RESNA

Working To Restore Nature

3315 Almaden Expressway, Suite 34
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WORK PLAN
for
ADDITIONAL SUBSURFACE INVESTIGATION AND AQUIFER PUMPING TEST
at
ARCO Station 2185
9800 East 14th Street
Oakland, California

#3876

62026.02

Report prepared for

ARCO Products Company
P.O. Box 5811
San Mateo, California 94402

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November 25, 1992

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For ARCO Products Company

INTRODUCTION

At the request of ARCO Products Company (ARCO), RESNA Industries Inc. (RESNA) has prepared this Work Plan for review by the Alameda County Health Care Services Agency (ACHCSA). This Work Plan was initiated in response to discussions during a meeting on September 30, 1992, attended by Mr. Mike Whelan of ARCO, Mr. Joel Coffman of RESNA, and Ms. Susan Hugo and Mr. Barney Chan of the ACHCSA. This Work Plan summarizes environmental work previously performed by RESNA and others at the subject site, and describes the project steps proposed for an additional subsurface investigation and pumping test. The objectives of this work are to further evaluate the vertical and lateral extent of gasoline hydrocarbons in the soil and groundwater in the vicinity of the former gasoline underground storage tanks (USTs), and collect hydrogeologic data necessary for evaluating the feasibility and design of future remediation systems.

The work proposed for this phase of additional subsurface investigation includes: after receiving approval of this Work Plan from ACHCSA, obtaining encroachment and excavation permits from the City of Oakland; submitting a well permit application to the Alameda County Flood Control and Water Conservation District, Zone 7 (ACFCWCD); drilling two onsite soil borings (B-13 and B-14); installing two onsite 4-inch-diameter groundwater monitoring wells (MW-5 and MW-6); drilling one offsite soil boring (B-15); installing one offsite 2-inch-diameter groundwater monitoring well (MW-7); developing the monitoring wells; surveying wells MW-5 through MW-7 to a local Geodetic Vertical Datum

to establish top-of-casing elevations; performing a step-drawdown test; performing a 24-hour pump and recovery test; measuring depths-to-water; recording visual evidence of floating product in initial groundwater samples; collecting groundwater samples from MW-5 through MW-7 for laboratory analysis; conducting a well survey of all wells within a ½-mile radius of the site; conducting a records search including historical aerial photographs; and preparing a report of the results.

SITE DESCRIPTION AND BACKGROUND

General

ARCO Station 2185 is located in a commercial and residential area on the southeastern corner of East 14th Street and 98th Avenue in Oakland, California. The location of the site is shown on the Site Vicinity Map, Plate 1. The site is on a relatively flat, asphalt and concrete covered lot at an elevation of approximately 25 feet above mean sea level (msl). The site is currently occupied by an operating AM/PM mini-market and self-serve gasoline station with regular unleaded and supreme unleaded gasoline pumps. Pertinent site features include two service islands (located in the northern section of the site), a station building, four newly installed USTs in the northeastern portion of the site, four groundwater monitoring wells, and two vapor extraction wells. These site features are shown on Plate 2, Generalized Site Plan.

Geology and Hydrogeology

The site is located in the East Bay Plain, an area of generally low relief lying between San Francisco Bay to the west and the foothills of the Diablo Range to the east. The East Bay Plain in underlain by about 1,000 ft. of unconsolidated Quaternary sediments, consisting mostly of sand and silt deposited by alluvial systems, and clay and silt deposited in shoreline and estuarine environments (Hickenbottom and Muir, 1988). The soils in the vicinity of the site have been mapped as medium-grained alluvium consisting of moderately sorted fine sand, silt and clayey silt, with localized layers of coarse sand (Helley et al., 1979).

The direction of groundwater flow beneath the site appears to be to the west-southwest based our third quarter 1992 monitoring data, and regional and local topography and drainage patterns.

PREVIOUS WORK

Preliminary Tank Replacement Assessment

In May 1991, Roux conducted a preliminary tank replacement assessment at the site (Roux, August 1991). The purpose of the assessment was to evaluate the presence of gasoline hydrocarbons in the soil in the area of the existing USTs prior to the planned tank removal activities. The investigation consisted of drilling and sampling four soil borings (B1 through B4) in the area of the existing USTs, submitting selected soil samples for laboratory analyses (total petroleum hydrocarbons [TPHg] and benzene, toluene, ethylbenzene and total xylenes [BTEX] using EPA Method 8015/8020) and drilling two soil borings and installing two vapor-extraction wells (VW-1 and VW-2) to be used for a vapor extraction test (VET). Locations of the soil borings and vapor extraction wells are shown on Plate 2.

Based on laboratory analytical results, petroleum hydrocarbons were detected in soil samples collected from the borings B1 through B4 at depths of 5 and 10 feet below ground surface, adjacent to the former USTs. Concentrations of TPHg in the soil ranged from nondetectable (less than 1.0 part per million [ppm]) to 350 ppm, concentrations of BTEX ranged from nondetectable (less than 0.005 ppm) to 19 ppm. Results of laboratory analyses are shown on Table 1, Cumulative Results of Laboratory Analyses of Soil Samples.

Vapor Extraction Test

On June 6, 1991, Roux conducted a one day VET to evaluate whether subsurface soil conditions at the site were favorable for soil venting remediation techniques (Roux, July 1991). A vacuum was applied to vapor well VW-2 while vapor well VW-1 was monitored for air pressure change, to determine if the soils were amenable to vapor extraction and if so, to estimate the radius of influence. No air pressure change was detected in vapor well VW-1, indicating subsurface conditions at the site will not allow a capture radius of 21 feet,

the distance between the two wells. From these results Roux concluded that the subsurface conditions at this site would not be suitable for soil venting remediation techniques.

Limited Subsurface Investigation

On September 10, 1991, Roux performed a limited subsurface investigation to evaluate the impact of gasoline hydrocarbons on the soil in the area of the then proposed new underground storage tank pit (Roux, November 1991). The investigation included drilling four soil borings (B5 through B8), collecting samples for laboratory analyses and preparing a report of the findings.

The results of laboratory analyses indicated that the soil in borings B5 and B6, located on the eastern edge of the proposed tank pit, had not been impacted by gasoline hydrocarbons. However, results of laboratory analyses of soil samples from borings B7 and B8, indicated the presence of relatively minor concentrations of TPHg and BTEX at depths of 11 and 13 feet. Concentrations of TPHg in these borings at 11 and 13 feet ranged from 1.3 to 1.7 ppm, and concentrations of BTEX ranged from 0.0053 to 0.27 ppm. Results of laboratory analyses are summarized in Table 1.

Underground Storage Tank Removal

On October 30, 1991, three USTs were excavated and removed from the site by ARCO's tank replacement contractor, Paradiso Construction Co. (Paradiso) of Oakland, California (Roux, June 17, 1992). The former tank excavation for these USTs is shown on Plate 2. Because visibly impacted soil was observed in the former tank pit excavation, the pit was over-excavated prior to sampling. Paradiso over-excavated the former tank pit to a depth of approximately 16 feet, which was approximately one foot below the static water level, and widened the excavation laterally between 3 and 6 feet. Following sampling on November 6, 1991, the bottom five feet of the former tank cavity were filled with pea gravel, and the remainder of the cavity was filled with clean, imported fill material.

On November 6, 1991, twelve soil samples (SW-1 through SW-12) were collected by Roux from the sidewalls of the former UST excavation (Roux, June 17, 1992). The samples were

analyzed for TPHg and BTEX by Sequoia Analytical of Concord, California. On November 5, 1991, former product and vent lines were excavated and removed by Paradiso. Because visibly impacted soil was observed beneath the product dispensers, selected areas were over-excavated prior to sampling. Fourteen soil samples (L-1 through L-14) were collected from below the removed lines and dispensers. These samples were also analyzed for TPHg and BTEX by Sequoia Analytical. Locations of the soil samples collected are shown on Plate 2. Results of laboratory analyses are presented in Table 1.

Roux concluded that although most of the impacted soil was removed from below the former tanks and dispensers during over-excavation, analytical results of the soil samples indicate that residual gasoline hydrocarbons may still be present in the vicinity of the former product dispensers and the former tank excavation (Roux, June 17, 1992).

Initial Subsurface Investigation

In July 1992, RESNA conducted an initial subsurface investigation (RESNA, September 28, 1992), which included drilling four soil borings (B-9 through B-12), one along each side of the site, and installing four groundwater monitoring wells (MW-1 through MW-4). The wells were surveyed, developed and sampled following installation.

Laboratory results of samples from the soil borings indicated that boring B-9, located upgradient from the former USTs, and boring B-12, located crossgradient from the former USTs, were not impacted by gasoline hydrocarbons. Laboratory results from soil samples from boring B-10, located immediately downgradient of the former USTs, and boring B-11, located downgradient of the pump islands, were impacted by gasoline hydrocarbons. The laboratory results of soil samples from these borings are presented in Table 1.

Laboratory analytical results of groundwater samples collected during July 1992, indicated that well MW-1, located upgradient from the former USTs, and well MW-4, located crossgradient from the former USTs, did not appear to be impacted by gasoline hydrocarbons. Laboratory analytical results from well MW-2, located near the southwestern edge of the former tank pit, indicated concentrations of 5,900 parts per billion (ppb) TPHg, and BTEX ranging from nondetectable (<0.5 ppb) to 510 ppb. Monitoring well MW-3,

located downgradient from the dispenser islands, was not sampled due to the presence of a product sheen. Laboratory analytical results for groundwater samples are summarized in Table 3, Results of Laboratory Analyses of Groundwater Samples - TPHg and BTEX.

Quarterly Groundwater Monitoring

Following the Initial Subsurface Investigation in July 1992, quarterly groundwater monitoring began at the site. Monitoring for the third quarter consisted of measuring depth-to-water levels to interpret groundwater gradient and flow direction. The analytical results from groundwater sampling during the July 1992 Initial Subusurface Investigation were used to represent third quarter 1992 sampling data. Based on monitoring data from July to September, first encountered groundwater beneath the site appears to flow approximately west-southwestward with a gradient of approximately 0.02 as depicted on Plates 3 and 4, Groundwater Gradient Maps. Cumulative groundwater monitoring data results are shown in Table 2, Cumulative Groundwater Monitoring Data.

PROPOSED WORK

Field work involved with the following project steps will be performed in accordance with RESNA's Field Protocol, which is included in Appendix A, and an updated Site Specific Safety Plan which will be prepared.

RESNA recommends the following work at the site based on the findings and conclusions of previous investigations:

Step 1 Upon gaining regulatory approval of this work plan, obtain encroachment and excavation permits from the City of Oakland to drill and install one groundwater monitoring well in East 14th Street, southwest of the site. Submit well permit applications to the ACFCWCD, Zone 7, for proposed offsite well MW-7, and proposed onsite wells MW-5 and MW-6.
move slightly north ~20' if possible

Step 2 After obtaining permit approval, drill and collect soil samples for soil classification and laboratory analysis from two onsite borings (B-13 and B-

14), and one offsite boring (B-15) as shown on Plate 5, Proposed Boring/Well Locations. Drill borings B-13 through B-15 to an anticipated depth of approximately 25 to 30 feet which includes 5 feet into a possible confining layer beneath first encountered groundwater. Install two onsite 4-inch-diameter groundwater monitoring wells (MW-5 and MW-6) using 4-inch-diameter polyvinyl chloride (PVC) well casing and 0.02 inch machine slotted screen. Install one offsite 2-inch-diameter groundwater monitoring well (MW-7) using 2-inch-diameter PVC well casing and 0.02 inch machine slotted screen. The purpose of borings B-13 through B-15 and wells MW-5 through MW-7 is to delineate the lateral and vertical extents of gasoline hydrocarbons downgradient of the former USTs, and to function as observation wells during the proposed aquifer pumping test.

Step 3 Submit selected soil samples from borings B-13 through B-15 to a State-Certified laboratory for analyses for TPHg and BTEX using Environmental Protection Agency (EPA) Method 5030/8015/8020. Chain-of-Custody protocol will be observed for all samples submitted for analysis.

Step 4 Direct a survey of wellhead elevations to a U.S. Coast and Geodetic Survey Datum, by a State licensed surveyor.

Step 5 Develop groundwater monitoring wells MW-5 through MW-7. Methods used for well development are described in Appendix A, Field Protocol.

Step 6 Measure depths-to-water, purge, and collect groundwater samples from monitoring wells MW-5 through MW-7. Submit groundwater samples from the wells to a State-Certified laboratory for analysis for TPHg and BTEX using EPA Method 5030/8015/602. Chain-of-Custody protocol will be observed for all samples submitted for analysis.

Step 7 Perform a step draw-down test and use the data to estimate the sustainable pumping rates for the pumping test. Perform a pumping and recovery test using monitoring well MW-3 as the pumping well and other wells

Will the backfill in former tank pit short circuit the extraction test? Shouldn't they pump from MW-2 too?

associated with the site as observation wells. Data obtained from the pumping and recovery tests will be used to determine the hydraulic conductivity, transmissivity, and storativity of the aquifer. The information will also be used to evaluate the zone of capture of the extraction well and the feasibility of groundwater extraction as an effective means of remediation at the site.

Step 8 Conduct a well survey to identify wells located within a ½-mile radius of the site. The survey of available information will include depth, use, and owners of domestic supply, irrigation, commercial, cathodic, groundwater monitoring, and abandoned wells.

Step 9 Conduct a records search consisting of obtaining copies of aerial photographs of the site vicinity and a report containing environmental data which identifies environmental problem sites and activities in the vicinity of the subject site. This data will be reviewed to identify potential offsite sources of hydrocarbons detected in the soil and groundwater at the subject site.

Step 10 Prepare a draft report summarizing research conducted, field and laboratory procedures, findings, interpretations, and conclusions and submit to ARCO for review.

Step 11 ARCO to review draft report.

Step 12 Issue final report.

SCHEDULE

A Preliminary Time Schedule to perform Steps 1 through 12 is included on Plate 6. This time schedule is an estimate and is dependent upon receiving the encroachment and excavation permits from the City of Oakland. ARCO and the appropriate regulatory agencies will be informed should the estimated time for completion of the work proposed in the Work Plan be delayed beyond the estimated time of completion. Time is estimated in weeks after gaining regulatory approval of the Work Plan and any changes which must be incorporated into this Work Plan due to regulatory request.

PROJECT STAFF

Mr. James L. Nelson, a Certified Engineering Geologist in the State of California, will be in overall charge of hydrogeologic facets, and Ms. Valli Voruganti will be in overall charge of engineering facets of the project. Mr. Greg Barclay, General Manager, will provide supervision of field and office operations of the project. Mr. Joel Coffman, Project Geologist, will be responsible for the day-to-day field and office operations of the Project. RESNA employs a staff of geologists, engineers and technicians who will assist with the project.

DISTRIBUTION

It is recommended that copies of this Work Plan be forwarded to:

Mr. Richard Heitt
Regional Water Quality Control Board
San Francisco Bay Region
2101 Webster Street, Suite 500
Oakland, California 94612

Mr. Barney Chan
Alameda County Health Care Services Agency
Department of Environmental Health
80 Swan Way, Room 200
Oakland, California 94624

REFERENCES

Helley, E. S., K. R. Lajoie, W. E. Spangle, and M. L. Blair. 1979. Flatland Deposits of the San Francisco Bay Region, California, U.S. Geological Survey Professional Paper 943.

Hickenbottom, K. and Muir, K. 1988. Geohydrology and Ground water - Quality Overview, East Bay Plain Area, Alameda County, California. Alameda County Flood Control and Water Conservation District 205 (j) Report.

RESNA, June 16, 1992. Site Safety Plan for ARCO Station 2185, 9800 E. 14th Street, Oakland California. 62026.01.

RESNA, September 28, 1992. Initial Subsurface Investigation at ARCO Station 2185, 9800 East 14th Street, Oakland, California. 62026.01.

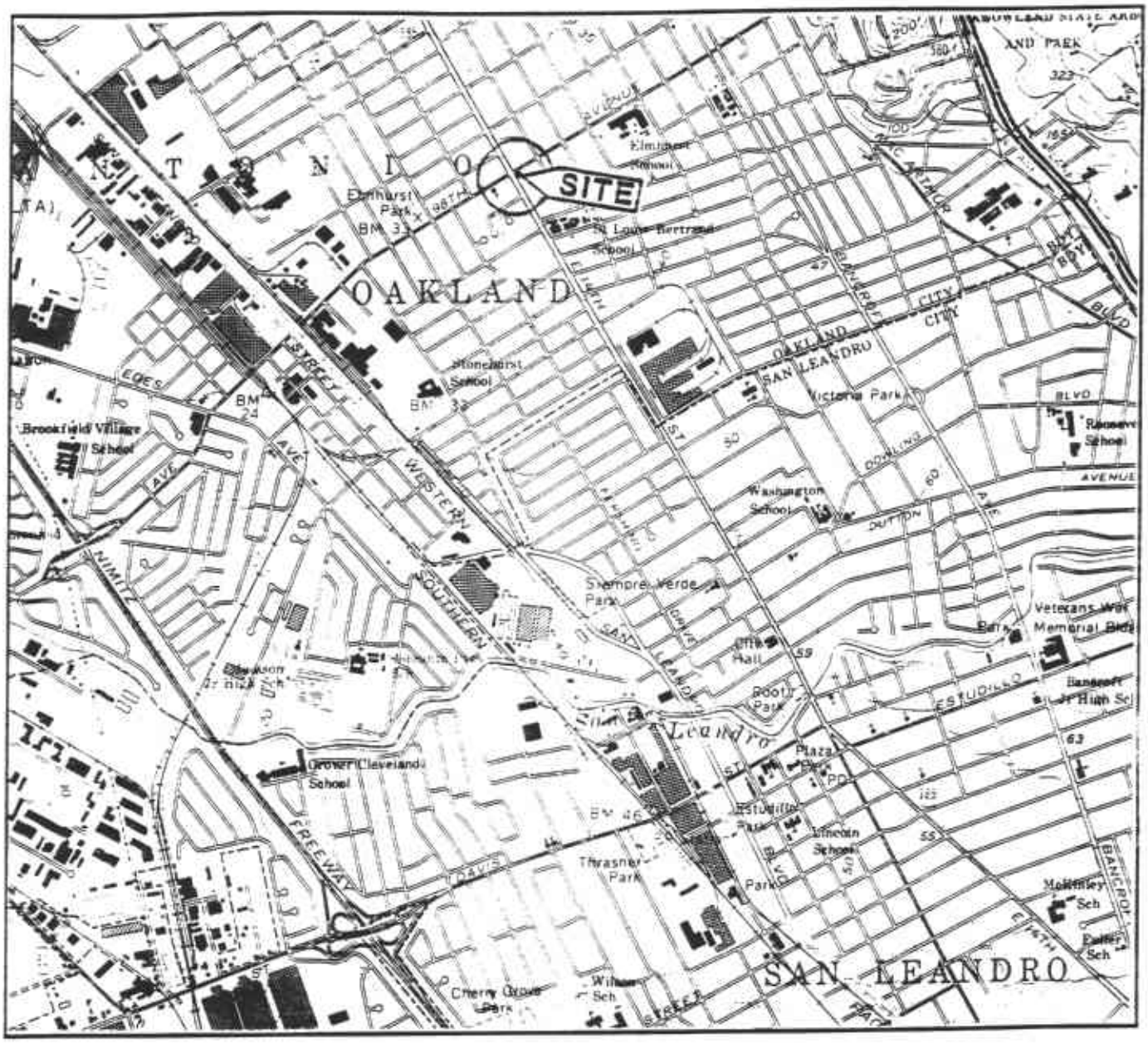
Roux, July 16, 1991. Letter Report Limited Soil Performance Test, ARCO Facility No. 2185, 9800 East 14th Street, Oakland, California. Doc #A102W02.1.1

Roux, August 8, 1991. Preliminary Tank Replacement Assessment, ARCO Facility No. 2185, 9800 East 14th Street, Oakland, California. Doc #A102W01.1.8

Roux, November 22, 1991. Limited Subsurface Soil Investigation, ARCO Facility No. 2185, 9800 East 14th Street, Oakland, California. Doc #A102W03.1.1

Roux, December 18, 1991. Site Investigation Work Plan, ARCO Facility No. 2185, 9800 East 14th Street, Oakland California. Doc #A119W02.1.1

Roux, June 17, 1992. Underground Storage Tank Removal and Soil Sampling, ARCO Facility No. 2185, East 14th Street, Oakland California. Doc #A119W01.1.2



Base: U.S. Geological Survey
7.5–Minute Quadrangles
San Leandro, California.
Photorevised 1980

N

LEGEND

⊙ = Site Location

Approximate Scale

2000 1000 0 2000 4000

feet

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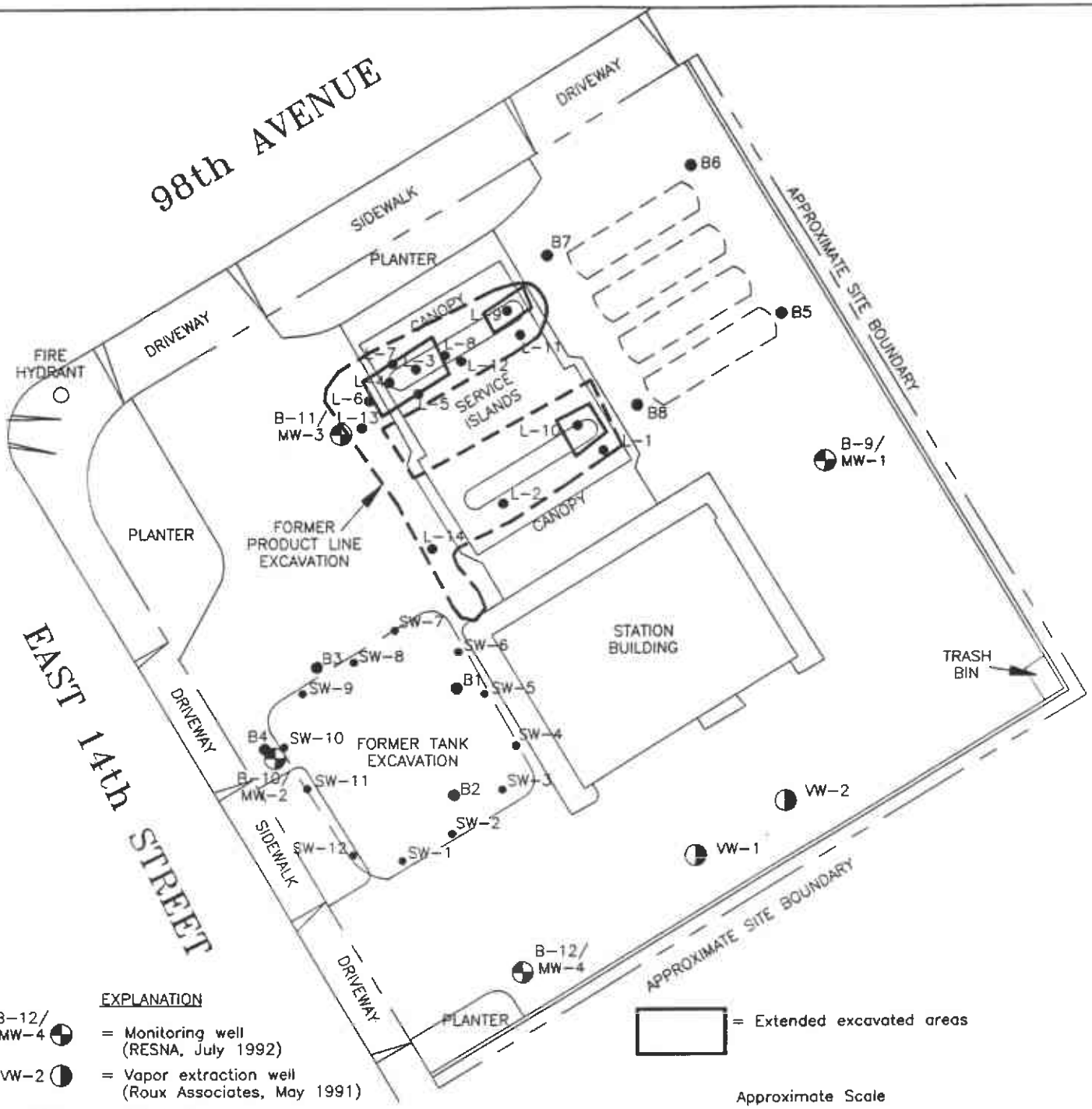
SITE VICINITY MAP
ARCO Station 2185
9800 East 14th Street
San Leandro, California

PLATE
1



EXPLANATION

- B-12/ MW-4 = Monitoring well (RESNA, July 1992)
- VW-2 = Vapor extraction well (Roux Associates, May 1991)
- B8 = Soil boring (Roux Associates, May and September 1991)
- L-13 = Soil boring (Roux Associates, November 1991)
- SW-12 = Tank cavity soil sample (Roux Associates, November 1991)
- = Existing underground storage tanks
- = Extended excavated areas

Approximate Scale

30 15 0 30 60

feet

Source: Modified from a site plan provided by Roux Associates dated December 1991. Also surveyed by John Koch, Licensed Land Surveyor, July 1992.

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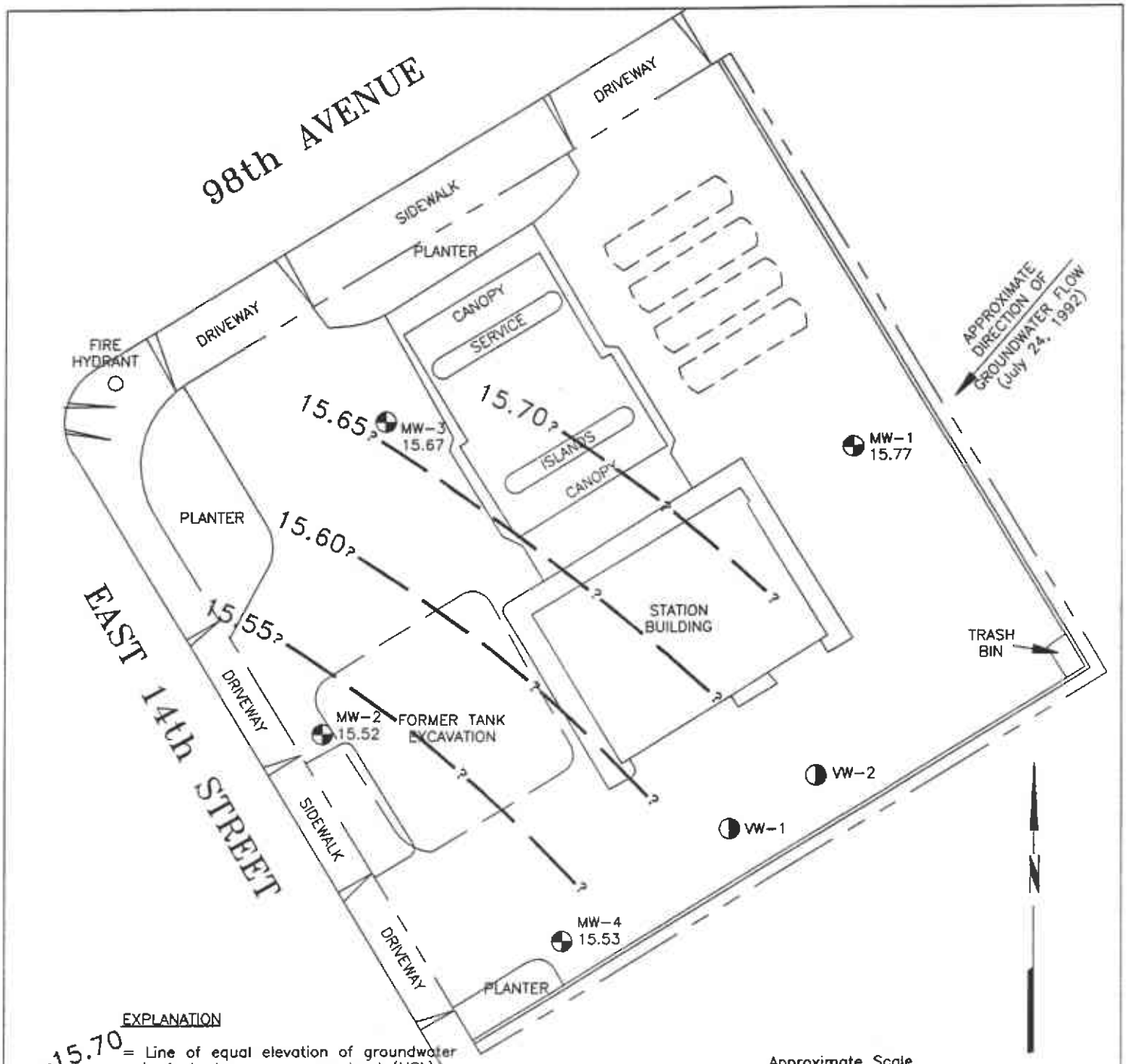
GENERALIZED SITE PLAN
ARCO Station 2185
9800 East 14th Street
Oakland, California

PLATE 2



SOURCE: Modified from a site plan provided by ROUX Associates dated December 1991. Also surveyed by John Koch, Licensed Land Surveyor, July 1992.

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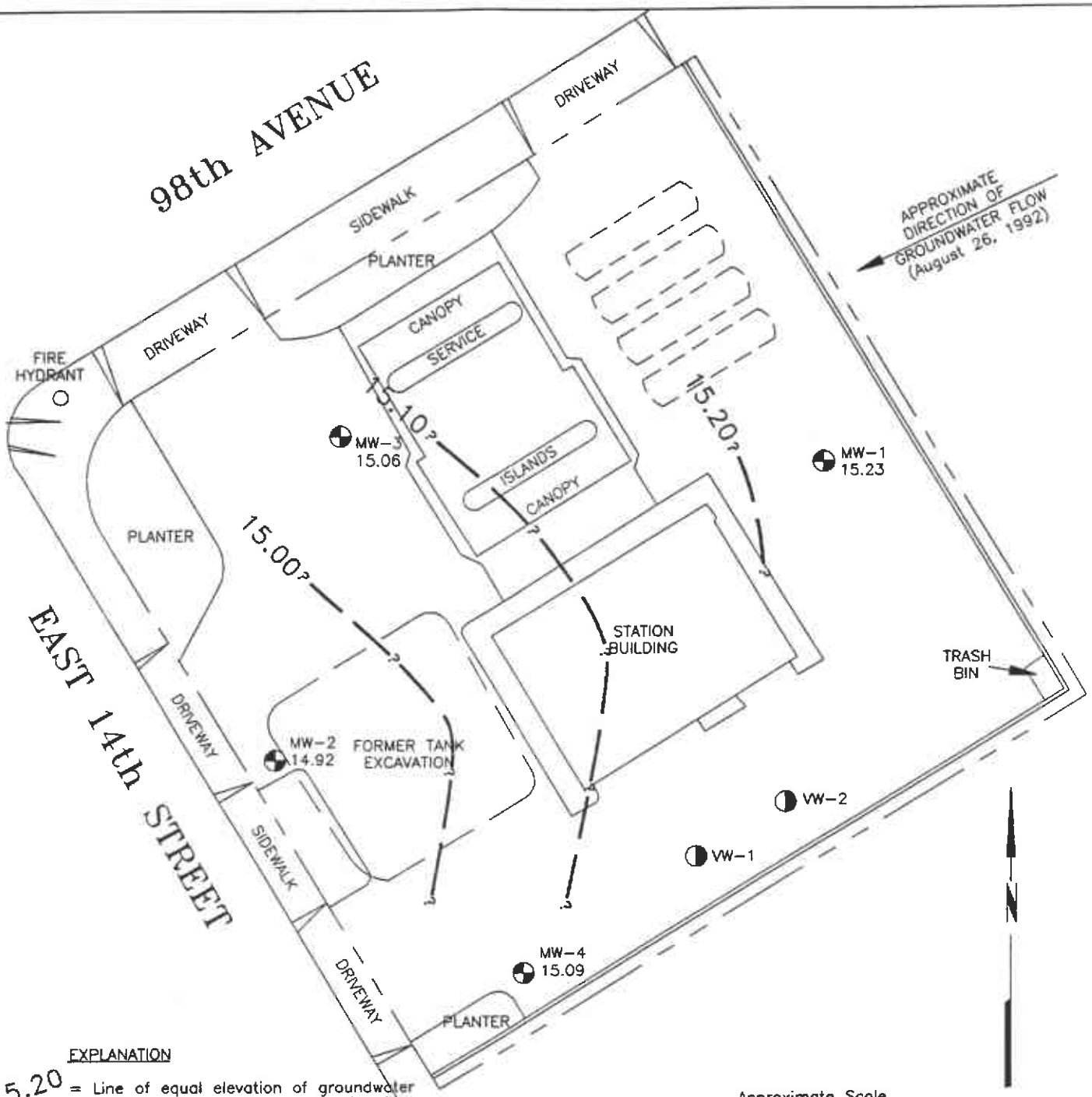
GROUNDWATER GRADIENT MAP
ARCO Station 2185
9800 East 14th Street
Oakland, California

PLATE 3



EXPLANATION

15.20 = Line of equal elevation of groundwater in feet above mean sea level (MSL)

15.23 = Elevation of groundwater in feet above MSL, August 26, 1992

MW-4 = Monitoring well (RESNA, July 1992)

VW-2 = Vapor extraction well (Roux Associates, May 1991)

= Existing underground storage tanks

Approximate Scale

30 15 0 30 60

feet

SOURCE: Modified from a site plan provided by ROUX Associates dated December 1991. Also surveyed by John Koch, Licensed Land Surveyor, July 1992.

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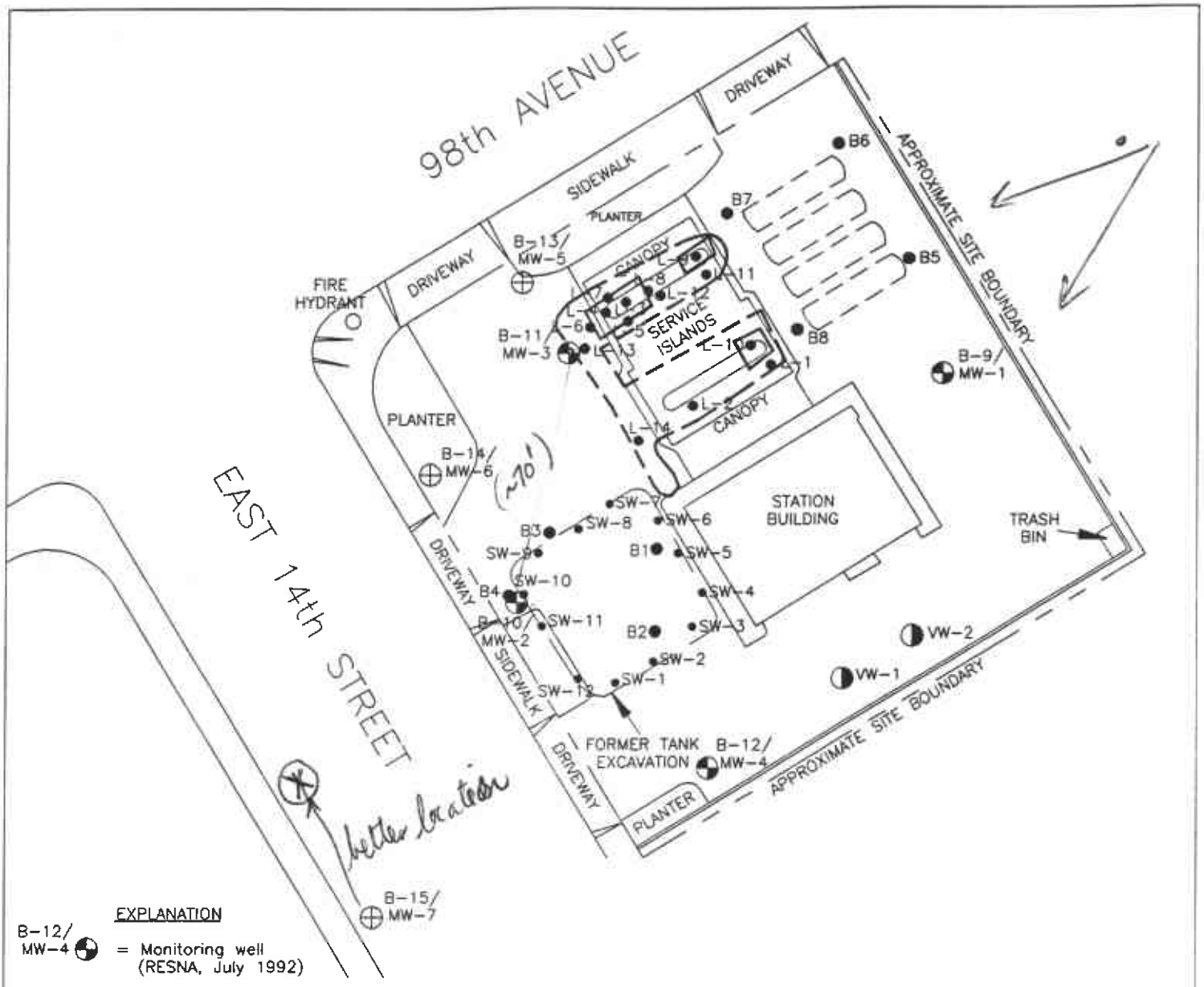
GROUNDWATER GRADIENT MAP
ARCO Station 2185
9800 East 14th Street
Oakland, California

PLATE 4



EXPLANATION

- B-12/ MW-4 = Monitoring well (RESNA, July 1992)
- VW-2 = Vapor extraction well (Roux Associates, May 1991)
- B8 or L-13 = Soil boring (Roux Associates, May, September, and November 1991)
- SW-12 = Tank cavity soil sample (Roux Associates, November 1991)
- = Existing underground storage tanks
- = Former product line excavation
- = Extended excavated areas
- B-15/ MW-5 = Proposed boring/well

Approximate Scale

40 20 0 40 80

feet

Source: Modified from a site plan provided by Roux Associates dated December 1991. Also surveyed by John Koch, Licensed Land Surveyor, July 1992.

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PROPOSED BORING/WELL LOCATIONS
ARCO Station 2185
9800 East 14th Street
Oakland, California

PLATE 5

STEP 1:
Obtain encroachment and excavation permits from the City of Oakland and well installation permits from ACFCWCD Zone 7

STEP 2:
Drill borings and install wells

STEP 3:
Submit soil samples for laboratory analyses and receive results

STEP 4:
Survey wells

STEP 5:
Develop wells

STEP 6:
Sample wells, submit samples for laboratory analyses, receive results

STEP 7:
Perform a step draw down and pumping and recovery test

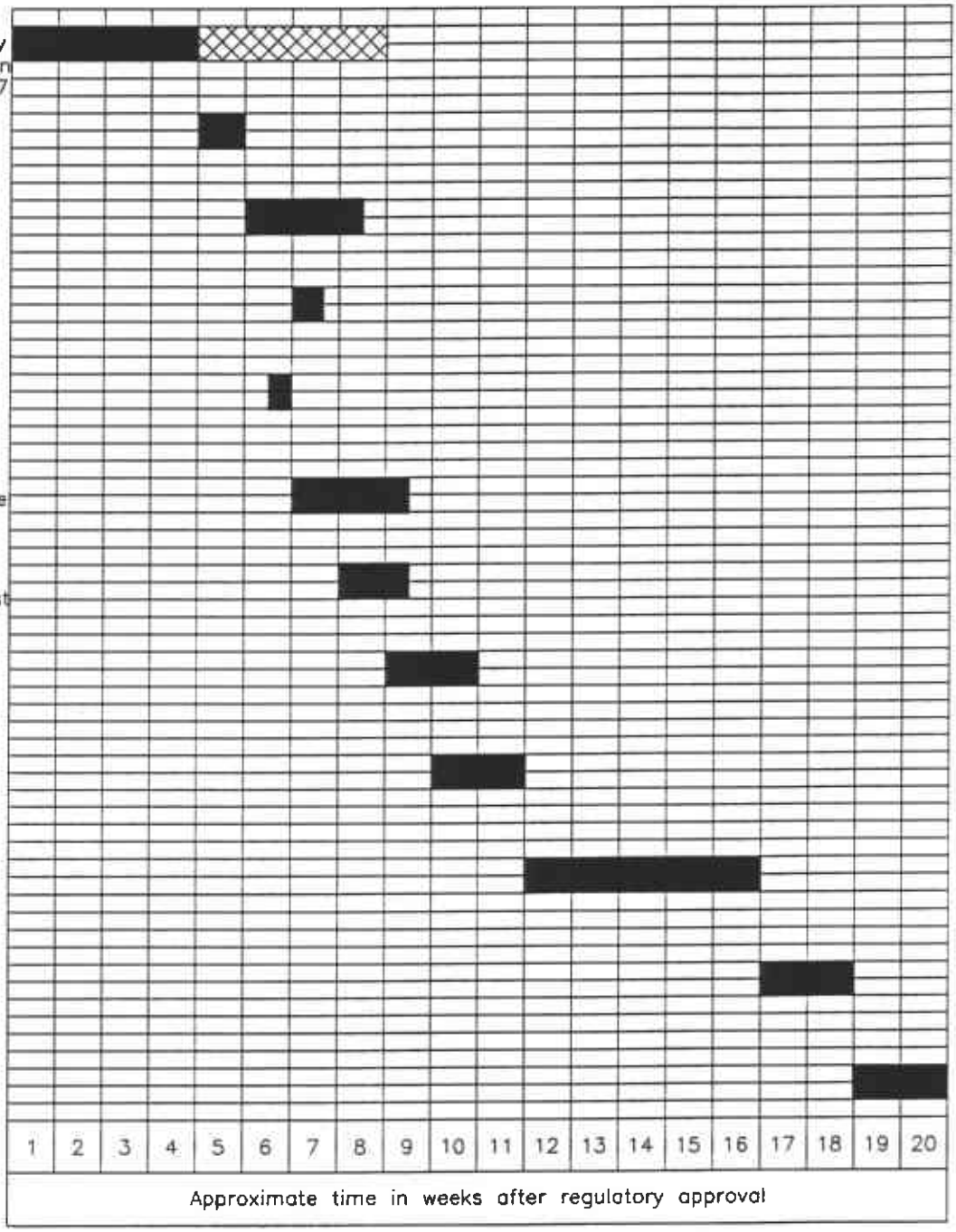
STEP 8:
Conduct a well search

STEP 9:
Conduct a record search including obtaining historical aerial photographs

STEP 10:
Prepare draft report

STEP 11:
ARCO review of draft report

STEP 12:
Finalize report



Schedule is dependent upon City of Oakland granting encroachment and excavation permits for well installation.

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PRELIMINARY TIME SCHEDULE
ARCO Station 2185
9800 East 14th Street
Oakland, California

PLATE
6

TABLE 1
CUMULATIVE RESULTS OF LABORATORY
ANALYSES OF SOIL SAMPLES
ARCO Station 2185
Oakland, California
(Page 1 of 2)

Sample ID	Depth	TPHg	B	T	E	X
May 1991						
B1-5	5	<1.0	0.021	<0.0050	<0.0050	<0.0050
B1-10	10	350	1.1	0.65	4.9	19
B2-5	5	<1.0	0.034	<0.0050	<0.0050	<0.0050
B2-10	10	280	1.3	0.34	3.4	10
B3-5	5	1.6	0.015	<0.0050	0.021	0.048
B3-10	10	38	<0.050	0.24	.031	2.0
B4-5	5	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
B4-10	10	110	0.40	0.20	0.72	0.24
September 1991						
B5-5	5	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
B5-11	11	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
B5-13	13	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
B6-5	5	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
B6-10	10	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
B7-5	5	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
B7-11	11	1.7	0.04	0.013	0.0079	0.078
B7-13	13	1.7	0.27	0.0083	0.04	0.028
B8-5	5	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
B8-11	11	1.7	0.054	0.0094	0.012	0.019
B8-13	13	1.3	0.013	0.0073	0.0053	0.0069
Tank Excavation November 1991						
SW-1	14	810	3.4	1.0	13	50
SW-2	6	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
SW-3	14	370	1.6	17	8.8	53
SW-4	14	220	0.73	1.2	2.8	15
SW-5	6	1.1	0.014	0.0069	0.012	0.034
SW-6	14	230	0.84	2.3	2.4	15
SW-7	14	1100	5.9	28	15	90
SW-8	6	1.3	0.11	0.0054	<0.0050	0.016
SW-9	14	500	3.7	0.92	7.1	32
SW-10	14	750	5.9	5.3	10	61
SW-11	6	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
SW-12	14	210	1.6	0.26	3.2	5.0
Product Lines						
L-1	3	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
L-2	3	<1.0	<0.0050	<0.0050	<0.0050	<0.0050
L-3	5	1,400	0.51	87	55	350
L-4	11	450	2.6	24	8.7	56
L-5	8	18	<0.0050	0.029	0.042	0.38
L-6	8	<1.0	<0.0050	<0.0050	<0.0050	<0.0050

See notes on page 2 of 2.

TABLE 1
CUMULATIVE RESULTS OF LABORATORY
ANALYSES OF SOIL SAMPLES
ARCO Station 2185
Oakland, California
(Page 2 of 2)

Sample ID	Depth	TPHg	B	T	E	X	
Product Lines (cont.)							
L-7	8	5.1	0.032	0.047	0.058		0.13
L-8	8	240	0.17	2.8	2.8	15	
L-9	9.5	5,400	22	330	120	640	
L-10	8	2,600	5	130	53	29	
L-11	3	1.4	<0.0050	0.014	0.012	0.1	
L-12	3	<1.0	<0.0050	<0.0050	<0.0050	<0.0050	
L-13	3	13	<0.0050	0.026	0.05	0.7	
L-14	3	<1.0	<0.0050	<0.0050	<0.0050	<0.0050	
July 1992							
S-10.5-B9	10.5	<1.0	<0.0050	<0.0050	<0.0050		<0.0050
S-13-B9	13	<1.0	<0.0050	<0.0050	<0.0050		<0.0050
S-23.5-B9	23.5	<1.0	<0.0050	<0.0050	<0.0050		<0.0050
S-9.5-B10	9.5	9.3	0.034	0.023	0.014		0.059
S-12-B10	12	220	1.1	0.75	5.1		6.3
S-23-B10	23	<1.0	<0.0050	<0.0050	<0.0050		<0.0050
S-10.5-B11	10.5	<1.0	0.0060	<0.0050	<0.0050		<0.0050
S-29-B11	29	<1.0	<0.0050	0.015	0.015		0.078
S-10-B12	10	<1.0	<0.0050	<0.0050	<0.0050		<0.0050
S-13-B12	13	<1.0	<0.0050	<0.0050	<0.0050		<0.0050
S-23.5-B12	23.5	<1.0	<0.0050	<0.0050	<0.0050		<0.0050
Composited Stockpile Sample							
SPA-SPD	NA	<1.0	<0.0050	<0.0050	0.010		0.012

Results in parts per million (ppm).
Depth in feet below ground surface.
TPHg =Total petroleum hydrocarbons as gasoline using EPA Method 5030/8020/8015
B = benzene, T = toluene, E = ethylbenzene, X = total xylenes (EPA Method 8020/8015)
< =Below indicated laboratory reporting limits.
NA = Not applicable
Sample Identification:

S-10-B12
- Boring number
- Sample depth in feet below ground surface
- Soil sample

SW-1
- Sample number
- Former tank cavity sample

B1-5
- Sample depth in feet below ground surface
- Boring number

SPA-SPD
- Composite sample
- Soil pile

Line-1
- Sample number
- Product line sample

TABLE 2
CUMULATIVE GROUNDWATER MONITORING DATA
ARCO Station 2185
Oakland, California
(Page 1 of 1)

Date Well Measured	Well Elevation	Depth to Water	Water Elevation	Floating Product
MW-1				
7-24-92	29.15	13.38	15.77	None
8-26-92		13.92	15.23	None
9-22-92		14.18	14.97	None
MW-2				
7-24-92	28.47	12.95	15.52	None
8-26-92		13.55	14.92	None
9-22-92		13.78	14.69	None
MW-3				
7-24-92	28.57	12.90	15.67	Sheen
8-26-92		13.51	15.06	None
9-22-92		13.73	14.84	None
MW-4				
7-24-92	29.21	13.68	15.53	None
8-26-92		14.12	15.09	None
9-22-92		14.46	14.75	None

Measurements in feet. Elevations in feet above mean sea level. Wells surveyed on July 23, 1992 (Benchmark #24/D, near the corner of 98th Avenue [5' feet west of west curb] and East 14th Street [7' feet east of the south curb] in Oakland).

TABLE 3
RESULTS OF LABORATORY ANALYSES OF
GROUNDWATER SAMPLES-TPHg AND BTEX
ARCO Station 2185
Oakland, California
(Page 1 of 1)

Well	TPHg	B	T	E	X
MW-1					
7-24-92	<50	<0.5	<0.5	<0.5	<0.5
MW-2					
7-24-92	5,900	510	<10*	370	430
MW-3					
7-24-92		Not sampled – sheen			
MW-4					
7-24-92	<50	<0.5	<0.5	<0.5	<0.5
MCL	—	1.0	—	680	1,750
DWAL	—	—	100	—	—

Results in parts per billion (ppb).
TPHg = Total petroleum hydrocarbons as gasoline by EPA Method 5030/8020 DHS LUFT.
B = benzene, T = toluene, E = ethylbenzene, X = total xylenes
< = Below indicated laboratory detection limits.
* = Laboratory raised Method Reporting Limit (MRL) due to high analyte concentration requiring sample dilution.
MCL = State Maximum Contaminant Level (California Department of Health Services, October 1990).
DWAL = State Recommended Drinking Water Action Level (California Department of Health Services, October 1990).

APPENDIX A

FIELD PROTOCOL

FIELD PROTOCOL

The following presents RESNA's protocol for a typical site investigation involving gasoline hydrocarbon-impacted soil and/or groundwater.

Site Safety Plan

The Site Safety Plan describes the safety requirements for the evaluation of gasoline hydrocarbons in soil, groundwater, and the vadose-zone at the site. The Site Safety Plan is applicable to personnel of RESNA and its subcontractors. RESNA personnel and subcontractors of RESNA scheduled to perform the work at the site are to be briefed on the contents of the Site Safety Plan before work begins. A copy of the Site Safety Plan is available for reference by appropriate parties during the work. A site Safety Officer is assigned to the project.

Sampling of Stockpiled Soil

One composite soil sample is collected for each 50 cubic yards of stockpiled soil, and for each individual stockpile composed of less than 50 cubic yards. Composite soil samples are obtained by first evaluating relatively high, average, and low areas of hydrocarbon concentration by digging approximately one to two feet into the stockpile and placing the intake probe of a field calibrated OVM against the surface of the soil; and then collecting one sample from the "high" reading area, and three samples from the "average" areas. Samples are collected by removing the top one to two feet of soil, then driving laboratory-cleaned brass sleeves into the soil. The samples are sealed in the sleeves using aluminum foil, plastic caps, and aluminized duct tape; labeled; and promptly placed in iced storage for transport to the laboratory, where compositing will be performed.

Soil Borings

Prior to the drilling of borings and construction of monitoring wells, permits are acquired from the appropriate regulatory agency. In addition to the above-mentioned permits, encroachment permits from the City or State are acquired if drilling of borings offsite in the City or State streets is necessary. Copies of the permits are included in the appendix of the project report. Prior to drilling, Underground Services Alert is notified of our intent to drill, and known underground utility lines and structures are approximately marked.

The borings are drilled by a truck-mounted drill rig equipped with 8- or 12-inch-diameter, hollow-stem augers. The augers are steam-cleaned prior to drilling each boring to minimize

the possibility of cross-contamination. After drilling the borings, monitoring wells are constructed in the borings, or neat-cement grout with bentonite is used to backfill the borings to the ground surface.

Borings for groundwater monitoring wells are drilled to a depth of no more than 20 feet below the depth at which a saturated zone is first encountered, or a short distance into a stratum beneath the saturated zone which is of sufficient moisture and consistency to be judged as a perching layer by the field geologist, whichever is shallower. Drilling into a deeper aquifer below the shallowest aquifer can begin only after a conductor casing is properly installed and allowed to set, to seal the shallow aquifer.

Drill Cuttings

Drill cuttings subjectively evaluated as having hydrocarbon contamination at levels greater than 100 parts per million (ppm) are separated from those subjectively evaluated as having hydrocarbon contamination levels less than 100 ppm. Evaluation is based either on subjective evidence of soil discoloration, or on measurements made using a field calibrated OVM. Readings are taken by placing a soil sample into a ziplock type plastic bag and allowing volatilization to occur. The intake probe of the OVM is then inserted into the headspace created in the plastic bag immediately after opening it. The drill cuttings from the borings are placed in labeled 55-gallon drums approved by the Department of Transportation; or on plastic at the site, and covered with plastic. The cuttings remain the responsibility of the client.

Soil Sampling in Borings

Soil samples are collected at no greater than 5-foot intervals from the ground surface to the total depth of the borings. The soil samples are collected by advancing the boring to a point immediately above the sampling depth, and then driving a California-modified, split-spoon sampler containing brass sleeves through the hollow center of the auger into the soil. The sampler and brass sleeves are laboratory-cleaned, steam-cleaned, or washed thoroughly with Alconox® and water, prior to each use. The sampler is driven with a standard 140-pound hammer repeatedly dropped 30 inches. The number of blows to drive the sampler each successive six inches are counted and recorded to evaluate the relative consistency of the soil.

The samples selected for laboratory analyses are removed from the sampler and quickly sealed in their brass sleeves with aluminum foil, plastic caps, and aluminized duct tape. The samples are then be labeled, promptly placed in iced storage, and delivered to a laboratory certified by the State of California to perform the analyses requested.

One of the samples in brass sleeves not selected for laboratory analyses at each sampling interval is tested in the field using an OVM that is field calibrated at the beginning of each day it is used. This testing is performed by inserting the intake probe of the OVM into the headspace created in the plastic bag containing the soil sample as described in the Drill Cuttings section above. The OVM readings are presented in Logs of Borings included in the project report.

Logging of Borings

A geologist is present to log the soil cuttings and samples using the Unified Soil Classification System. Samples not selected for chemical analyses, and the soil in the sampler shoe, are extruded in the field for inspection. Logs include texture, color, moisture, plasticity, consistency, blow counts, and any other characteristics noted. Logs also include subjective evidence for the presence of hydrocarbons, such as soil staining, noticeable or obvious product odor, and OVM readings.

Monitoring Well Construction

Monitoring wells are constructed in selected borings using clean 2- or 4-inch-diameter, thread-jointed, Schedule 40 polyvinyl chloride (PVC) casing. No chemical cements, glues, or solvents are used in well construction. Each casing bottom is sealed with a threaded end-plug, and each casing top with a locking plug. The screened portions of the wells are constructed of machine-slotted PVC casing with 0.020-inch-wide (typical) slots for initial site wells. Slot size for subsequent wells may be based on sieve analyses and/or well development data. The screened sections in groundwater monitoring wells are placed to allow monitoring during seasonal fluctuations of groundwater levels.

The annular space of each well is backfilled with No. 2 by 12 sand, or similar sorted sand, to approximately two feet above the top of the screened casing for initial site wells. The sand pack grain size for subsequent wells may be based on sieve analyses and/or well development data. A 1- to 2-foot-thick bentonite plug is placed above the sand as a seal against cement entering the filter pack. The remaining annulus is then backfilled with a slurry of water, neat cement, and bentonite to approximately one foot below the ground surface.

An aluminum utility box with a PVC apron is placed over each wellhead and set in concrete placed flush with the surrounding ground surface. Each wellhead cover has a seal to protect the monitoring well against surface-water infiltration and requires a special wrench to open. The design discourages vandalism and reduces the possibility of accidental disturbance of the well.

Groundwater Monitoring Well Development

The monitoring wells are developed by bailing or over-pumping and surge-block techniques. The wells are either bailed or pumped, allowed to recharge, and bailed or pumped again until the water removed from the wells is determined to be clear. Turbidity measurements (in NTUs) are recorded during well development and are used in evaluating well development. The development method used, initial turbidity measurement, volume of water removed, final turbidity measurement, and other pertinent field data and observations are included in reports. The wells are allowed to equilibrate for at least 48 hours after development prior to sampling. Water generated by well development will be stored in 17E Department of Transportation (DOT) 55-gallon drums on site and will remain the responsibility of the client.

Groundwater Sampling

The static water level in each well is measured to the nearest 0.01-foot using a Solinst® electric water-level sounder or oil/water interface probe (if the wells contain floating product) cleaned with Alconox® and water before use in each well. The liquid in the onsite wells is examined for visual evidence of hydrocarbons by gently lowering approximately half the length of a Teflon® bailer (cleaned with Alconox® and water) past the air/water interface. The sample is then retrieved and inspected for floating product, sheen, emulsion, color, and clarity. The thickness of floating product detected is recorded to the nearest 1/8-inch.

Wells which do not contain floating product are purged using a submersible pump. The pump, cables, and hoses are cleaned with Alconox® and water prior to use in each well. The wells are purged until withdrawal is of sufficient duration to result in stabilized Ph, temperature, and electrical conductivity of the water, as measured using portable meters calibrated to a standard buffer and conductivity standard. If the well becomes dewatered, the water level is allowed to recover to at least 80 percent of the initial water level. Prior to the collection of each groundwater sample, the Teflon® bailer is cleaned with Alconox® and rinsed with tap water and deionized water, and the latex gloves worn by the sampler changed. Hydrochloric acid is added to the sample vials as a preservative (when applicable). A sample method blank is collected by pouring distilled water into the bailer and then into sample vials. A sample of the formation water is then collected from the surface of the water in each of the wells using the Teflon® bailer. The water samples are then gently poured into laboratory-cleaned, 40-milliliter (ml) glass vials, 500 ml plastic bottles or 1-liter glass bottles (as required for specific laboratory analysis) and sealed with Teflon®-lined caps, and inspected for air bubbles to check for headspace, which would allow volatilization to occur. The samples are then labeled and promptly placed in iced storage. A field log of

well evacuation procedures and parameter monitoring is maintained. Water generated by the purging of wells is stored in 17E DOT 55-gallon drums onsite and remains the responsibility of the client.

Sample Labeling and Handling

Sample containers are labeled in the field with the job number, sample location and depth, and date, and promptly placed in iced storage for transport to the laboratory. A Chain of Custody Record is initiated by the field geologist and updated throughout handling of the samples, and accompanies the samples to a laboratory certified by the State of California for the analyses requested. Samples are transported to the laboratory promptly to help ensure that recommended sample holding times are not exceeded. Samples are properly disposed of after their useful life has expired.

Aquifer Testing

Step Drawdown Test

The initial water level is measured in the test well, then water is pumped at a steady rate while depth-to-water measurements are taken at 5 minute intervals until the reaction of the aquifer can be characterized. If the water in the test well draws down rapidly and the well appears to be going dry or is pumped dry, a lesser pumping rate is attempted. If the water does not draw down or draws down and stabilizes leaving several feet of water column above the bottom of the well, a greater pumping rate is attempted. The evacuated water is stored in a storage tank at the site and remains the responsibility of the client. The reaction of the water level in the test well is recorded and the pumping rate for the pumping and recovery test is chosen based on these results.

Pumping and Recovery Test

The initial water levels in wells to be used during the test are measured prior to commencement of pumping. The flow rate of the pump is adjusted to the desired rate, as determined in the step drawdown test, and pumping begins. The starting time is recorded, and drawdowns in observation wells are recorded at intervals throughout the pumping. Evacuated water is stored in a storage tank at the site and remains the responsibility of the client. After the pump is shut off, recovery measurements are taken in the wells until recovery is at least 80 percent of the initial water level. Barometric pressure and tidal information are collected for the time interval of the pumping test to allow screening of possible effects of atmospheric pressure and tidal fluctuations on the groundwater levels.