38.92	901.25
46.00	35.50	0.010	0.3550	102.90	36.53	937.78
48.00	35.00	0.010	0.3500	98.20	34.37	972.15
50.00	37.00	0.010	0.3700	93.80	34.71	1006.86
52.00	36.50	0.010	0.3650	89.70	32.74	1039.60
54.00	38.50	0.010	0.3850	85.80	33.03	1072.63
56.00	41.00	0.010	0.4100	82.30	33.74	1106.38
58.00	43.00	0.010	0.4300	79.00	33.97	1140.35
60.00	44.50	0.010	0.4450	75.80	33.73	1174.08
62.00	46.50	0.010	0.4650	72.90	33.90	1207.98
64.00	49.00	0.010	0.4900	70.10	34.35	1242.32
66.00	53.50	0.010	0.5350	67.50	36.11	1278.44
68.00	57.50	0.010	0.5750	65.00	37.38	1315.81
70.00	56.00	0.010	0.5600	62.70	35.11	1350.92
72.00	59.00	0.010	0.5900	60.40	35.64	1386.56
74.00	61.50	0.010	0.6150	58.30	35.85	1422.41
76.00	53.50	0.010	0.5350	56.30	30.12	1452.53
78.00	67.00	0.010	0.6700	54.40	36.45	1488.98
80.00	71.50	0.010	0.7150	52.50	37.54	1526.52
82.00	76.00	0.010	0.7600	50.70	38.53	1565.05
84.00	81.50	0.010	0.8150	49.00	39.94	1604.99
86.00	85.00	0.010	0.8500	47.40	40.29	1645.28
88.00	90.50	0.010	0.9050	45.80	41.45	1686.73
90.00	95.00	0.010	0.9500	44.30	42.09	1728.81
92.00	101.50	0.010	1.0150	42.80	43.44	1772.25
94.00	107.00	0.010	1.0700	41.40	44.30	1816.55
96.00	113.50	0.010	1.1350	40.10	45.51	1862.06
98.00	119.50	0.010	1.1950	38.80	46.37	1908.43
100.00	126.50	0.010	1.2650	37.50	47.44	1955.87

*APPARENT RESISTIVITY = (2iiR) [1/1/r1-1/r2-1/r3+1/r4] where K=[]

TABLE 2.4

SOUNDING 4 BLOOMFIELD REFINING CO.
BLOOMFIELD, NEW MEXICO

p-p1 spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	*k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.00	20.00	0.010	0.2000	2499.80	499.96	499.96
4.00	35.00	0.010	0.3500	1249.50	437.33	937.29
6.00	39.00	0.010	0.3900	832.60	324.71	1262.00
8.00	601.50	0.001	0.6015	624.00	375.34	1637.34
10.00	42.00	0.010	0.4200	498.80	209.50	1846.83
12.00	62.00	0.010	0.6200	415.20	257.42	2104.26
14.00	80.50	0.010	0.8050	355.40	286.10	2390.35
16.00	102.00	0.010	1.0200	310.50	316.71	2707.06
18.00	113.50	0.010	1.1350	275.50	312.69	3019.75
20.00	136.50	0.010	1.3650	247.50	337.84	3357.59
22.00	146.00	0.010	1.4600	224.50	327.77	3685.36
24.00	156.00	0.010	1.5600	205.30	320.27	4005.63
26.00	189.00	0.010	1.8900	189.10	357.40	4363.03
28.00	222.00	0.010	2.2200	175.10	388.72	4751.75
30.00	242.00	0.010	2.4200	162.90	394.22	5145.97
32.00	265.00	0.010	2.6500	152.30	403.60	5549.56
34.00	285.50	0.010	2.8550	142.80	407.69	5957.26
36.00	307.00	0.010	3.0700	134.40	412.61	6369.87
38.00	326.00	0.010	3.2600	126.80	413.37	6783.23
40.00	356.50	0.010	3.5650	120.00	427.80	7211.03
42.00	377.50	0.010	3.7750	113.80	429.60	7640.63
44.00	396.00	0.010	3.9600	108.10	428.08	8068.71
46.00	424.50	0.010	4.2450	102.90	436.81	8505.52
48.00	439.00	0.010	4.3900	98.20	431.10	8936.61
50.00	466.50	0.010	4.6650	93.80	437.58	9374.19
52.00	497.00	0.010	4.9700	89.70	445.81	9820.00
54.00	526.00	0.010	5.2600	85.80	451.31	10271.31
56.00	549.00	0.010	5.4900	82.30	451.83	10723.13
58.00	600.50	0.010	6.0050	79.00	474.40	11197.53
60.00	625.00	0.010	6.2500	75.80	473.75	11671.28
62.00	653.00	0.010	6.5300	72.90	476.04	12147.32
64.00	691.00	0.010	6.9100	70.10	484.39	12631.71
66.00	727.50	0.010	7.2750	67.50	491.06	13122.77
68.00	756.00	0.010	7.5600	65.00	491.40	13614.17
70.00	786.50	0.010	7.8650	62.70	493.14	14107.31
72.00	812.50	0.010	8.1250	60.40	490.75	14598.06
74.00	859.00	0.010	8.5900	58.30	500.80	15098.85
76.00	892.00	0.010	8.9200	56.30	502.20	15601.05
78.00	920.50	0.010	9.2050	54.40	500.75	16101.80
80.00	962.00	0.010	9.6200	52.50	505.05	16606.85
82.00	986.00	0.010	9.8600	50.70	499.90	17106.75
84.00	102.50	0.100	10.2500	49.00	502.25	17609.00
86.00	104.50	0.100	10.4500	47.40	495.33	18104.33
88.00	106.50	0.100	10.6500	45.80	487.77	18592.10
90.00	109.50	0.100	10.9500	44.30	485.09	19077.19
92.00	115.00	0.100	11.5000	42.80	492.20	19569.39
94.00	119.00	0.100	11.9000	41.40	492.66	20062.05
96.00	122.00	0.100	12.2000	40.10	489.22	20551.27
98.00	125.00	0.100	12.5000	38.80	485.00	21036.27
100.00	130.00	0.100	13.0000	37.50	487.50	21523.77

*APPARENT RESISTIVITY = (2iiR) [1/1/r1-1/r2-1/r3+1/r4] where K=[]

TABLE 2.5

SOUNDING 5 BLOOMFIELD REFINING CO.
BLOOMFIELD, NEW MEXICO

p-p1 spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	*k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
2.00	6.50	0.010	0.0650	2499.80	162.49	162.49
4.00	12.00	0.010	0.1200	1249.50	149.94	312.43
6.00	17.50	0.010	0.1750	832.60	145.71	458.13
8.00	23.00	0.010	0.2300	624.00	143.52	601.65
10.00	29.00	0.010	0.2900	498.80	144.65	746.30
12.00	34.50	0.010	0.3450	415.20	143.24	889.55
14.00	40.00	0.010	0.4000	355.40	142.16	1031.71
16.00	46.50	0.010	0.4650	310.50	144.38	1176.09
18.00	53.00	0.010	0.5300	275.50	146.02	1322.11
20.00	60.50	0.010	0.6050	247.50	149.74	1471.84
22.00	65.50	0.010	0.6550	224.50	147.05	1618.89
24.00	74.00	0.010	0.7400	205.30	151.92	1770.81
26.00	81.50	0.010	0.8150	189.10	154.12	1924.93
28.00	89.50	0.010	0.8950	175.10	156.71	2081.64
30.00	96.00	0.010	0.9600	162.90	156.38	2238.03
32.00	101.00	0.010	1.0100	152.30	153.82	2391.85
34.00	110.00	0.010	1.1000	142.80	157.08	2548.93
36.00	117.50	0.010	1.1750	134.40	157.92	2706.85
38.00	125.50	0.010	1.2550	126.80	159.13	2865.98
40.00	135.00	0.010	1.3500	120.00	162.00	3027.98
42.00	142.50	0.010	1.4250	113.80	162.17	3190.15
44.00	151.00	0.010	1.5100	108.10	163.23	3353.38
46.00	158.50	0.010	1.5850	102.90	163.10	3516.48
48.00	166.50	0.010	1.6650	98.20	163.50	3679.98
50.00	174.50	0.010	1.7450	93.80	163.68	3843.66
52.00	183.50	0.010	1.8350	89.70	164.60	4008.26
54.00	188.00	0.010	1.8800	85.80	161.30	4169.56
56.00	200.50	0.010	2.0050	82.30	165.01	4334.58
58.00	209.50	0.010	2.0950	79.00	165.51	4500.08
60.00	220.00	0.010	2.2000	75.80	166.76	4666.84
62.00	231.00	0.010	2.3100	72.90	168.40	4835.24
64.00	240.50	0.010	2.4050	70.10	168.59	5003.83
66.00	253.50	0.010	2.5350	67.50	171.11	5174.94
68.00	262.50	0.010	2.6250	65.00	170.63	5345.57
70.00	276.00	0.010	2.7600	62.70	173.05	5518.62
72.00	286.00	0.010	2.8600	60.40	172.74	5691.36
74.00	299.00	0.010	2.9900	58.30	174.32	5865.68
76.00	309.50	0.010	3.0950	56.30	174.25	6039.93
78.00	320.50	0.010	3.2050	54.40	174.35	6214.28
80.00	331.00	0.010	3.3100	52.50	173.78	6388.06
82.00	345.00	0.010	3.4500	50.70	174.92	6562.97
84.00	361.00	0.010	3.6100	49.00	176.89	6739.86
86.00	377.00	0.010	3.7700	47.40	178.70	6918.56
88.00	392.00	0.010	3.9200	45.80	179.54	7098.10
90.00	406.00	0.010	4.0600	44.30	179.86	7277.95
92.00	421.50	0.010	4.2150	42.80	180.40	7458.36
94.00	438.50	0.010	4.3850	41.40	181.54	7639.89
96.00	454.50	0.010	4.5450	40.10	182.25	7822.15
98.00	470.50	0.010	4.7050	38.80	182.55	8004.70
100.00	488.50	0.010	4.8850	37.50	183.19	8187.89

*APPARENT RESISTIVITY = (2iiR) [1/1/r1-1/r2-1/r3+1/r4] where K=[]

TABLE 2.6

SOUNDING 6 BLOOMFIELD REFINING CO.
BLOOMFIELD, NEW MEXICO

p-p1 spacing (feet)	dial reading (ohms)	scale multiplier	corrected reading (ohms)	*k (feet)	apparent resistivity (ohm-ft)	cumulative resistivity (ohm-ft)
10.00	33.00	0.001	0.03	4498.70	148.46	148.46
20.00	33.50	0.001	0.03	2247.50	75.29	223.75
30.00	50.00	0.001	0.05	1496.20	74.81	298.56
40.00	34.50	0.001	0.03	1120.00	38.64	337.20
50.00	40.00	0.001	0.04	893.70	35.75	372.95
60.00	4.50	0.010	0.05	742.50	33.41	406.36
70.00	7.50	0.010	0.08	634.10	47.56	453.92
80.00	7.50	0.010	0.08	552.50	41.44	495.35
90.00	8.00	0.010	0.08	488.80	39.10	534.46
100.00	7.50	0.010	0.08	437.50	32.81	567.27
110.00	8.50	0.010	0.09	395.30	33.60	600.87
120.00	9.00	0.010	0.09	360.00	32.40	633.27
130.00	10.50	0.010	0.11	330.00	34.65	667.92
140.00	11.50	0.010	0.12	303.90	34.95	702.87
150.00	12.50	0.010	0.13	281.20	35.15	738.02
160.00	12.50	0.010	0.13	261.20	32.65	770.67
170.00	13.50	0.010	0.14	243.50	32.87	803.54
180.00	15.00	0.010	0.15	227.50	34.13	837.67
190.00	15.00	0.010	0.15	213.10	31.97	869.63
200.00	16.50	0.010	0.17	200.00	33.00	902.63
210.00	17.00	0.010	0.17	188.00	31.96	934.59
220.00	18.00	0.010	0.18	177.00	31.86	966.45
230.00	18.50	0.010	0.19	166.90	30.88	997.33
240.00	19.50	0.010	0.20	157.50	30.71	1028.04
250.00	20.50	0.010	0.21	148.70	30.48	1058.52
260.00	22.00	0.010	0.22	140.60	30.93	1089.46
270.00	22.50	0.010	0.23	132.90	29.90	1119.36
280.00	22.50	0.010	0.23	125.70	28.28	1147.64
290.00	26.00	0.010	0.26	118.90	30.91	1178.56
300.00	25.00	0.010	0.25	112.50	28.13	1206.68

*APPARENT RESISTIVITY = (2iiR) [1/1/r1-1/r2-1/r3+1/r4] where K=[]

FIGURE 2.3

BLOOMFIELD REFINING CO. : SOUNDING LOCATIONS

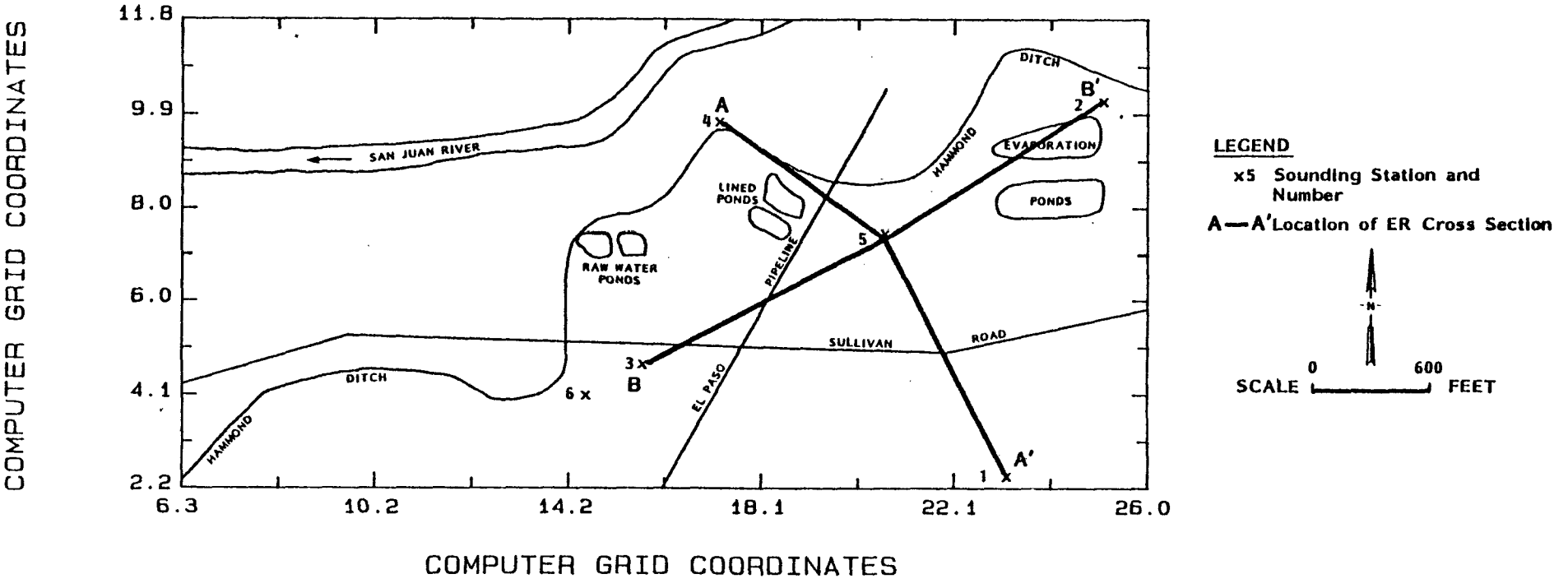
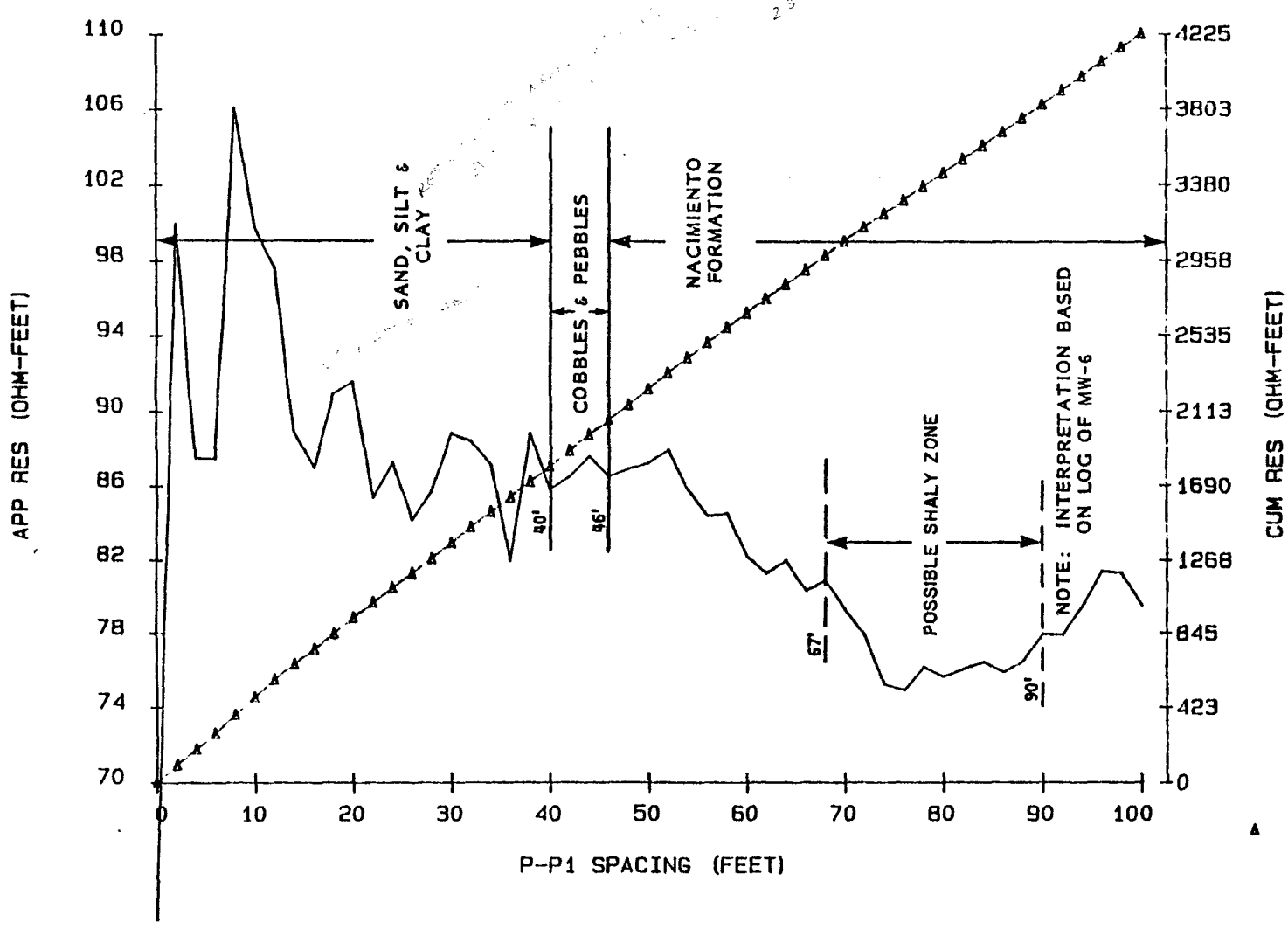


FIGURE 2.4

BLOOMFIELD REFINING CO. SOUNDING 1



ES ENGINEERING-SCIENCE

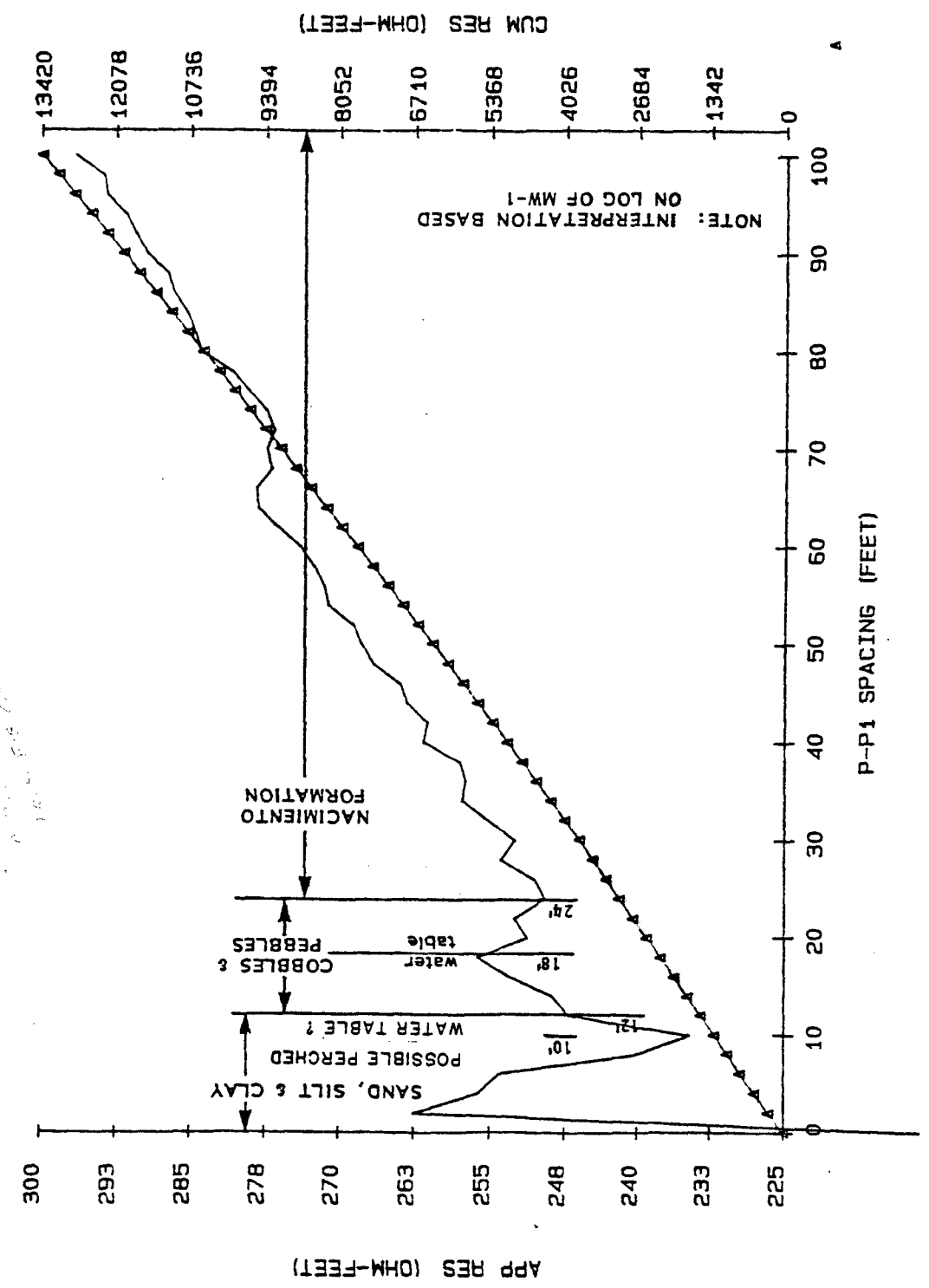


FIGURE 2.5

BLOOMFIELD REFINING CO. SOUNDING 2

Sounding 3 (Figure 2.6) was conducted just south of Sullivan Road near the employee parking lot. The water table was believed to be 10 feet deep at this location. The unconsolidated sediment zone extends from ground surface to 24 feet where the top of the Nacimiento Formation occurs. A zone of possible sandstone lenses within the Nacimiento Formation occurs from 36 to 47 feet underlain by a possible shaly zone from 47 to 64 feet deep.

Sounding 4 (Figure 2.7) was conducted on the bluff northwest of the refinery. The Nacimiento Formation is interpreted to exist at a 24-feet depth at this point. The Nacimiento outcrops along the bluff in the area included sandstone. Shale was not visible at this location.

Sounding 5 (Figure 2.8) was conducted on the refinery road southwest of storage tank number 11. At this location, the unconsolidated sediments are interpreted to exist to 24 feet where the top of the Nacimiento Formation occurs.

Sounding 6 (Figure 2.9) was located southwest of Sullivan Road near Hammond Ditch. This sounding was taken to a depth of 300 feet in an attempt to interpret deeper zones within the Nacimiento. The unweathered Nacimiento at this location is interpreted to exist at a 60-foot depth.

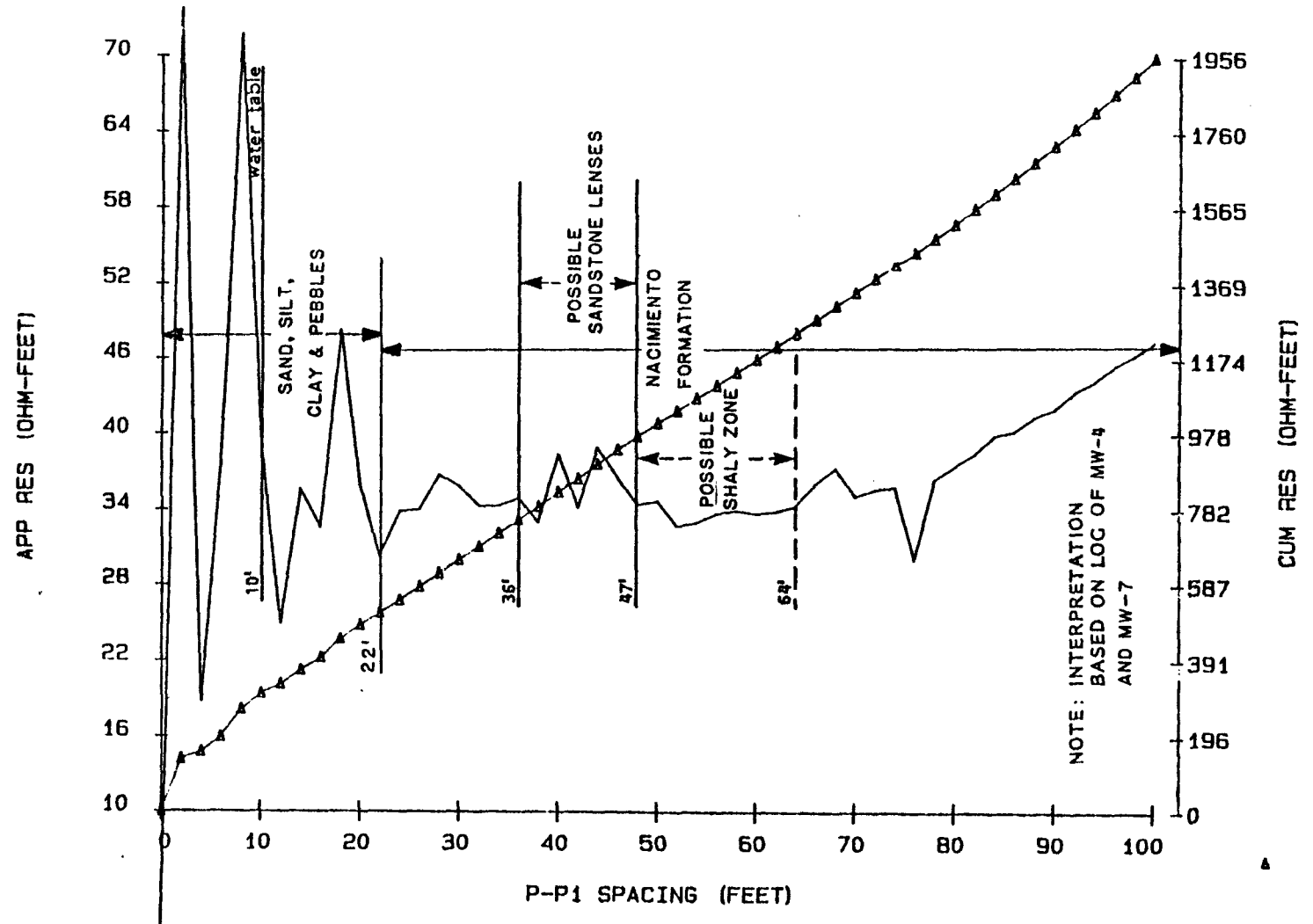
The subsurface geology underlying the refinery and in the immediate vicinity is generally homogeneous, although it does appear that at certain locations, especially southwest of the refinery, the Nacimiento may contain some shale. Figures 2.10 and 2.11 illustrate two ER subsurface cross-sections, the locations of which are shown on Figure 2.3. The cross-sections show the homogeneous nature of the subsurface with a southwest and northwest dip in the top of the Nacimiento.

ELECTRICAL RESISTIVITY PROFILES

Profiles were conducted at 102 locations throughout the refinery and in the immediate vicinity to aid in subsurface interpretations (Figure 2.12). Profile zones were selected based upon the monitoring well data, sounding data, and outcrops along the San Juan River bluff. The shallow profile zones (10 and 20 feet) were selected to aid in the interpretations of the unconsolidated sediment zone. The deeper profile zones

FIGURE 2.6

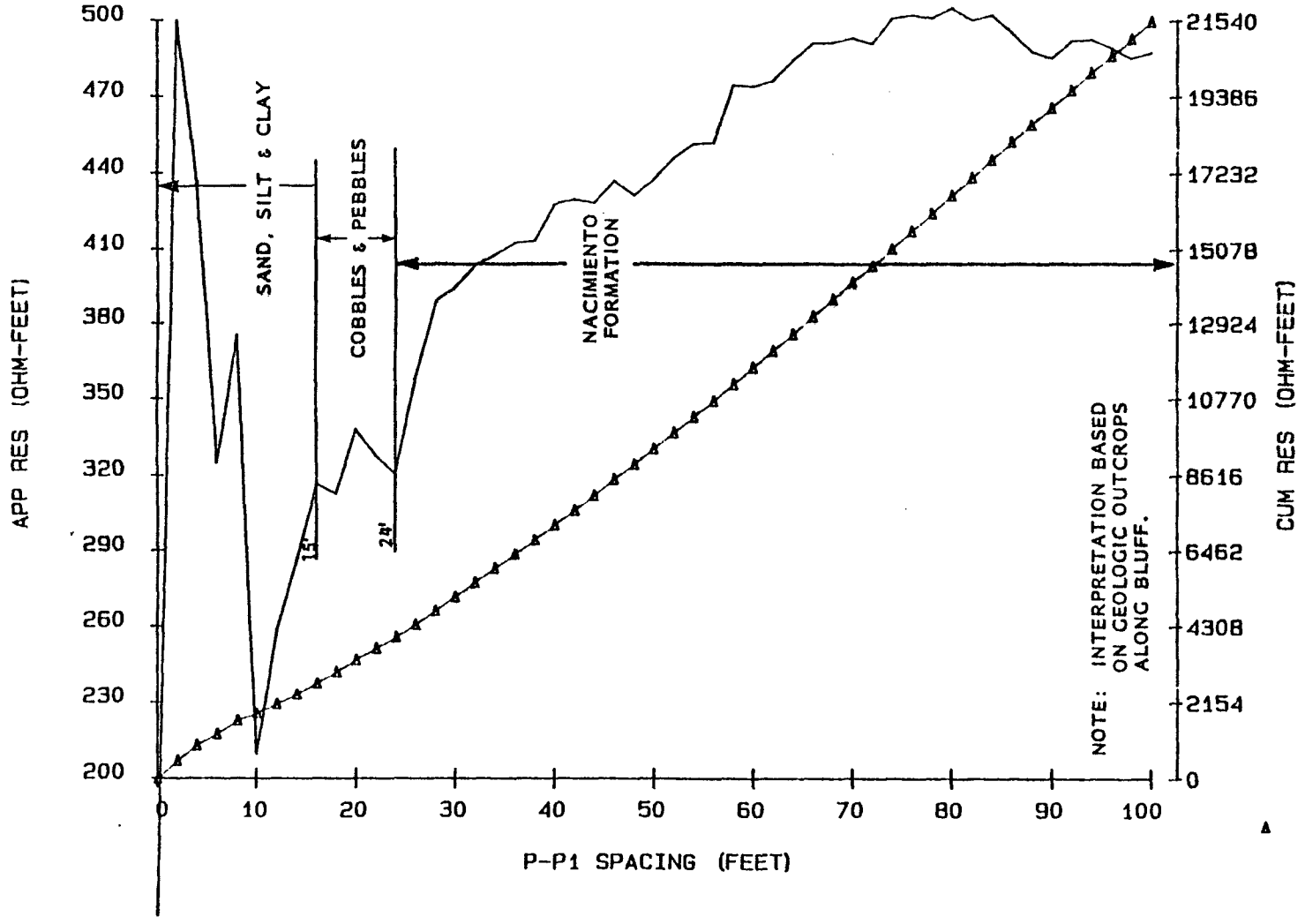
BLOOMFIELD REFINING CO. SOUNDING 3



ES ENGINEERING-SCIENCE

FIGURE 2.7

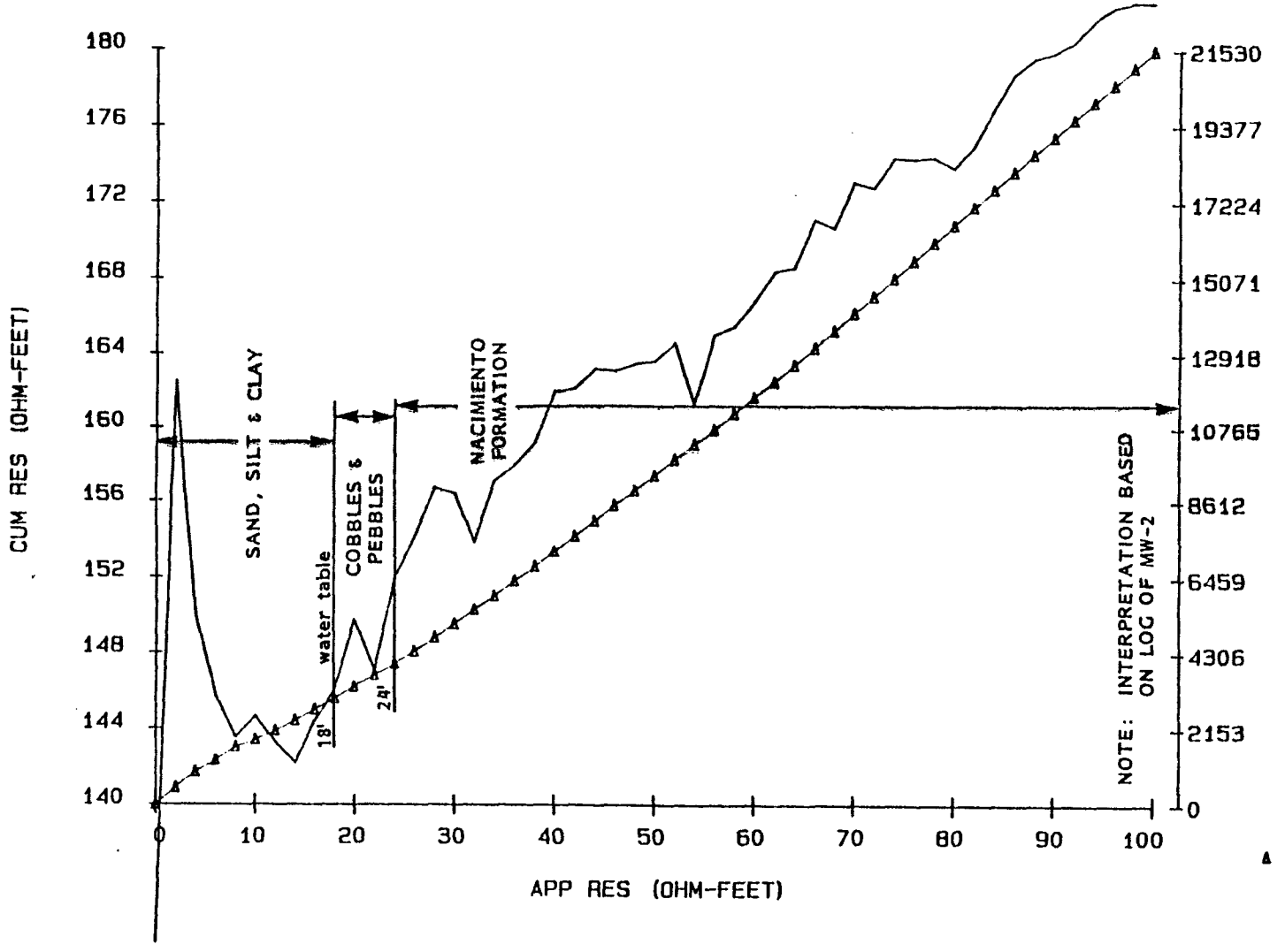
BLOOMFIELD REFINING CO. SOUNDING 4



ES ENGINEERING-SCIENCE

FIGURE 2.8

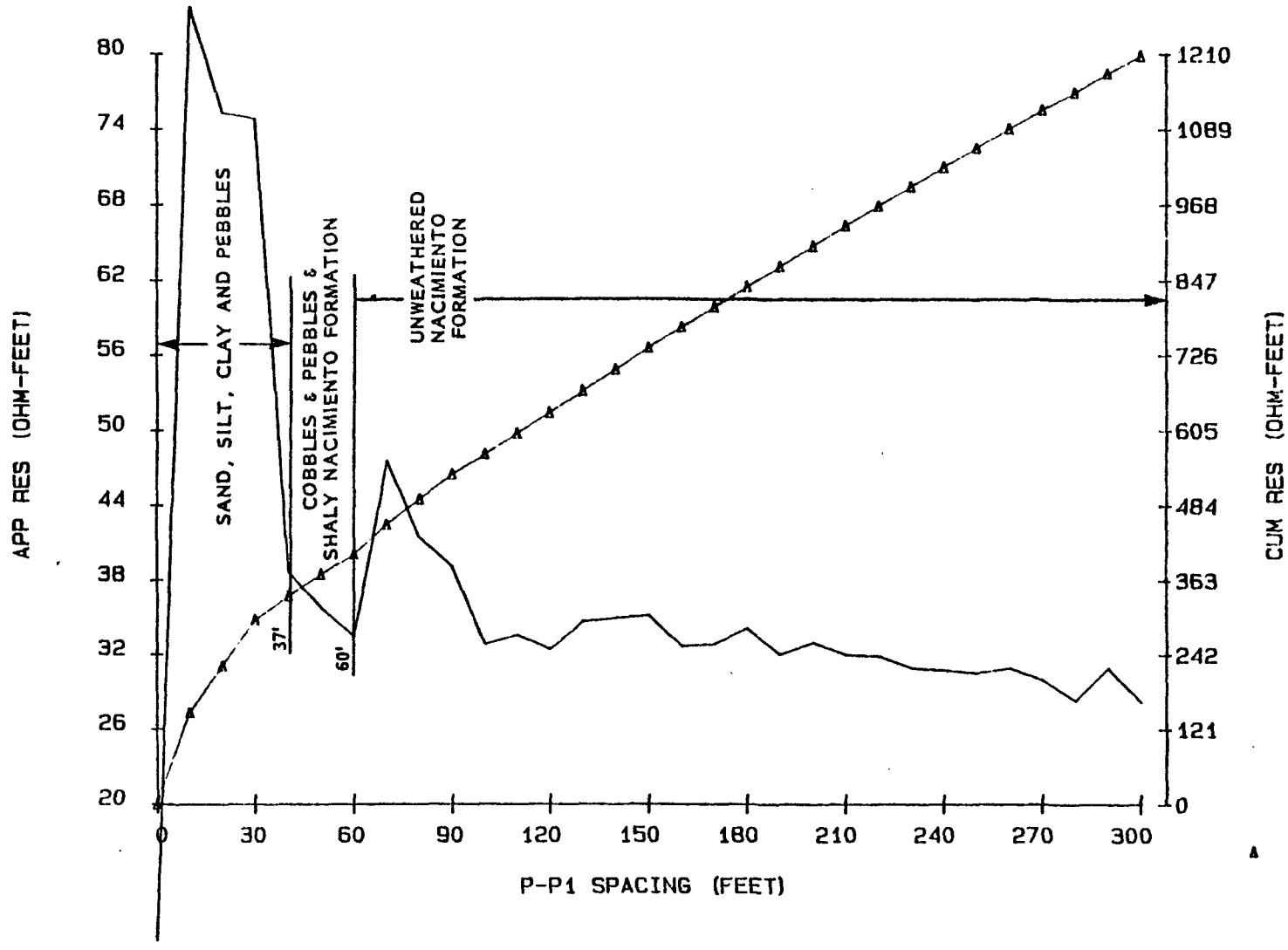
BLOOMFIELD REFINING CO. SOUNDING 5



ES ENGINEERING-SCIENCE

FIGURE 2.9

BLOOMFIELD REFINING CO. SOUNDING 6



ES ENGINEERING-SCIENCE

FIGURE 2.10

ER SUBSURFACE CROSS-SECTION

FIGURE 10

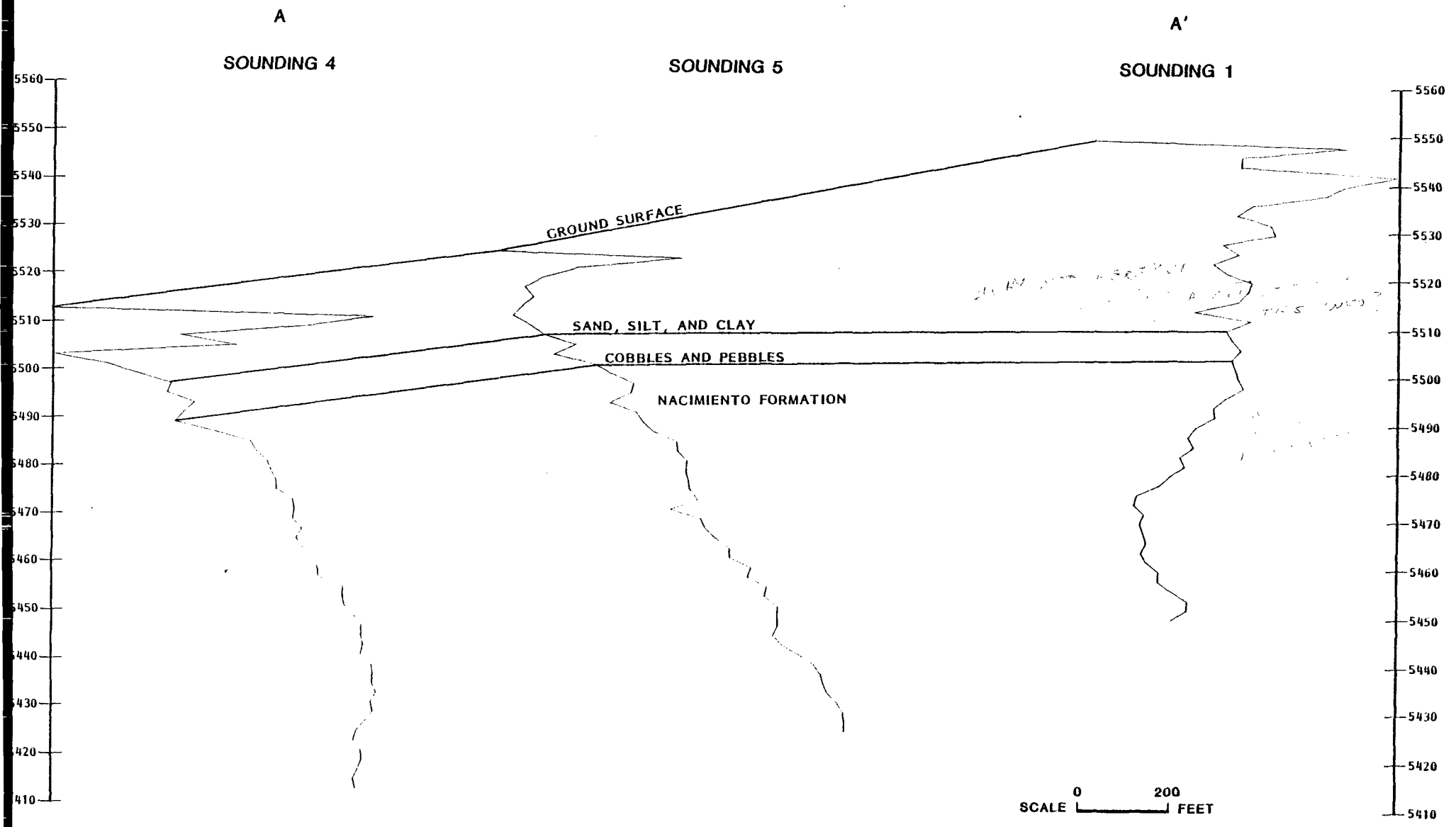
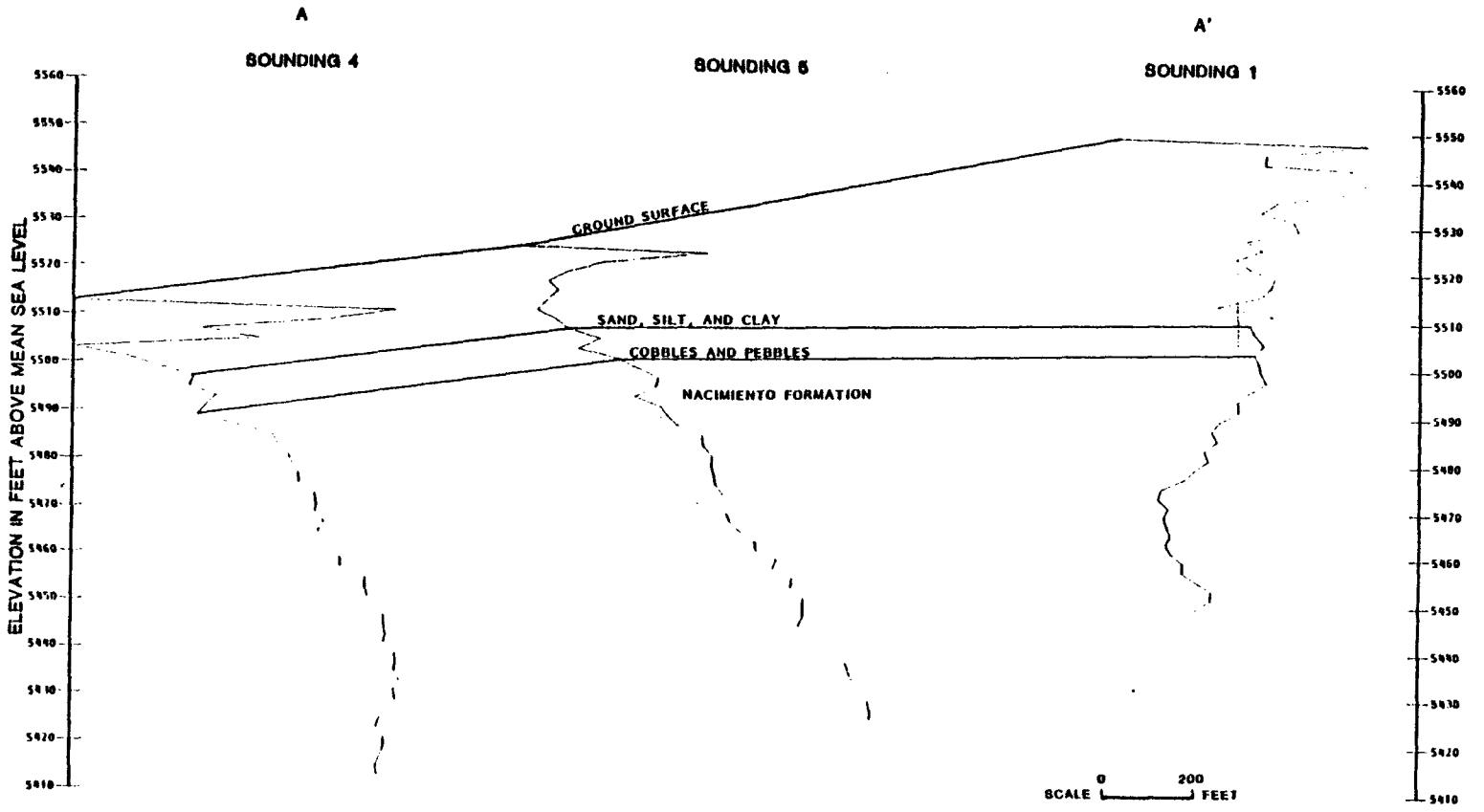


FIGURE 2.11

ER SUBSURFACE CROSS-SECTION

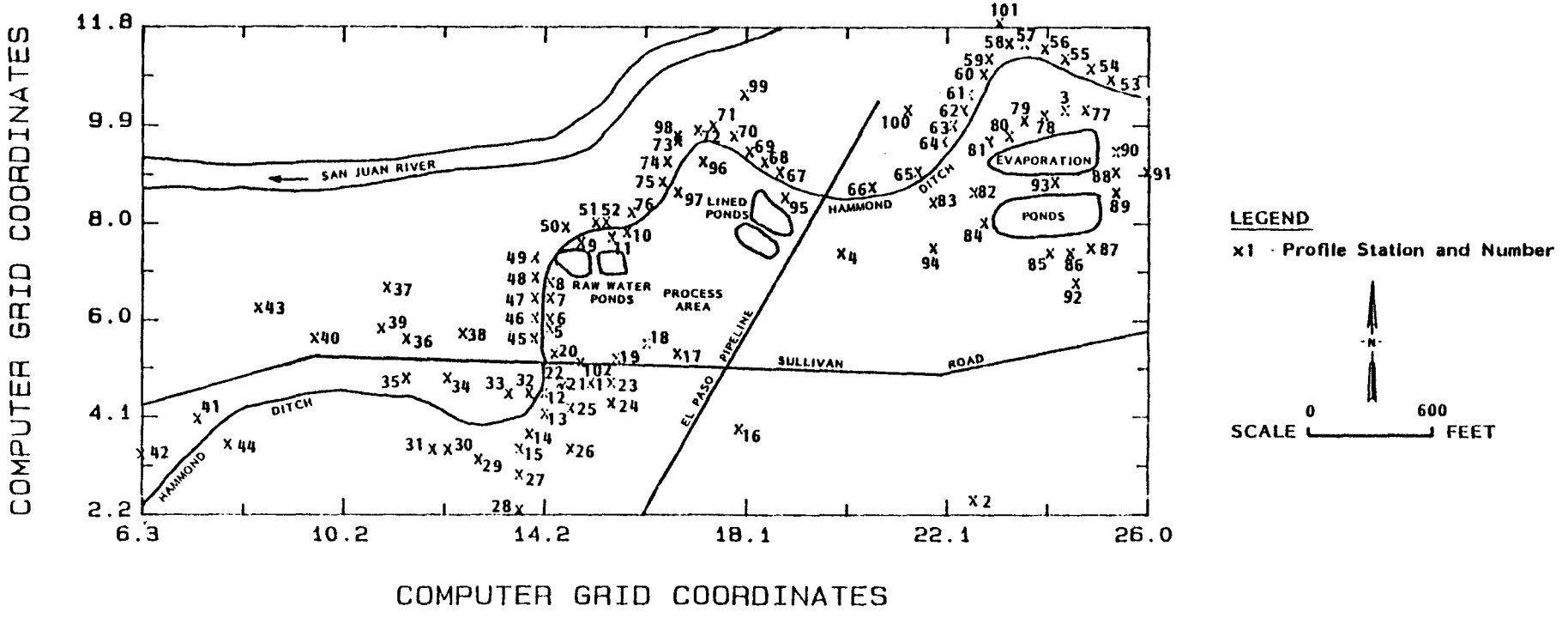


Same as Fig 2.10

ES ENGINEERING-SCIENCE

FIGURE 2.12

BLOOMFIELD REFINING CO.: PROFILE LOCATIONS



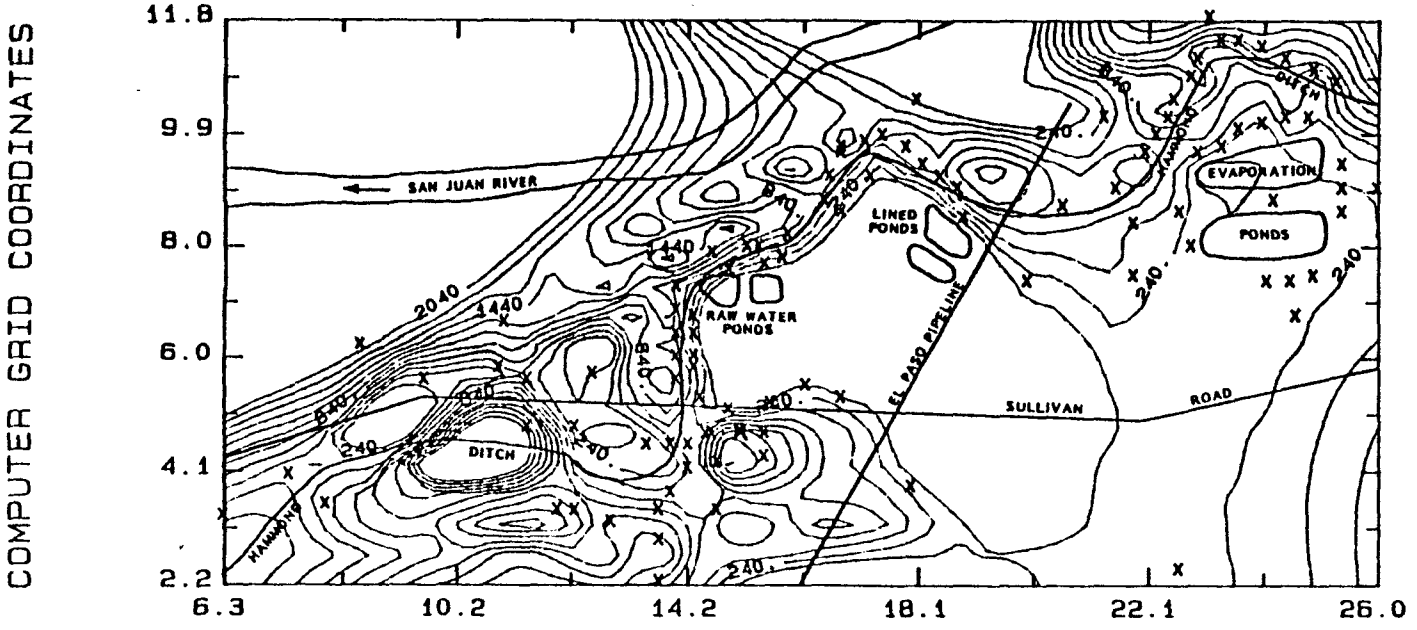
ES ENGINEERING-SCIENCE

(30, 40, 60, 80, and 100 feet) were selected to aid in the interpretations of the cobble and pebble zone just above the top of the Nacimiento and in the top of the Nacimiento Formation itself. The profile maps for each depth zone are shown as computer generated plots in Figures 2.13 through 2.19.

A complete interpretation of the profile data is premature at this time. Additional subsurface data are necessary to confirm or deny subsurface variations in geology, hydrology, and/or subsurface hydrocarbons.

FIGURE 2.13

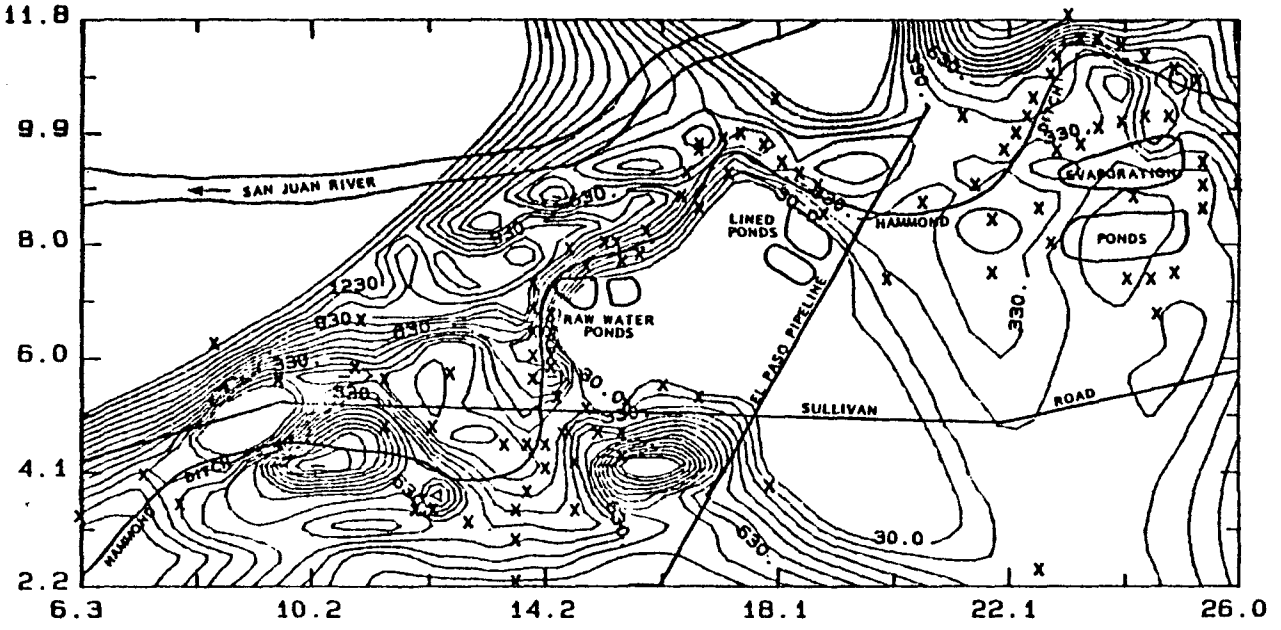
BLOOMFIELD REFINING CO. : 10-FT. ER PROFILE MAP



ES ENGINEERING - SCIENCE

FIGURE 2.14

BLOOMFIELD REFINING CO. : 20-FT. ER PROFILE MAP



LEGEND

x Profile Station

N

0 600

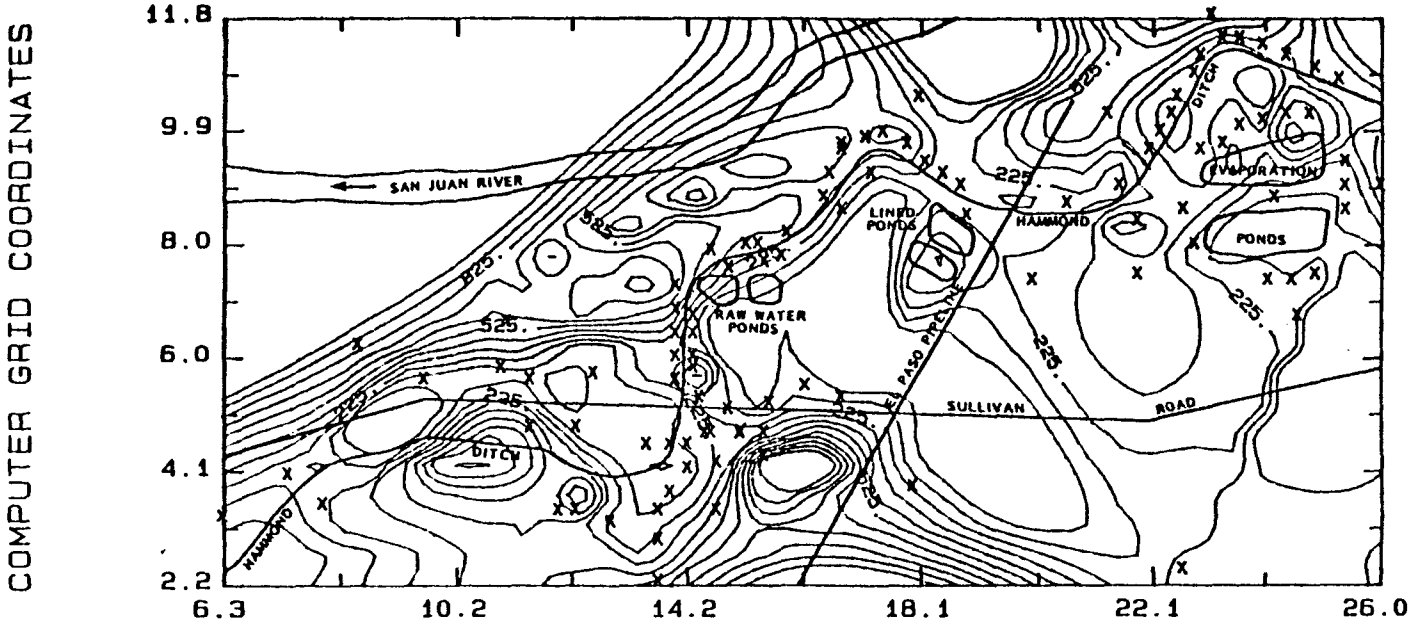
SCALE FEET

CONTOUR FROM 30.00 TO 1430.00 CONTOUR INTERVAL = 100.00 OHM-FEET

ES ENGINEERING-SCIENCE

FIGURE 2.15

BLOOMFIELD REFINING CO. : 30-FT. ER PROFILE MAP



LEGEND

x Profile Station

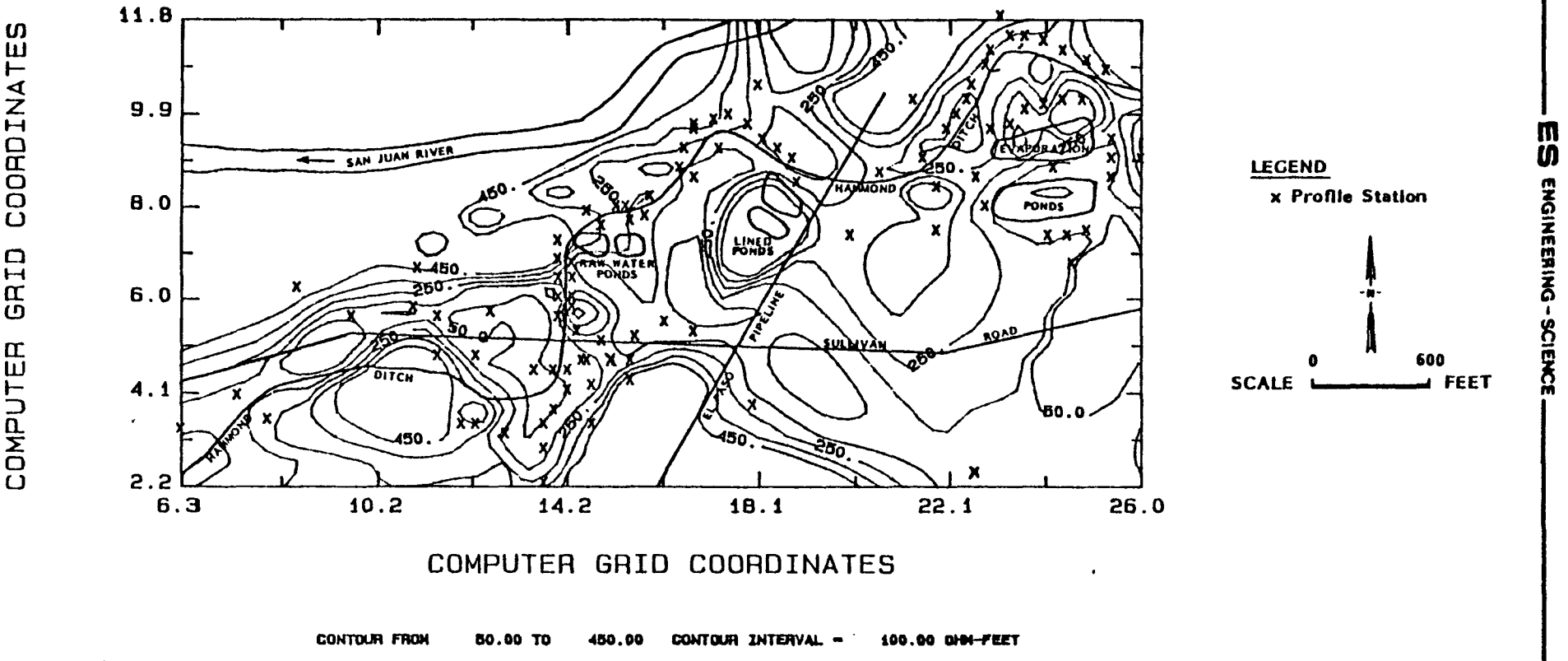
N

SCALE 0 600 FEET

ES ENGINEERING-SCIENCE

FIGURE 2.16

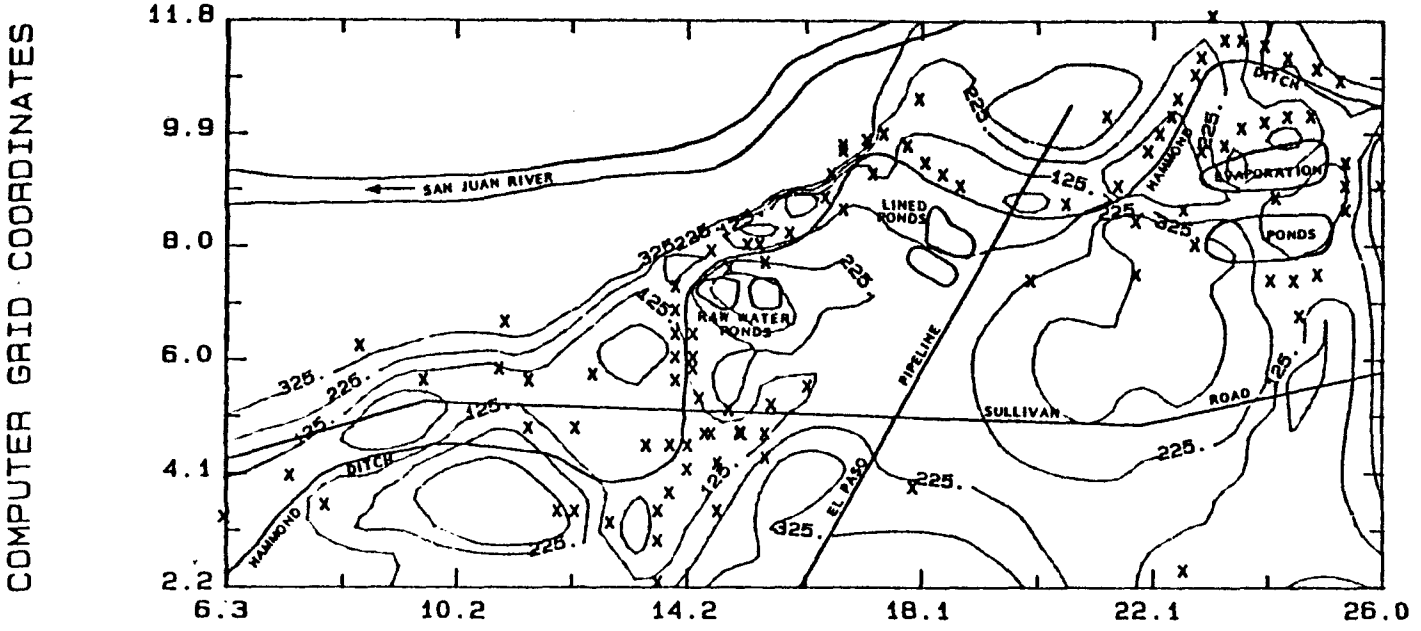
BLOOMFIELD REFINING CO. : 40-FT. ER PROFILE MAP



ES ENGINEERING-SCIENCE

FIGURE 2.17

BLOOMFIELD REFINING CO. : 60-FT. ER PROFILE MAP



LEGEND

x Profile Station

N

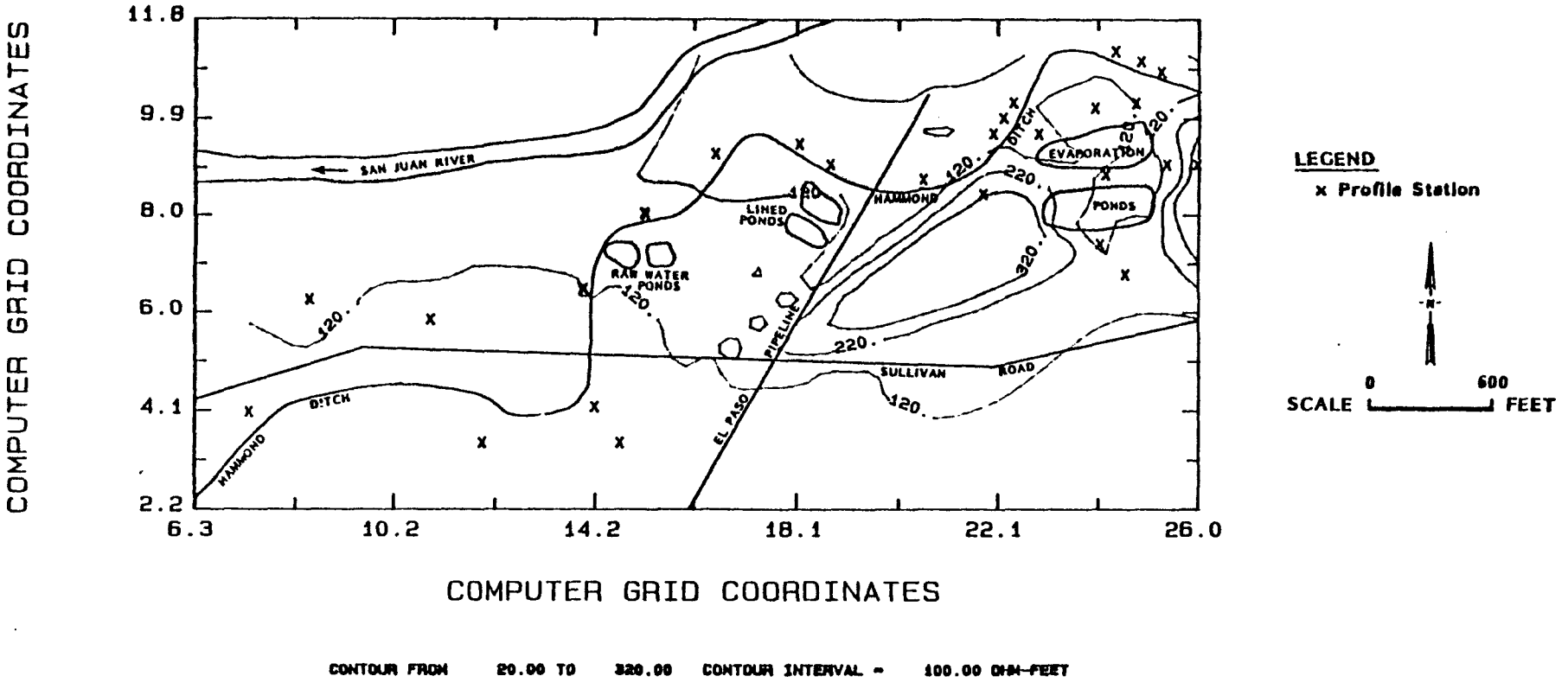
SCALE 0 600 FEET

CONTOUR FROM 25.00 TO 325.00 CONTOUR INTERVAL = 100.00 OHM-FEET

ES ENGINEERING-SCIENCE

FIGURE 2.18

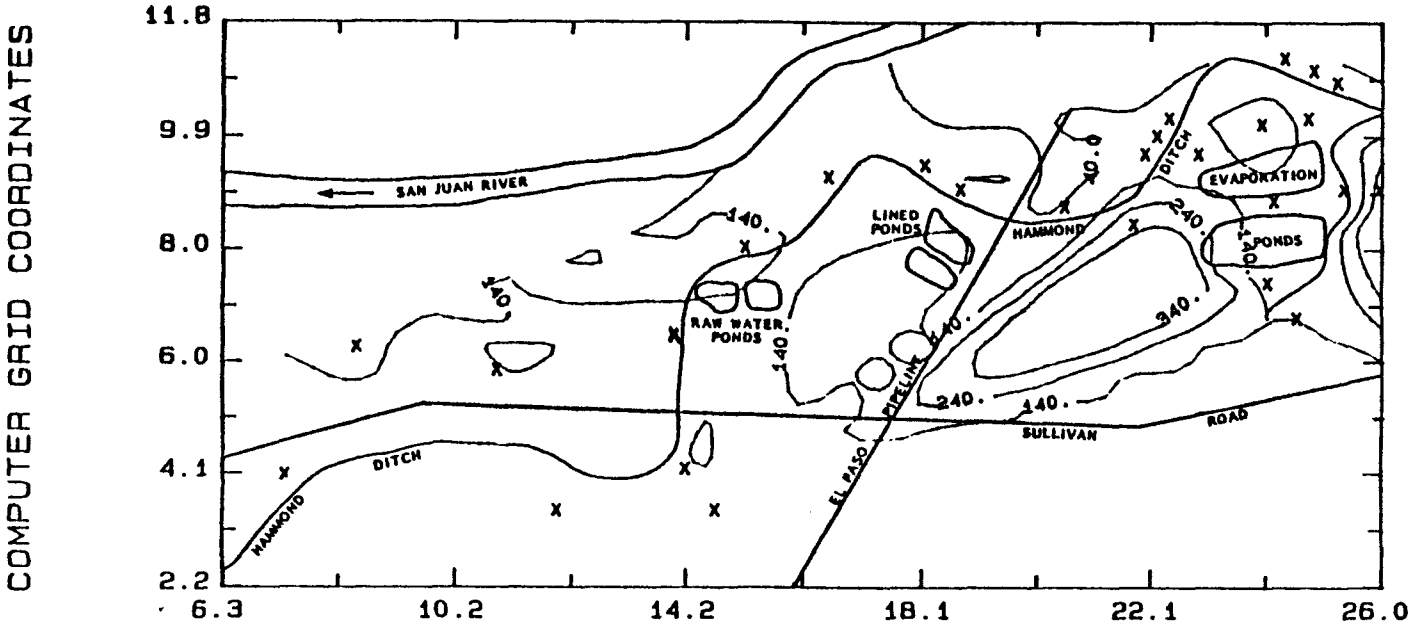
BLOOMFIELD REFINING CO. : 80-FT. ER PROFILE MAP



ES ENGINEERING - SCIENCE

FIGURE 2.19

BLOOMFIELD REFINING CO. : 100-FT. ER PROFILE MAP



LEGEND

x Profile Station

N

0 600

SCALE FEET

CONTOUR FROM 40.00 TO 340.00 CONTOUR INTERVAL = 100.00 OHM-FEET

ES ENGINEERING-SCIENCE

REFERENCES

Bison. Bison Instruction Manual, Bison Instruments, Earth Resistivity Meters: Bison Instruments, Inc., Minneapolis, Minnesota, 1975.

Carrington, T.J. and Watson, D.A., Preliminary Evaluation of an Alternative Electrode Array for Use in Shallow-Subsurface Electrical Resistivity Studies: Groundwater - January-February, Vol. 10, No. 1, 1981.

U.S. Geological Survey. National Handbook of Recommended Methods for Water-Data Acquisition: U.S. Department of the Interior, Reston, Virginia, 1977.

SECTION 3

MONITORING WELL DATA

GROUNDWATER MONITORING WELLS

Four additional groundwater monitoring wells (MW-7, 8, 9, and 10) were installed by Bloomfield Refining Company in late February and early March of 1986 to supplement the existing monitoring system, completed in February 1984, and to provide information on the extent of petroleum hydrocarbons in the subsurface at the refinery. Monitoring well specifications for drilling and completion of all wells are summarized in Table 3.1 based on historic reports and current records of the newly installed wells.

All monitoring wells MW-1 to MW-10 are located on Figure 3.1 which also depicts the current groundwater table contours and flow directions within the Quaternary age Lake Jackson Terrace deposits (unconfined to semiconfined aquifer).

WATER LEVEL MEASUREMENTS

Static groundwater levels for the terrace deposits at the Bloomfield Refinery have been recorded at least monthly by refinery personnel since March 1986 and the completion of the new wells. These data are summarized in Table 3.2.

Figure 3.1 illustrates groundwater flow trends prior to and following the initiation of irrigation flow through the Hammond Ditch in mid-April. The data suggest a reversal of the hydraulic gradient in the southwest portion of the refinery near the Sullivan Road intersection with Hammond Ditch. Additional water level measurements will be made on a monthly basis and will be useful in confirm this trend.

The hydraulic gradient (dimensionless) currently varies from about 2.45×10^{-3} to 4.75×10^{-3} (April 4, 1986; non-irrigation flow) to as much as 1.25×10^{-3} to 4.75×10^{-3} during the initial period following the resumption of the irrigation flow in Hammond Ditch (May 23, 1986).

TABLE 3.1

MONITORING WELL SPECIFICATIONS[1] AND AQUIFER TEST RESULTS

Well Number	Top of[2] Casing Elevation in feet Above MSL	Total Depth[3] Drilled/ Date Completed	Well Casing[4] Screened Interval (Depth in feet)	Sand or Natural Pack/ Depth (feet)	Well Seals	Hydraulic[1] Conductivity (cm/sec)	Depth of Terrace Deposits (feet)	Remarks
MW-1	5515.77	25 feet 2/8/84	5-25	Natural pack	Unknown[5]	1.59×10^{-2} 45 ft/d	5-22	Steel well casing driven through cobble zone with hammer in conjunction with air drilling.
MW-2	5519.45	26 feet 2/7/84	6-26	Natural pack	Unknown[5]	1.44×10^{-1} 408 ft/d	6-25	Steel well casing driven through cobble zone with hammer in conjunction with air drilling.
MW-3	5535.85	40 feet 2/8/84	20-40	Natural pack	Unknown[5]	3.43×10^{-3} 9.7 ft/d	20-40	Steel well casing driven through cobble zone with hammer in conjunction with air drilling.
MW-4	5524.30	32 feet 2/9/84	12-32	Natural pack	Unknown[5]	3.92×10^{-3} 11.1 ft/d	12-32	Steel well casing driven through cobble zone with hammer in conjunction with air drilling.
MW-5	5545.10	54 feet 2/6/84	34-54	Natural pack	Unknown[5]	4.32×10^{-3} 12.2 ft/d	34-50	Steel well casing driven through cobble zone with hammer in conjunction with air drilling.
MW-6	5551.23	52 feet 2/7/84	32-52	Natural pack	Unknown[5]	Dry well	32-49	Well has been dry since initial installation.
MW-7	5524.09	62 feet 2/27/86	48.5-58.5	Sand pack 45-58.5	Bentonite, 41-45 feet; Grout, 0-41 feet	Not tested	None	Nacimiento FMN well; has possible hydraulic connection with terrace deposits.
MW-8	5531.12	34 feet 2/28/86	12-32	Sand pack 7-32	Bentonite, 5-7 feet; Grout, 0-5 feet	3.84×10^{-3} 10.9 ft/day	12-32	Assumed average washout in terrace cobble 14-inches diameter.
MW-9	5519.70	35 feet 3/3/86	10.5-30.5	Sand pack 7-30.5	Bentonite, 5-7 feet; Grout, 0-5 feet	1.20×10^{-3} 3.4 ft/d	10.5-27	Assumed average washout in terrace cobble 14-inches diameter.
MW-10	5516.86	35 feet 3/4/86	13-33	Sand pack 8-33	Bentonite, 6-8 feet; Grout, 0-6 feet	9.00×10^{-3} 25.5 ft/d	13-23	Assumed average washout in terrace cobble 14-inches diameter.

[1] Monitoring well design for old wells based upon available completion information; slug test results from tests performed 4/30/86 and from data analyzed by the Bouwer and Rice (1976) method.

[2] Typical top of casing is 2 feet above ground level.

[3] New wells drilled with an 8-inch-diameter bit using mud-rotary techniques, while older wells (MW-1 through MW-6) were air drilled, with a 5- to 6-inch-diameter drilling device with well casing driven through the cobble formation.

[4] MW-1 to MW-6 had 6-inch-O.D. steel casing with torch-cut perforations, while the new wells (MW-7 to MW-10) utilized 6-inch-I.D. stainless steel, machine-slotted (0.012-inch) casing with Schedule 40 PVC riser pipe.

[5] Probably grout-sealed from just above screen to ground level.

FIGURE 3.1
BLOOMFIELD REFINING COMPANY
GROUNDWATER ELEVATIONS ON APRIL 4 AND MAY 23, 1986

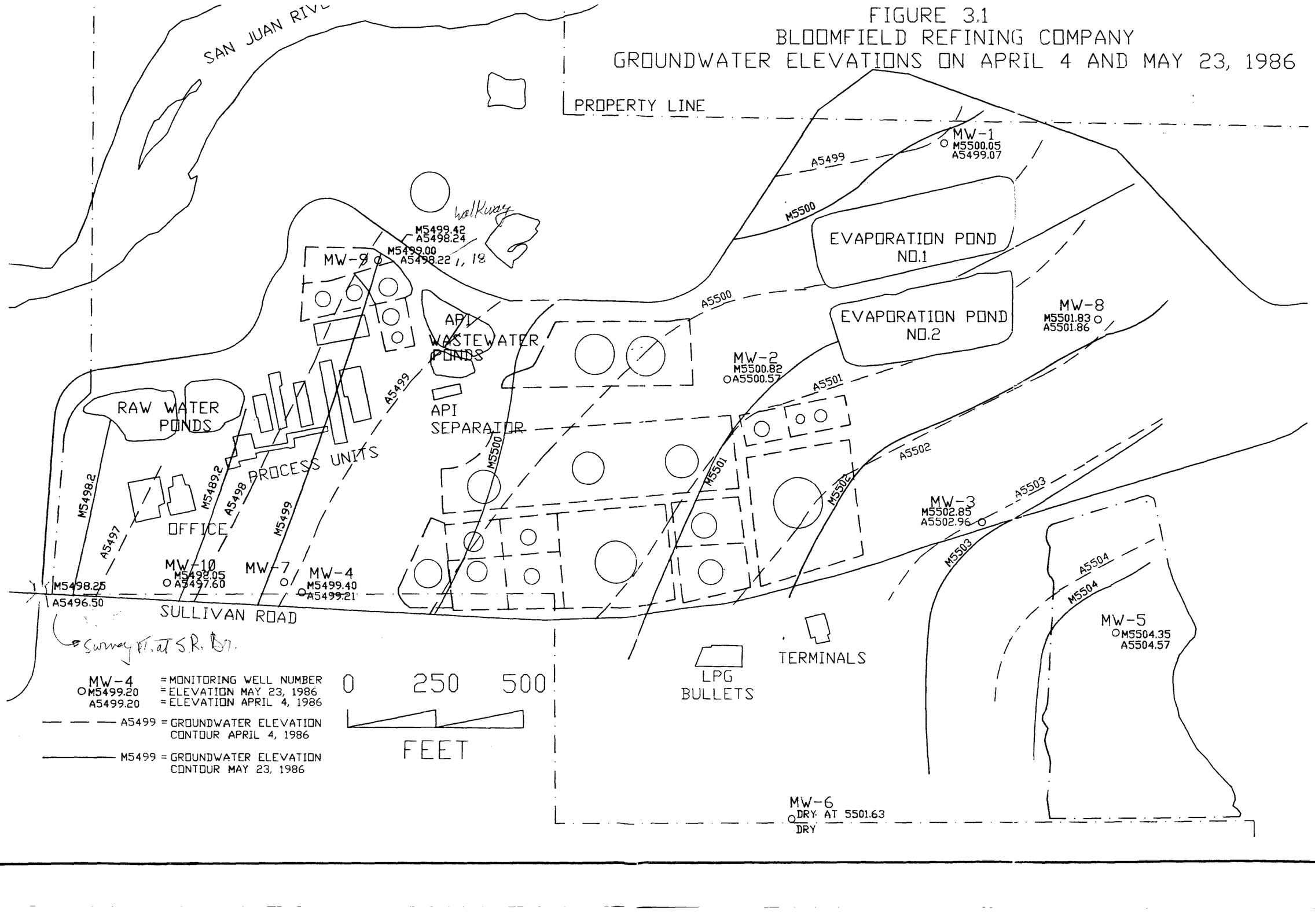


TABLE 3.2

RECENT WATER LEVEL ELEVATIONS MEASURED IN THE BLOOMFIELD REFINERY AREA
(Feet Above MSL)

	Well									
Date	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10
Benchmark[1]	5515.77	5519.45	5535.85	5524.10	5545.10	5551.23	5524.09	5531.12	5519.70	5516.86
3/21/86	5499.10	5500.65	5502.89	5499.30	5504.23	Dry	5498.09	5501.95	5498.15	5497.65
4/4/86	5499.07	5500.57	5502.98	5499.21	5504.57	Dry	5498.77	5501.86	5498.22	5497.60
5/5/86	5499.43	5500.57	5502.92	5499.32	5504.27	Dry	5497.28	5501.79	5498.62	5497.83
5/23/86	5500.05	5500.82	5502.85	5499.40	5504.35	Dry	5498.86	5501.83	5499.00	5498.05

[1]Measuring point elevation in feet above mean sea level; new and revised measurement of datum.

AQUIFER TEST RESULTS

Slug tests to determine the hydraulic conductivity of the Quaternary Jackson Lake Terrace deposits were performed by ES at 8 of the 10 Bloomfield Refining groundwater monitoring wells on April 30, 1986. The tests were performed by introducing a known volume of water into each well and monitoring the change in water level over time. Slug test analytical results are included in Table 3.1 as hydraulic conductivity in centimeters per second (cm/sec).

Slug test data were compiled and analyzed using the Bouwer and Rice method (1976) for determining hydraulic conductivity (K) of unconfined aquifers with completely or partially penetrating wells. Hydraulic conductivity values generally ranged around 10^{-3} centimeters per second (cm/sec). Variations from this range are believed to be the result of primarily two factors: (1) actual increased or decreased K in the aquifer, or (2) variations in completions and development of various wells. Older wells, such as MW-1 to MW-5, which were torch-cut slotted and air drilled with a driven casing, generally showed higher K values, while the newer wells, MW-8, MW-9, and MW-10 (machine slotted, mud rotary, larger borehole washouts and filter packing mix) showed lower values. ES believes that the results of slug tests on the older wells are more indicative of actual hydraulic conductivity due to the relatively undisturbed nature of the sand/cobble formation during drilling and completion of the monitoring wells as opposed to the mud rotary washouts experienced in the new wells, and to the use of sand filter packing in the wells which may have a lower K than the cobble zone.

MONITORING WELL ANALYTICAL DATA

All of the groundwater monitoring wells, with the exception of MW-6 which is dry, were sampled on March 26-27, 1986. Samples were collected with a clean stainless steel bailer after removal of at least two casing volumes of groundwater. Two casing volumes could not be removed from MW-7 due to the slow recharge, so a sample was collected during the initial bailing. The bailer was cleaned between samples with Alconox detergent, followed by an acetone wash and a final deionized water rinse.

The samples to be analyzed for the priority pollutant metals were filtered in the laboratory at the refinery prior to sample shipment. All samples were delivered to Assaigai Analytical Laboratories overnight by bus under standard chain-of-custody procedures.

Analytical results of these samples are included as Appendix A. As shown, relatively low concentrations of phenols were detected in MW-1, MW-2, MW-3, MW-4, MW-5, MW-9, and MW-10. Benzene, toluene, xylene, and/or ethylbenzene were detected in MW-4, MW-7, MW-8, MW-9, and MW-10. These data are similar to previous groundwater analyses and indicate possible impacts in these areas. Additional analytical data being developed as part of the subsurface hydrocarbon investigation will be necessary to evaluate these impacts adequately. No product information

HAMMOND DITCH SAMPLING

Surface water samples were collected in the Hammond Ditch within 24 hours of the start of the irrigation season in April 1986. Composite samples were collected just downstream of the API wastewater ponds (sample HAPI5) and Sullivan Road (sample HSRD5) and analyzed for base/neutral and acid extractable priority pollutants, priority pollutant metals, pH, cyanide, and phenols. Analytical results for both samples are included in Appendix B. The analytical results for the base/neutral priority pollutants were not available at the time this report was prepared. As shown in Appendix B, low concentrations of benzene and toluene were detected in the Hammond Ditch near Sullivan Road but not in the vicinity of the API wastewater ponds. Both samples had low concentrations of phenols (0.002 mg/l). No other compounds were present in detectable quantities.

APPENDIX A

GROUNDWATER MONITORING WELL ANALYTICAL RESULTS 3/26-27/86

ASSAIGAI
ANALYTICAL
LABORATORIES

TO: Bloomfield Refinery
Attn: Chris Hawley
P.O. Box 159
Bloomfield, NM 87413

DATE: 14 May 1986
0502

ANALYTE	SAMPLE ID/ ANALYTICAL RESULTS		
	MW 1	MW 2	MW 3
CN	<0.01 mg/l	<0.01 mg/l	<0.10 mg/l
Phenols	0.009 mg/l	0.063 mg/l	0.006 mg/l
TOC	18 mg/l	18 mg/l	29 mg/l
TDS	2936 mg/l	2796 mg/l	4836 mg/l
Cl	750 mg/l	200 mg/l	1500 mg/l
SO 4	7.5 mg/l	11.0 mg/l	29.5 mg/l
Benzene	ND	ND	ND
Toluene	ND	ND	ND
Xylenes	ND	ND	ND
Ethylbenzene	ND	ND	ND
Sb	<0.01 mg/l	<0.01 mg/l	<0.01 mg/l
As	<0.050 mg/l	<0.050 mg/l	<0.050 mg/l
Be	<0.01 mg/l	<0.01 mg/l	<0.01 mg/l
Cd	0.050 mg/l	0.060 mg/l	0.12 mg/l
Cr	<0.050 mg/l	<0.050 mg/l	<0.050 mg/l
Cu	<0.03 mg/l	<0.03 mg/l	<0.03 mg/l
Pb	0.085 mg/l	0.12 mg/l	0.14 mg/l
Hg	<0.002 mg/l	0.003 mg/l	0.004 mg/l
Ni	0.08 mg/l	0.07 mg/l	0.08 mg/l
Se	<0.010 mg/l	<0.010 mg/l	<0.010 mg/l
Ag	<0.050 mg/l	<0.050 mg/l	<0.050 mg/l
Tl	<0.01 mg/l	<0.01 mg/l	<0.01 mg/l
Zn	<0.01 mg/l	<0.01 mg/l	<0.01 mg/l

TO: Bloomfield Refinery

0502

ANALYTE	SAMPLE ID/ ANALYTICAL RESULTS		
	MW 4	MW 5	MW 7
CN	<0.01 mg/l	<0.01 mg/l	<0.10 mg/l
Phenols	0.633 mg/l	0.006 mg/l	<0.001 mg/l
TOC	110 mg/l	14 mg/l	11 mg/l
TDS	1868 mg/l	3840 mg/l	6076 mg/l
Cl	500 mg/l	1100 mg/l	30 mg/l
SO 4	0.3 mg/l	14.0 mg/l	5.5 mg/l
Benzene	11.8 mg/l	ND	0.015 mg/l
Toluene	7.5 mg/l	ND	0.053 mg/l
Xylenes	ND	ND	ND
Ethylbenzene	0.107 mg/l	ND	0.007 mg/l
Sb	<0.01 mg/l	<0.01 mg/l	<0.01 mg/l
As	<0.050 mg/l	<0.050 mg/l	<0.050 mg/l
Be	<0.01 mg/l	<0.01 mg/l	<0.01 mg/l
Cd	0.060 mg/l	0.10 mg/l	0.050 mg/l
Cr	<0.050 mg/l	<0.050 mg/l	0.050 mg/l
Cu	<0.03 mg/l	<0.03 mg/l	<0.03 mg/l
Pb	0.074 mg/l	0.16 mg/l	<0.050 mg/l
Hg	0.002 mg/l	<0.002 mg/l	<0.002 mg/l
Ni	0.08 mg/l	0.10 mg/l	0.08 mg/l
Se	<0.010 mg/l	<0.010 mg/l	<0.010 mg/l
Ag	<0.050 mg/l	<0.050 mg/l	<0.050 mg/l
Tl	<0.01 mg/l	<0.01 mg/l	<0.01 mg/l
Zn	0.012 mg/l	0.012 mg/l	0.018 mg/l
Acrolein	ND		ND
Acrylonitrile	ND		ND
Bromoform	ND		ND
Carbon Tetrachloride	ND		ND
Chlorobenzene	ND		ND
Chlorodibromomethane	ND		ND
Chloroethane	ND		ND
2-Chloroethylvinyl Ether	ND		ND
Chloroform	ND		ND
Dichlorogromomethane	ND		ND
1,1-Dichloroethane	ND		ND
1.2-Dichloroethane	ND		ND
1,1-Dichloroethylene	ND		ND
1,2-Dichloropropane	ND		ND
1,3-Dichloropropylene	ND		ND

TO: Bloomfield Refinery

0502

ANALYTE	SAMPLE ID/ ANALYTICAL RESULTS		
	MW 4	MW 5	MW 7
Methyl Bromide	ND		ND
Methyl Chloride	ND		ND
Methylene Chloride	ND		ND
1,1,2,2-Tetrachloroethane	ND		ND
Tetrachloroethylene	ND		ND
1,2-Transdichloroethylne	ND		ND
1,1,1-Trichloroethane	ND		ND
1,1,2-Trichloroethane	ND		ND
Trichloroethylene	ND		ND
Vinyl Chloride	ND		ND
Acid Compounds			
2-chlorophenol	ND		ND
2,4-dichlorophenol	0.200 mg/l		ND
2,4-dimethylphenol	ND		ND
4,6-dinitro-o-cresol	0.100 mg/l		0.013 mg/l
2,4-dinitrophenol	0.050 mg/l		ND
2-nitrophenol	ND		ND
4-nitrophenol	0.090 mg/l		ND
p-chloro-m-cresol	ND		ND
pentachlorophenol	ND		ND
Phenol	0.202 mg/l		ND
2,4,6-trichlorophenol	ND		ND
Base Neutrals			
Acenaphthene	0.044 mg/l		ND
Acenaphthylene	ND		ND
Anthracene	ND		ND
Benzidine	ND		ND
Benzo(a)anthracene	ND		ND
Benzo(a)pyrene	ND		ND
3,4-benzofluoranthene	ND		ND
Benzo(ghi)perylene	ND		ND
Benzo(k)fluoranthene	ND		ND
Bis(2-chloroethoxy)methane	ND		ND
Bis(2-chloroethyl)ether	ND		ND
Bis(2-chloroisopropyl)ether	ND		ND
Bis(2-ethylhexyl)phthalate	ND		ND
4-bromophenyl phenyl ether	ND		ND
Butylbenzyl phthalate	ND		ND
2-chloronaphtalene	ND		ND
4-chlorophenyl phenyl ether	ND		ND
Chrysene	ND		ND

TO: Bloomfield Refinery

0502

ANALYTE	SAMPLE ID/ ANALYTICAL RESULTS		
	MW 4	MW 5	MW 7
Dibenzo(a,h)anthracene	ND		ND
1,2-Dichlorobenzene	ND		ND
1,3-Dichlorobenzene	ND		ND
1,4-Dichlorobenzene	ND		ND
3,3-Dichlorobenzidine	ND		ND
Diethyl phthalate	ND		ND
Dimethyl phthalate	ND		ND
Din-n-butyl phthalate	ND		ND
2,4-dinitrotoluene	ND		ND
2,6-dinitrotoluene	ND		ND
Di-n-octyl phthalate	ND		ND
1,2-diphenylhydrazine	ND		ND
Fluoranthene	ND		ND
Fluorene	0.150 mg/l		ND
Hexachlorobenzene	ND		ND
Hexachlorobutadiene	ND		ND
Hexachlorocyclopentadiene	ND		ND
Hexachloroethane	ND		ND
Indeno(1,2,3-cd)pyrene	ND		ND
Isophorone	ND		ND
Naphthalene	0.036 mg/l		ND
Nitrobenzene	ND		ND
N-nitrosodimethylamine	ND		ND
N-nitrosodie-n-propylamine	ND		ND
N-nitrosodiphenylamine	ND		ND
Phenanthrene	ND		ND
Pyrene	0.166 mg/l		ND
1,2,4-trichlorobenzene	ND		ND

TO: Bloomfield Refinery

DATE: 0502

ANALYTE	SAMPLE ID/ ANALYTICAL RESULTS		
	MW 8	MW 9	MW 10
CN	<0.01 mg/l	<0.01 mg/l	<0.10 mg/l
Phenols	<0.001 mg/l	0.304 mg/l	0.147 mg/l
TOC	5 mg/l	143 mg/l	34 mg/l
TDS	806 mg/l	2360 mg/l	1546 mg/l
Cl	160 mg/l	149 mg/l	245 mg/l
SO 4	4.0 mg/l	13.0 mg/l	5.3 mg/l
Benzene	ND	7.4 mg/l	0.093 mg/l
Toluene	ND	6.3 mg/l	ND
Xylenes	ND	ND	ND
Ethylbenzene	0.107 mg/l	3.2 mg/l	ND
Sb	<0.01 mg/l	<0.01 mg/l	<0.01 mg/l
As	<0.050 mg/l	<0.050 mg/l	<0.050 mg/l
Be	<0.01 mg/l	<0.01 mg/l	<0.01 mg/l
Cd	0.010 mg/l	0.010 mg/l	0.020 mg/l
Cr	<0.050 mg/l	<0.050 mg/l	<0.050 mg/l
Cu	<0.03 mg/l	<0.03 mg/l	<0.03 mg/l
Pb	<0.050 mg/l	<0.050 mg/l	<0.050 mg/l
Hg	<0.002 mg/l	<0.002 mg/l	<0.002 mg/l
Ni	<0.06 mg/l	0.30 mg/l	0.08 mg/l
Se	<0.010 mg/l	<0.010 mg/l	<0.010 mg/l
Ag	<0.050 mg/l	<0.050 mg/l	<0.050 mg/l
Tl	<0.01 mg/l	<0.01 mg/l	<0.01 mg/l
Zn	<0.01 mg/l	0.012 mg/l	<0.01 mg/l
Acrolein	ND	ND	ND
Acrylonitrile	ND	ND	ND
Bromoform	ND	ND	ND
Carbon Tetrachloride	ND	ND	ND
Chlorobenzene	ND	ND	ND
Chlorodibromomethane	ND	ND	ND
Chloroethane	ND	ND	ND
2-Chloroethylvinyl Ether	ND	ND	ND
Chloroform	ND	ND	ND
Dichlorogromomethane	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND
1.2-Dichloroethane	ND	ND	ND
1,1-Dichloroethylene	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND
1,3-Dichloropropylene	ND	ND	ND

TO: Bloomfield Refinery

0502
Page 6 of 8

ANALYTE	SAMPLE ID/ ANALYTICAL RESULTS		
	MW 8	MW 9	MW 10
Methyl Bromide	ND	ND	ND
Methyl Chloride	ND	ND	ND
Methylene Chloride	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND
Tetrachloroethylene	ND	ND	ND
1,2-Transdichloroethylne	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND
Trichloroethylene	ND	ND	ND
Vinyl Chloride	ND	ND	ND
Acid Compounds			
2-chlorophenol	ND	ND	ND
2,4-dichlorophenol	ND	ND	ND
2,4-dimethylphenol	ND	0.160 mg/l	0.025 mg/l
4,6-dinitro-o-cresol	ND	ND	0.020 mg/l
2,4-dinitrophenol	ND	ND	ND
2-nitrophenol	ND	ND	ND
4-nitrophenol	ND	ND	ND
p-chloro-m-cresol	ND	ND	ND
pentachlorophenol	ND	ND	ND
Phenol	ND	0.149 mg/l	0.090 mg/l
2,4,6-trichlorophenol	ND	ND	ND
Base Neutrals			
Acenaphthene	ND	ND	ND
Acenaphthylene	ND	ND	ND
Anthracene	ND	ND	0.039 mg/l
Benzidine	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND
3,4-benzofluoranthene	ND	ND	ND
Benzo(ghi)perylene	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND
Bis(2-chloroethoxy)methane	ND	ND	ND
Bis(2-chloroethyl)ether	ND	ND	ND
Bis(2-chloroisopropyl)ether	ND	ND	ND
Bis(2-ethylhexyl)phthalate	ND	ND	ND
4-bromophenyl phenyl ether	ND	ND	ND
Butylbenzyl phthalate	ND	ND	ND
2-chloronaphtalene	ND	ND	ND
4-chlorophenyl phenyl ether	ND	ND	ND
Chrysene	ND	ND	ND

ANALYTE	SAMPLE ID/ ANALYTICAL RESULTS		
	MW 8	MW 9	MW 10
Dibenzo(a,h)anthracene	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND
3,3-Dichlorobenzidine	ND	ND	ND
Diethyl phthalate	ND	ND	ND
Dimethyl phthalate	ND	ND	ND
Din-n-butyl phthalate	ND	ND	ND
2,4-dinitrotoluene	ND	ND	ND
2,6-dinitrotoluene	ND	ND	ND
Di-n-octyl phthalate	ND	ND	ND
1,2-diphenylhydrazine	ND	ND	ND
Fluoranthene	ND	ND	0.034 mg/l
Fluorene	ND	0.012 mg/l	0.033 mg/l
Hexachlorobenzene	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND
Hexachloroethane	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND
Isophorone	ND	ND	ND
Naphthalene	ND	ND	ND
Nitrobenzene	ND	ND	ND
N-nitrosodimethylamine	ND	ND	ND
N-nitrosodie-n-propylamine	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND
Phenanthrene	ND	ND	ND
Pyrene	ND	ND	0.030 mg/l
1,2,4-trichlorobenzene	ND	ND	ND

ND = None Detected

REFERENCE:"Test Methods for Evaluating Solid Waste, Physical/ Chemical Methods, USEPA, SW 846, EMSL-Cincinnati, 1982.

NOMINAL DETECTION LIMITS

CN	0.01 mg/l
Phenols	0.001 mg/l
TOC	0.1 mg/l
TDS	1 mg/l
Cl	1.0 mg/l
SO 4	1.0 mg/l
Benzene	5 mg/l
Toluene	5 mg/l
Xylenes	5 mg/l
Ethylbenzene	5 mg/l
Sb	0.01 mg/l
As	0.050 mg/l
Be	0.01 mg/l
Cd	0.002 mg/l
Cr	0.050 mg/l
Cu	0.03 mg/l
Pb	0.001 mg/l
Hg	0.002 mg/l
Ni	0.01 mg/l
Se	0.010 mg/l
Ag	0.050 mg/l
Tl	0.01 mg/l
Zn	0.01 mg/l

Detection limits for Volatiles, Acid Compounds, and Base/Neutrals are all 0.001 mg/l

An invoice for services is enclosed. Thank you for contacting Assaigai Laboratories.

Sincerely,

Jennifer V. Smith

Jennifer V. Smith, Ph.D.
Laboratory Director

APPENDIX B

HAMMOND DITCH SAMPLING RESULTS

ASSAIGAI ANALYTICAL LABORATORIES

TO: Bloomfield Refinery
Attn: Chris Hawley
P.O. Box 159
Bloomfield NM 87413

DATE: 14 May 1986
0660 partial

ANALYTE	SAMPLE ID/ ANALYTICAL RESULTS	
	HSRD 5	HAPI 5
CN	<0.01 mg/l	<0.01 mg/l
Phenols	0.002 mg/l	0.002 mg/l
Sb	<0.2 mg/l	<0.2 mg/l
As	<0.050 mg/l	<0.050 mg/l
Be	<0.01 mg/l	<0.01 mg/l
Cd	<0.010 mg/l	<0.010 mg/l
Cr	<0.050 mg/l	<0.050 mg/l
Cu	<0.03 mg/l	<0.03 mg/l
Pb	<0.050 mg/l	<0.050 mg/l
Hg	<0.002 mg/l	<0.002 mg/l
Ni	<0.06 mg/l	<0.06 mg/l
Se	<0.010 mg/l	<0.010 mg/l
Ag	<0.050 mg/l	<0.050 mg/l
Tl	<0.01 mg/l	<0.01 mg/l
Zn	<0.01 mg/l	<0.01 mg/l
Acrolein	ND	ND
Acrylonitrile	ND	ND
Benzene	0.006 mg/l	ND
Bromoform	ND	ND
Carbon Tetrachloride	ND	ND
Chlorobenzene	ND	ND
Chlorodibromomethane	ND	ND
Chloroethane	ND	ND
2-Chloroethylvinyl Ether	ND	ND
Chloroform	ND	ND
Dichlorogromomethane	ND	ND
1,1-Dichloroethane	ND	ND
1.2-Dichloroethane	ND	ND
1,1-Dichloroethylene	ND	ND
1,2-Dichloropropane	ND	ND
1,2-Dichloropropylene	ND	ND
Ethylbenzene	ND	ND

TO: Bloomfield Refinery

0660 partial

ANALYTE	SAMPLE ID/ ANALYTICAL RESULTS	
	HSRD 5	HAPI 5
Methyl Bromide	ND	ND
Methyl Chloride	ND	ND
Methylene Chloride	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND
Tetrachloroethylene	ND	ND
Toluene	0.003 mg/l	Nd
1,2-Transdichloroethylne	ND	ND
1,1,1-Trichloroethane	ND	ND
1,1,2-Trichloroethane	ND	ND
Trichloroethylene	ND	ND
Vinyl Chloride	ND	ND
Acid Compounds		
2-chlorophenol	ND	ND
2,4-dichlorophenol	ND	ND
2,4-dimethylphenol	ND	ND
4,6-dinitro-o-cresol	ND	ND
2,4-dinitrophenol	ND	ND
2-nitrophenol	ND	ND
4-nitrophenol	ND	ND
p-chloro-m-cresol	ND	ND
pentachlorophenol	ND	ND
Phenol	ND	ND
2,4,6-trichlorophenol	ND	ND
Base Neutrals		
Acenaphthene		
Acenaphthylene		
Anthracene		
Benzidine		
Benzo(a)anthracene		
Benzo(a)pyrene		
3,4-benzofluoranthene		
Benzo(ghi)perylene		
Benzo(k)fluoranthene		
Bis(2-chloroethoxy)methane		
Bis(2-chloroethyl)ether		
Bis(2-chloroisopropyl)ether		
Bis(2-ethylhexyl)phthalate		
4-bromophenyl phenyl ether		
Butylbenzyl phthalate		
2-chloronaphtalene		
4-chlorophenyl phenyl ether		
Chrysene		

ANALYTE	SAMPLE ID/ ANALYTICAL RESULTS	
	HSRD 5	HAPI 5
Dibenzo(a,h)anthracene		
1,2-Dichlorobenzene		
1,3-Dichlorobenzene		
1,4-Dichlorobenzene		
3,3-Dichlorobenzidine		
Diethyl phthalate		
Dimethyl phthalate		
Din-n-butyl phthalate		
2,4-dinitrotoluene		
2,6-dinitrotoluene		
Di-n-octyl phthalate		
1,2-diphenylhydrazine		
Fluoranthene		
Fluorene		
Hexachlorobenzene		
Hexachlorobutadiene		
Hexachlorocyclopentadiene		
Hexachloroethane		
Indeno(1,2,3-cd)pyrene		
Isophorone		
Naphthalene		
Nitrobenzene		
N-nitrosodimethylamine		
N-nitrosodie-n-propylamine		
N-nitrosodiphenylamine		
Phenanthrene		
Pyrene		
1,2,4-trichlorobenzene		

ND = None Detected

REFERENCE:"Test Methods for Evaluating Solid Waste Chemical/Physical Methods", USEPA, SW 846, EMSL-Cincinnati, 1982.

TO: Bloomfield Refinery

0660 partial

NOMINAL DETECTION LIMITS

CN	0.01 mg/l
Phenols	0.002 mg/l
Benzene	5 µg/l
Toluene	5 µg/l
Ethylbenzene	5 µg/l
Sb	0.2 mg/l
As	0.050 mg/l
Be	0.01 mg/l
Cd	0.010 mg/l
Cr	0.050 mg/l
Cu	0.03 mg/l
Pb	0.050 mg/l
Hg	0.002 mg/l
Ni	0.06 mg/l
Se	0.010 mg/l
Ag	0.050 mg/l
Tl	0.01 mg/l
Zn	0.01 mg/l

Detection limits for Volatiles, Acid Compounds, and Base/Neutrals are all 0.001 mg/l

An invoice for services is enclosed. Thank you for contacting Assaigai Laboratories.

Sincerely,

Jennifer V. Smith

Jennifer V. Smith, Ph.D.
Laboratory Director