Applied GeoSystems, Inc.
A RESNA Company

RESNA
Working To Restore Nature

91 OCT 22 AM 8:35

TRANSMITTAL

3315 Almaden Expressway, Suite 34
San Jose, CA 95118
Phone: (408) 264-7723
Fax: (408) 264-2435

TO: MS. SUSAN HUGO
ALAMEDA COUNTY HEALTH CARE SERVICES
AGENCY-DEPT OF ENVIR. HEALTH
80 SWAN WAY, ROOM 200
OAKLAND, CALIFORNIA 94621

DATE: 10/21/91
PROJECT NUMBER: 69028.06
SUBJECT: ARCO STATION 6113 AT 785 EAST STANLEY BOULEVARD, LIVERMORE, CALIF.

FROM: JOEL COFFMAN
TITLE: PROJECT GEOLOGIST

WE ARE SENDING YOU [xx] Attached [ ] Under separate cover via ________ the following items:

[ ] Shop drawings [ ] Prints [xx] Reports [ ] Specifications

[ ] Letters [ ] Change Orders [ ] ____________

COPIES	DATED	NO.	DESCRIPTION
1	10/17/91		FINAL-WORK PLAN FOR ADDITIONAL SUBSURFACE INVESTIGATION AND VAPOR EXTRACTION TEST AT THE ABOVE SUBJECT SITE.

THESE ARE TRANSMITTED as checked below:

[ ] For review and comment [ ] Approved as submitted [ ] Resubmit ___ copies for approval

[ ] As requested [ ] Approved as noted [ ] Submit ___ copies for distribution

[ ] For approval [ ] Return for corrections [ ] Return ___ corrected prints

[ ] For your files [ ] ____________

REMARKS: THIS REPORT HAS BEEN FORWARDED TO YOU AT THE REQUEST OF MR. CHUCK CARMEL OF ARCO PRODUCTS COMPANY.

Copies: 1 to AGS project file no. 69028.06

SAN JOSE READER'S FILE

*Revision Date: 10/15/90
*File Name: TRANSMT.PRJ

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WORK PLAN
for
ADDITIONAL SUBSURFACE INVESTIGATION AND VAPOR EXTRACTION TEST
at
ARCO Station 6113
785 East Stanley Boulevard
Livermore, California

69028.06

Prepared for
ARCO Products Company
P.O. Box 5811
San Mateo, California 94402
by
RESNA

Robert D. Campbell
Staff Geologist

Joel Coffman
Project Geologist

Joan E. Tiernan
Ph.D., P.E.
Engineering Manager

REGISTERED PROFESSIONAL ENGINEER
JOAN E. TIERNAN
No. C 044600
Exp. 3-31-94
CIVIL
STATE OF CALIFORNIA

October 17, 1991

A RESNA Company

RESNA
Working To Restore Nature

3315 Almaden Expressway, Suite 34
San Jose, CA 95118
Phone: (408) 264-7723
Fax: (408) 264-2435

October 17, 1991
69028.06

Mr. Chuck Carmel
Environmental Engineer
ARCO Products Company
P.O. Box 5811
San Mateo, California 94402

Subject: Transmittal of Work Plan for Additional Subsurface Investigation and Vapor Extraction Test at ARCO Station 6113, 785 East Stanley Boulevard, Livermore, California.

Mr. Carmel:

As requested by ARCO Products Company (ARCO), RESNA has prepared the attached Work Plan for review and approval by ARCO, the Regional Water Quality Control Board (RWQCB), the Alameda County Health Care Services Agency (ACHCSA), and the City of Livermore Fire Department. This Work Plan summarizes previous work performed at the subject site and RESNA's approach, field methods, and project tasks recommended to perform additional subsurface investigation and a vapor extraction test at this site. The proposed work includes drilling and sampling four soil borings, laboratory analysis of soil samples, performing a vapor extraction test, and preparing a report of our findings, interpretations, and conclusions. Recommendations will be included under separate cover as requested by ARCO.

RESNA recommends performing these project tasks to evaluate the extent of gasoline hydrocarbons in the soil in the area of the underground gasoline storage tanks and to evaluate the feasibility of vapor extraction as a remediation alternative at the site. Groundwater monitoring wells will be installed if groundwater is encountered; however, quarterly monitoring at the site has indicated that the water levels in the existing wells at the site have dropped approximately 10 to 18 feet between May and August 1991, and the wells at the site were dry or contained residual water in September 1991.

RESNA recommends that copies of this Work Plan be sent to the following regulatory agencies:

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

Ms. Susan Hugo
Alameda County Health Care Services Agency
Department of Environmental Health
80 Swan Way, Room 200
Oakland, California 94612

Mr. Randy Griffith
Livermore Fire Department
4550 East Avenue
Livermore, California 94550

If you should have any questions or comments about this Work Plan, please call us at (408) 264-7723.

Sincerely,
RESNA

Joel Coffman
Project Geologist

Enclosure: Work Plan

cc: H.C. Winsor, ARCO Products Company

TABLE OF CONTENTS

PLATES

TABLES

APPENDICES

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3315 Almaden Expressway, Suite 34
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WORK PLAN
for
ADDITIONAL SUBSURFACE INVESTIGATION
AND VAPOR EXTRACTION TEST
at
ARCO Station 6113
785 East Stanley Boulevard
Livermore, California
for
ARCO Products Company

INTRODUCTION

This Work Plan summarizes work previously performed by RESNA/Applied GeoSystems (RESNA) and others, and describes the project steps proposed to evaluate the vertical and lateral extent of gasoline hydrocarbons in the soil in the area of the underground gasoline storage tanks (USTs) and to evaluate the feasibility of vapor extraction as a possible remediation alternative (if necessary) at the site. ARCO Products Company (ARCO) requested that RESNA prepare this work plan for review and approval by the Regional Water Quality Control Board (RWQCB), the Alameda County Health Care Services Agency (ACHCSA), and the City of Livermore Fire Department.

Work includes drilling four soil borings; collecting soil samples from the borings; installing vapor wells (or groundwater monitoring wells if groundwater is present in the borings); performing a vapor extraction test (if gasoline hydrocarbons are present in the soil); and preparing a report.

After an initial subsurface environmental investigation in February through March 1991 (RESNA, April 1991), RESNA recommended that an additional monitoring well be installed at the site to further investigate the extent of gasoline hydrocarbons in groundwater, and that quarterly groundwater monitoring of the four existing wells at the site continue.

Quarterly groundwater monitoring has indicated that the groundwater level at the site has dropped approximately 10 to 18 feet between May and August 1991, and that in September 1991, the wells were dry or contained residual water. RESNA initiated preparation of a Work Plan for installation of additional groundwater monitoring wells in July 1991, however, since the water levels have decreased, ARCO has requested that a Work Plan be prepared for installation of vapor/groundwater monitoring wells and performance of a vapor extraction test. ACHCSA was notified on August 15, 1991 of the lack of water in the wells and RESNA was notified that Mr. Paul Smith of the ACHCSA now oversees the site.

SITE DESCRIPTION AND BACKGROUND

General

ARCO Station 6113 is an operating gasoline station and mini-market in a commercial and residential area. It is located on the southwestern corner of East Stanley Boulevard and Murrieta Boulevard in Livermore, California, as shown on the Site Vicinity Map (Plate 1). The site is bounded by East Stanley Boulevard to the north, Murrieta Boulevard to the east, and the Arroyo Mocho Creek to the south and west. An operating Shell Service Station is on the southeastern corner of East Stanley Boulevard and Murrieta Boulevard. The elevation of the site is approximately 457 feet above mean sea level.

Four USTs are present at the site. On January 26, 1989, prior to RESNA involvement with the site, the 280-gallon waste-oil storage tank was excavated and removed from the site (see previous work, below). The former waste-oil tank location is covered by a large concrete utility-pad. The USTs are presently in service at the site. The locations of a former underground waste-oil tank, USTs, and pertinent site features are shown on the Generalized Site Plan (Plate 2).

Regional Geology and Hydrogeology

The site is located in the Livermore Valley, which is an intermontane valley in the Coast Ranges Geomorphic Province. The valley is approximately 13 miles long in an east-west direction and is four miles wide. The valley is surrounded by hills of the Diablo Range

(California Department of Water Resources, 1974). The valley floor slopes gently toward the west. The principal streams in the area are the Arroyo Valley and Arroyo Mocho, which flow toward the western end of the valley. Arroyo Mocho is approximately 50 feet south-southwest of the site.

Livermore Valley is underlain by non-water-bearing rocks, water-bearing units, and sediments. The water-bearing units and sediments comprise the Livermore Valley groundwater basin. Water-bearing units include the Tassajara Formation, the Livermore Formation, and valley-fill materials (California Department of Water Resources, 1966, 1974). The Livermore Valley groundwater basin is divided into sub-basins on the basis of fault traces or other hydrologic discontinuities (California Department of Water Resources, 1974). The groundwater system in Livermore Valley is a multilayered system with an unconfined aquifer overlying a sequence of leaky or semiconfined aquifers. Groundwater in the basin flows downslope toward the east-west-trending axis of the valley and then flows generally to the west (Alameda County Flood Control and Water Conservation District - Zone 7, 1991).

PREVIOUS WORK

January and February 1989

Previous work performed at the site in January and February 1989 by Pacific Environmental Group (Pacific), included soil excavation, removal of the 280-gallon waste-oil tank, and collection of soil samples for laboratory analysis. The waste-oil tank pit was excavated and the tank removed from the pit by Crosby and Overton, Inc. on January 26, 1989. During removal of the waste-oil tank, Pacific noted that the tank displayed no sign of leakage from either the fill pipe or the tank, and reported no detectable product odor in the soil beneath the tank. Pacific reported that soil removed from the northern wall of the tank excavation was slightly darker than soil from other areas of the excavation. The tank pit was excavated to a depth of 7-1/2 feet below grade. Pacific collected a soil sample (WO-1) at this depth (two feet below the bottom of the former waste-oil tank) in the central portion of the excavation. Pacific also collected a soil sample (WOSW-N) from the discolored area at a depth of 5 feet in the northern wall of the tank excavation, as requested by Mr. Gil Wistar of ACHCSA. The soil samples were analyzed for total oil and grease (TOG), high boiling hydrocarbons (HBHC, calculated as oil and diesel), semi-volatile organic compounds (VOC), and cadmium, chromium, lead, and zinc at International Technology Corporation (Hazardous Waste Testing Laboratory No. 137) in San Jose, California. Pacific reported that concentrations of chromium, lead, and VOCs were below the levels set by the California Regional Water Quality Control Board for these compounds in soil. Because elevated concentrations of TOG (660 to 1700 parts per million [ppm] and HBHC (60 to 790 ppm) were detected in both samples, the pit was excavated further two feet laterally and one foot vertically on February 3, 1989. According to Pacific's report, further excavation would have threatened the stability of the station building. Two additional samples (WO-2 at a depth of 8-½ feet from the center of the excavation, and WOSW-N2, at a depth of 7 feet from the northern end of the excavation) were collected and analyzed for TOG and HBHC. Soil sample locations are shown on Plate 2. The results of Pacific's soil laboratory testing are shown in Table 1, Results Of Laboratory Analysis Of Soil Samples For Petroleum Hydrocarbons And Metals From Waste-Oil Tank Pit. The excavation was backfilled with clean fill.

<u>September 1989 - January 1991</u>

RESNA drilled and sampled three soil borings (B-1, B-2, and B-3), and installed and sampled three groundwater monitoring wells (MW-1, MW-2, and MW-3, respectively) in the borings (RESNA, December 6, 1989). The locations of these borings are shown on Plate 2. The results of laboratory analysis of soil samples are presented in Table 2, Results of Laboratory Analyses of Soil Samples. Laboratory analysis of soil samples obtained from each of the borings reported nondetectable (less than 1 ppm) levels of total petroleum hydrocarbons as gasoline (TPHg), nondetectable (less than 10 ppm) levels of total petroleum hydrocarbons as diesel (TPHd), and nondetectable (less than 30 ppm) levels of TOG.

Laboratory analysis of water samples obtained from wells MW-1, MW-2, and MW-3 during quarterly monitoring by RESNA reported nondetectable levels of TPHd (less than 100 parts per billion [ppb]) and TOG (less than 5,000 ppb) in the wells, with the exception of two samples collected on June 21, 1990, from the monitoring wells MW-1 and MW-2 which contained 13,000 ppb and 10,000 ppb of TOG respectively (see Table 3, Cumulative Results of Laboratory Analysis of Water Samples). Between September 1989 and January 1991, the gasoline constituents benzene, toluene, ethylbenzene, and total xylene isomers (BTEX) in water samples obtained from wells MW-1 through MW-3 have been below the California State Department of Health Services (DHS) maximum contaminant levels for drinking water.

The groundwater gradient evaluated from the groundwater elevation data (Table 4) remained consistent since September 1989 through January 1991, and ranged from 0.028 to 0.009 to the northeast.

February and March 1991

RESNA performed a limited subsurface environmental investigation (RESNA, April 16, 1991) to evaluate the lateral and vertical extent of waste-oil related hydrocarbons in the soil, and the potential impact of these hydrocarbons on groundwater downgradient of the former underground waste-oil tank. This work involved drilling one soil boring (B-4) collecting and describing soil samples from the boring, installing and developing a 4-inch-diameter groundwater monitoring well (MW-4) in the boring, sampling groundwater from the monitoring wells at the site, surveying wellhead elevations, measuring depths-to-water in the wells, laboratory analysis of selected soil and groundwater samples, and preparing a report. The location of the boring/monitoring well is shown on Plate 2.

Groundwater was first encountered at a depth of approximately 24 feet below the ground surface. Results of laboratory analysis of soil samples indicated nondetectable concentrations of TPHg, TPHd, TOG, and BTEX in all soil samples, with the exception of one sample collected at 29 feet in a damp silty clay layer, which contained a very low concentration of benzene at 0.008 ppm (slightly above the laboratory detection limit [<0.005]). The results of laboratory analysis of soil samples are presented in Table 2, Cumulative Results of Laboratory Analyses of Soil Samples.

Water samples collected from MW-1 through MW-4 for subjective analysis showed no evidence of measurable floating product or product sheen. Laboratory analysis of groundwater samples collected on February 21, 1991 from monitoring wells MW-1 through

MW-4 reported concentrations of BTEX in the wells below the State of California Department of Health Services (DHS) maximum contaminant levels (MCLs) and recommended action levels for drinking water (which for BTEX are 1.0 parts per billion [ppb], 100 ppb, 680 ppb, and 1,750 ppb, respectively [DHS, October 1990]), with the exception of benzene in wells MW-1 (1.2 ppb) and MW-4 (410 ppb). The concentration of benzene has increased in MW-1 since the last monitoring episode. Concentrations of TPHg and TOG continued to remain nondetectable in wells MW-1 through MW-3, which are generally upgradient of the former waste-oil tank; however, 3,500 ppb TPHg and nondetectable concentrations of TOG were reported in the water sample obtained from MW-4 in February 1991, downgradient of the former waste-oil tank (Table 2).

April through September 1991

Quarterly groundwater monitoring of wells MW-1 through MW-4 was performed at the site on May 20, 1991. The groundwater elevations for each well were calculated by subtracting the DTW measurements from the surveyed elevations of the wellheads. The DTW measurements, wellhead elevations, and groundwater elevations are presented in Table 4, Cumulative Groundwater Monitoring Data. The groundwater gradient evaluated from the April 10, 1991 data is 0.005 to the east-northeast as shown on the Groundwater Gradient Map (Plate 5). The groundwater gradient evaluated from the May 20, 1991 data is 0.008 to the west-southwest as shown on the Groundwater Gradient Map (Plate 6). The groundwater gradient evaluated from the June 20, 1991 data (using wells MW-1 through MW-3, well MW-4 was dry) is 0.03 to the east-southeast as shown on the Groundwater Gradient Map (Plate 7).

The groundwater elevations in the wells at the site have decreased approximately 10 to 18 feet since April 1991 (Table 4). Gradient interpretations from the previous monitoring episodes incorporating data from wells MW-1 through MW-3 indicated a groundwater gradient direction to the east-northeast. Directional variations in the relatively flat groundwater gradient at the site and the significant decrease in groundwater elevations may result from pumping of nearby existing irrigation wells in the vicinity of the site that may produce artificial, temporary changes in the groundwater elevation and direction of flow.

Laboratory analysis of groundwater samples collected from monitoring wells MW-1 through MW-4 in May 1991 reported:

- nondetectable levels of TPHg and BTEX in wells MW-1 and MW-2;
- TPHg concentrations in wells MW-3 and MW-4 of 97 parts per billion (ppb) and 1,400 ppb, respectively;
- concentrations of BTEX in the wells ranging from nondetectable (less than 0.5 ppb) to 150 ppb. BTEX levels were below the State of California Department of Health Services Maximum Contaminant Levels (MCLs) and recommended action levels for drinking water, (which for BTEX are 1.0 ppb, 100 ppb, 680 ppb, and 1,750 ppb, respectively)(State of California Department of Health Services, October 1990), with the exception of benzene in wells MW-3 (1.3 ppb) and MW-4 (150 ppb);
- concentrations of TOG remain nondetectable in wells MW-1 through MW-3, which, as of June 20, 1991, are generally upgradient or crossgradient of the former waste oil tank;
- nondetectable concentrations of TOG were reported in the water sample obtained from MW-4, downgradient of the former waste-oil tank, and near the existing underground gasoline storage tanks; and,
- the highest concentrations of TPHg and benzene are in well MW-4, which is the nearest well to the underground gasoline-storage tanks.

The wells were not sampled in September 1991 because they were dry or contained residual water (Table 4).

PROPOSED WORK

RESNA proposes the following project Steps 1 through 6 listed below as a method to evaluate vertical and lateral extent of gasoline hydrocarbons in soil in the area of the USTs and evaluate the feasibility of vapor extraction as a remediation alternative at the site. Field work involved with the following project steps will be performed in accordance with the attached AGS Field Protocol in Appendix A.

RESNA recommends the following work at the site based on previous investigations. All field work will be conducted in accordance with the Field Protocol attached in Appendix A and the Site Safety Plan (RESNA, February 1991).

Step 1 Obtain a well permit from the Alameda County Flood Control and Water Conservation District, Zone 7.

Step 2 Drill and obtain soil samples for soil classification and laboratory analysis from four onsite soil borings (B-5 through B-8) as shown on Plate 8, Proposed Borings/Vapor Wells. Drill borings B-5 through B-8 to depths of approximately 35 to 45 feet or to a depth of no more than five feet into the silty clay layer (possible perching or confining layer) underlying the previously saturated clayey silt and gravel. If elevated levels of gasoline hydrocarbons are present in the soil in the borings, install vapor extraction wells (VW-5 through VW-8) with 4-inch diameter well casing in borings B-5 through B-8.

Step 3 Submit selected soil samples from borings B-5 through B-8 to a State-certified laboratory for analysis for TPHg and BTEX by EPA Method 5030/8015/8020.

Step 4 Survey the new vapor extraction wells to a National Geodetic Vertical Datum.

Step 5 If elevated levels of gasoline hydrocarbons are present in the soil, perform a vapor extraction test (VET) using vapor extraction wells VW-5 through VW-8, and the existing dry groundwater monitoring wells, as appropriate. The test will be performed to evaluate vapor flow rates for design of an interim soil-vapor remediation system at the site. A portable unit consisting of a vacuum pump, flow meters, and vacuum gauges will be utilized for the test. The vacuum pump will be connected by a rigid line to a well and evacuate air from soil in the vicinity of the well through the well screen portion to be located above static ground-water level. This procedure will be repeated at different flow rates and vacuum pressures to evaluate the maximum capacity and maximum radius of influence of vapor extraction at the site.

Vapor-phase total volatile hydrocarbon concentrations (in parts per million [ppm]) from each vapor extraction/monitoring well tested will be monitored with a flame ionization detector (FID) or organic vapor meter (OVM) and recorded during the performance test.

Additionally, vapor samples will be collected throughout the test for laboratory analysis, these samples will be submitted to a State-certified laboratory for analysis for TPHg and BTEX by EPA Method 5030/8015/8020.

An internal combustion (I.C.) engine will be used at the discharge point to minimize emissions of hydrocarbons into the atmosphere. The I.C. emissions will be monitored with a FID or OVM.

Step 6 Prepare a report to include results of the subsurface investigation and vapor extraction test, conclusions and recommendations for possible remediation strategies and/or further delineation of possible gasoline at the site.

If groundwater is encountered in borings B-5 through B-8, groundwater monitoring wells will be constructed in the borings. Monitoring wells will be numbered in sequence with MW-5 being the first number of new monitoring well installed. These wells will be constructed of 4-inch diameter PVC casing. Additionally, the wells will be developed and surveyed for top of casing elevation, depths-to-water and visual evidence of floating product in initial groundwater samples will be recorded, and the wells will be purged and sampled for laboratory analysis. The groundwater samples will be submitted to an ARCO contracted, State-certified laboratory for analysis for TPHg and BTEX by EPA method 5030/8015/602, following chain-of-custody protocol.

SCHEDULE OF OPERATIONS

A preliminary time schedule to perform the steps described above is included as Plate 9, Preliminary Time Schedule. This time schedule is an estimate and is subject to change should circumstances dictate. ARCO and the appropriate regulatory agencies will be informed should the estimated time for completion of the work proposed in this work plan be delayed beyond the estimated time of completion depicted in Plate 9. 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. RESNA can initiate work at the site within one week after receiving authorization to proceed.

PROJECT STAFF

Dr. Joan E. Tiernan, a Registered Civil Engineer in the state of California will be in overall charge of this 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 and technicians who will assist with the project.

REFERENCES

Alameda County Flood Control and Water Conservation District - Zone 7. January 16, 1991. Fall 1990 Groundwater Level Report

Applied GeoSystems. July 18, 1989. Work Plan - Limited Subsurface Environmental Investigation at ARCO Station 6113, 785 East Stanley Boulevard, Livermore, California. AGS Report 69028-1W.

Applied GeoSystems. December 6, 1989. Limited Subsurface Environmental Investigation at ARCO Station 6113, 785 East Stanley Boulevard, Livermore, California. AGS Report 69028-2.

California Department of Health Services, October 24, 1990, Summary of California Drinking Water Standards, Berkeley, California.

California Department of Water Resources. 1966. Evaluation of Ground-Water Resources, Livermore and Sonol Valleys, California Department of Water Resources Bulletin 118-2, Appendix A.

California Department of Water Resources. 1974. Evaluation of Ground-Water Resources, Livermore and Sunol Valleys, California Department of Water Resources Bulletin 118-2, Appendix A.

Pacific Environmental Group. April 25, 1989. ARCO Station 6113, 785 E. Stanley Boulevard, Livermore, California. Project 330-53.01

RESNA/Applied GeoSystems. August 29, 1990. Letter Report, Quarterly Ground-Water Monitoring Second Quarter 1990 at ARCO Station 6113, 785 East Stanley Boulevard, Livermore, California. AGS Report 69028-3.

RESNA/Applied GeoSystems. November 2, 1990. Letter Report, Quarterly Ground-Water Monitoring Third Quarter 1990 at ARCO Station 6113, 785 East Stanley Boulevard, Livermore, California. AGS Report 69028-3.

RESNA/Applied GeoSystems. December 16, 1990. Addendum to Work Plan for Arco Station 6113, 785 East Stanley Boulevard, Livermore, California. AGS 69028-4.

REFERENCES (continued)

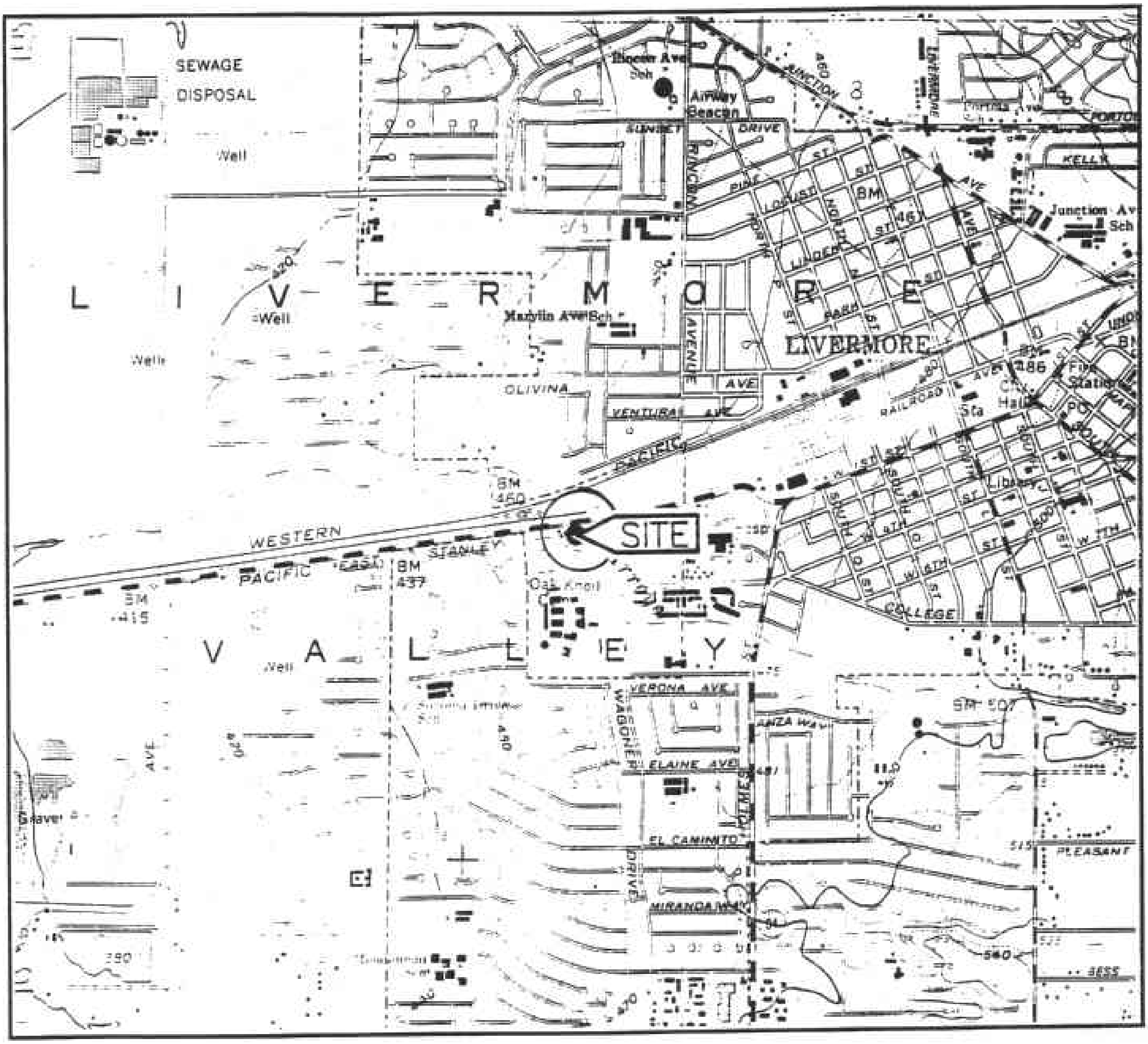
RESNA/Applied GeoSystems. January 27, 1991. Letter Report, Quarterly Ground-Water Monitoring Fourth Quarter 1990 at ARCO Station 6113, 785 East Stanley Boulevard, Livermore, California. AGS Report 69028-3.

RESNA/Applied GeoSystems. February 14, 1991. Site Safety Plan for Arco Station 6113, 785 East Stanley Boulevard, Livermore, California. AGS 69028-4S.

RESNA/Applied GeoSystems. April 16, 1991. Limited Subsurface Environmental Investigation Related to the Former Waste-Oil Tank at ARCO Station 6113, 785 East Stanley Boulevard, Livermore, California. AGS Report 69026.04.

RESNA/Applied GeoSystems. April 23, 1991. Letter Report, First Quarter 1991 Ground-Water Monitoring Report for ARCO Station 6113, 785 East Stanley Boulevard, Livermore, California. AGS Report 69028-3.

RESNA/Applied GeoSystems. April 23, 1991. Letter Report, Second Quarter 1991 Ground-Water Monitoring Report for ARCO Station 6113, 785 East Stanley Boulevard, Livermore, California. AGS Report 69028.05.



Base: U.S. Geological Survey
7.5–Minute Quadrangle
Livermore, California
Photorevised 1980

LEGEND

(•) = Site Location

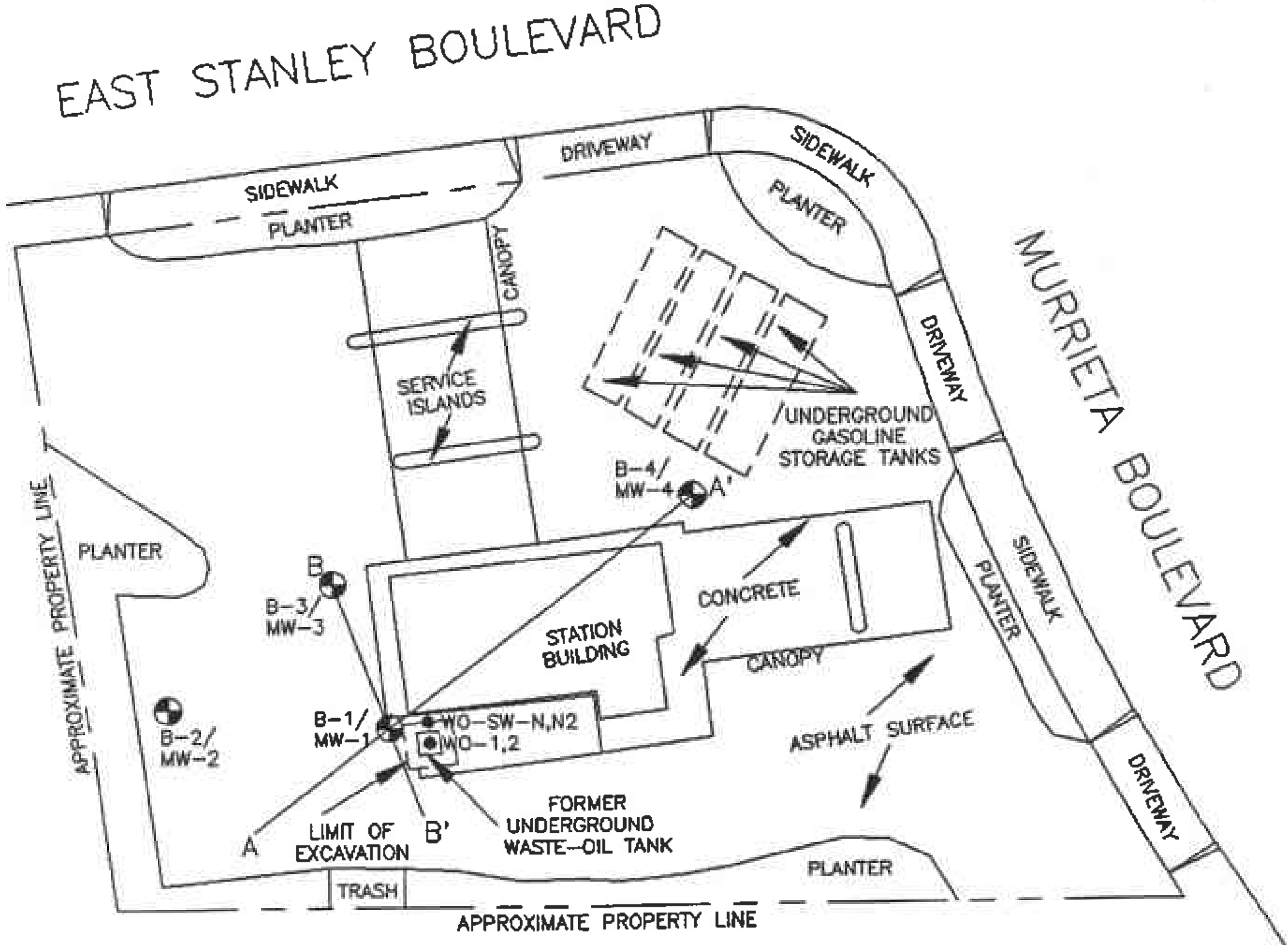
RESNA

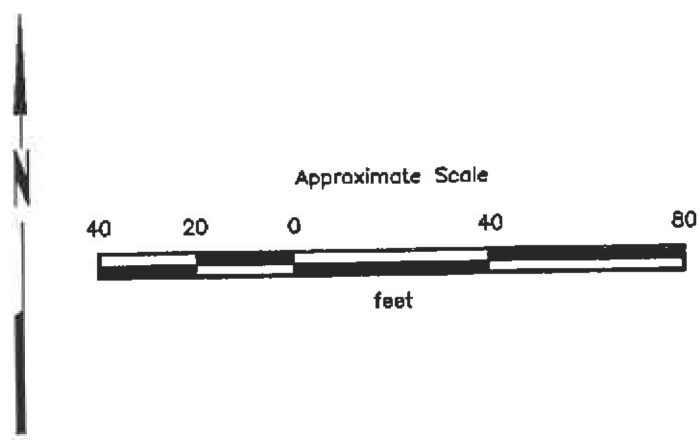
PROJECT 69028.06

SITE VICINITY MAP
ARCO Service Station 6113
785 East Stanley Boulevard
Livermore, California

PLATE

1





EXPLANATION

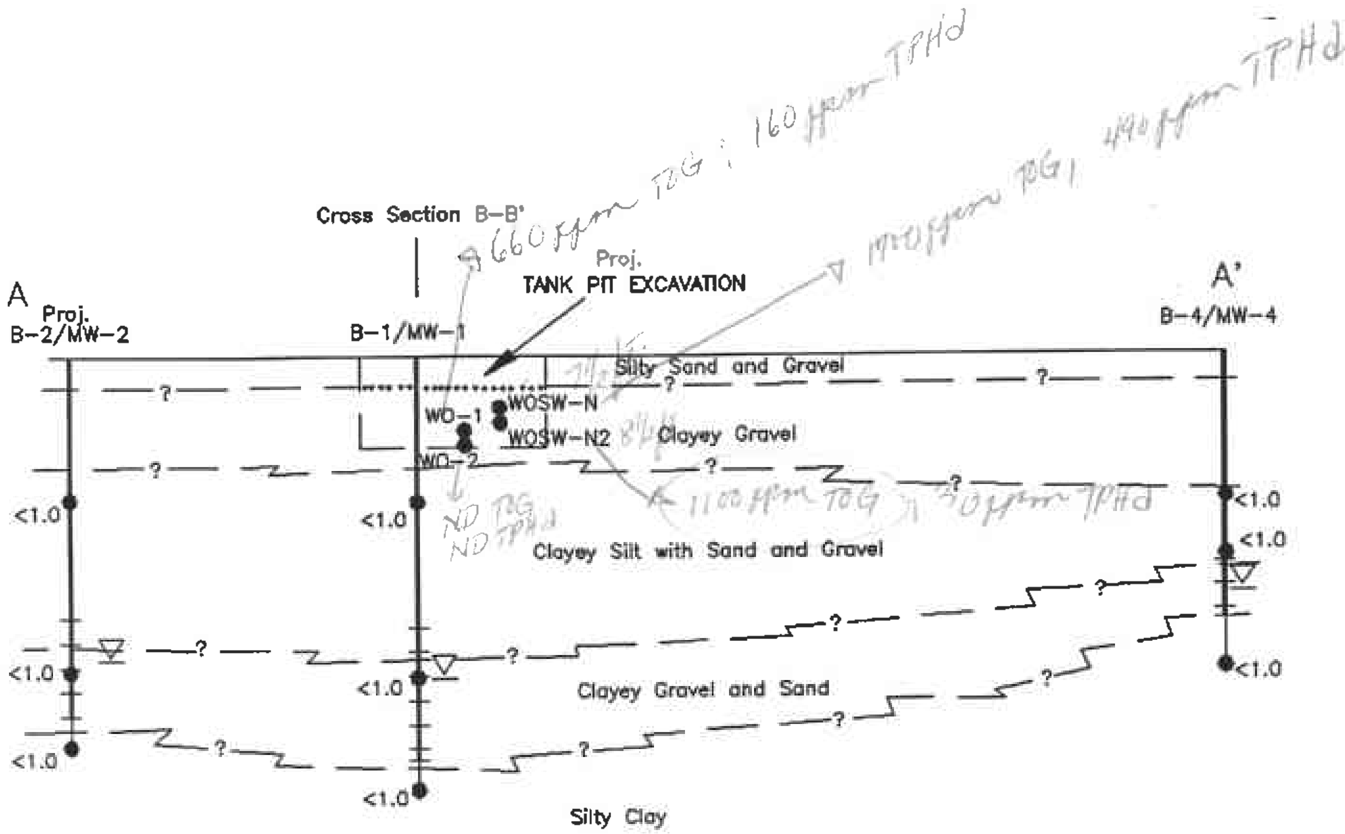
WO-SW-N,N2 ● = Soil sample collected by Pacific (1989)

B-4/MW-4 = Boring/monitoring well (Applied GeoSystems, September 1989 and February 1991)

B ——— B' = Geologic cross sections

Source: Modified from plan supplied by Ron Archer, Civil Engineer Inc., October 1988.

RESNA	GENERALIZED SITE PLAN ARCO Service Station 6113 785 East Stanley Boulevard Livermore, California	PLATE 2
PROJECT: 69028.06		



EXPLANATION

<1.0 = Laboratory analyzed soil samples showing concentration of TPHg in parts per million

= Well casing

= Well screen

= Boring

= Initial water level in boring

= Static water level in well (March 20, 1991)

Approximate Horizontal and Vertical Scale

20 10 0 20 40

feet

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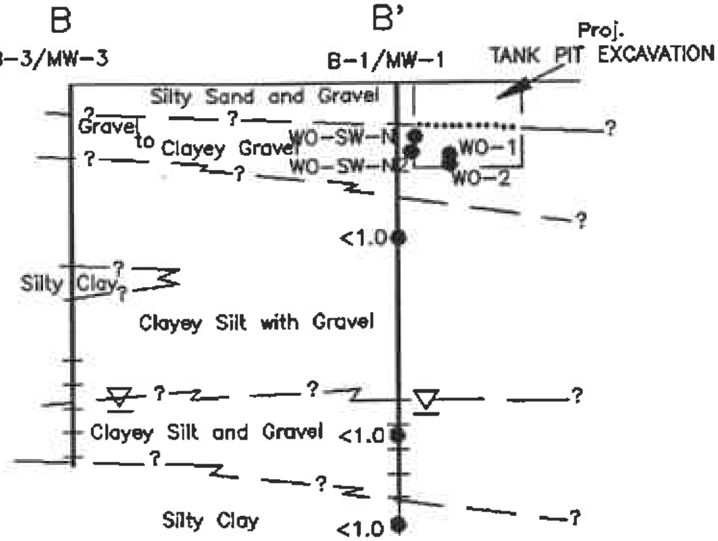
GEOLOGIC CROSS SECTION A-A'
ARCO Service Station 6113
785 East Stanley Boulevard
Livermore, California

PLATE 3



EXPLANATION

<1.0 = Laboratory analyzed soil sample showing concentration of TPHg in parts per million

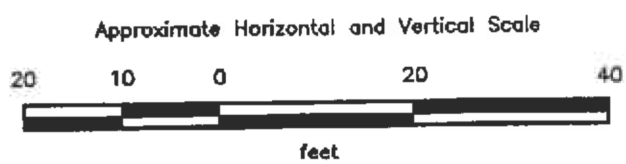
= Well casing

= Well screen

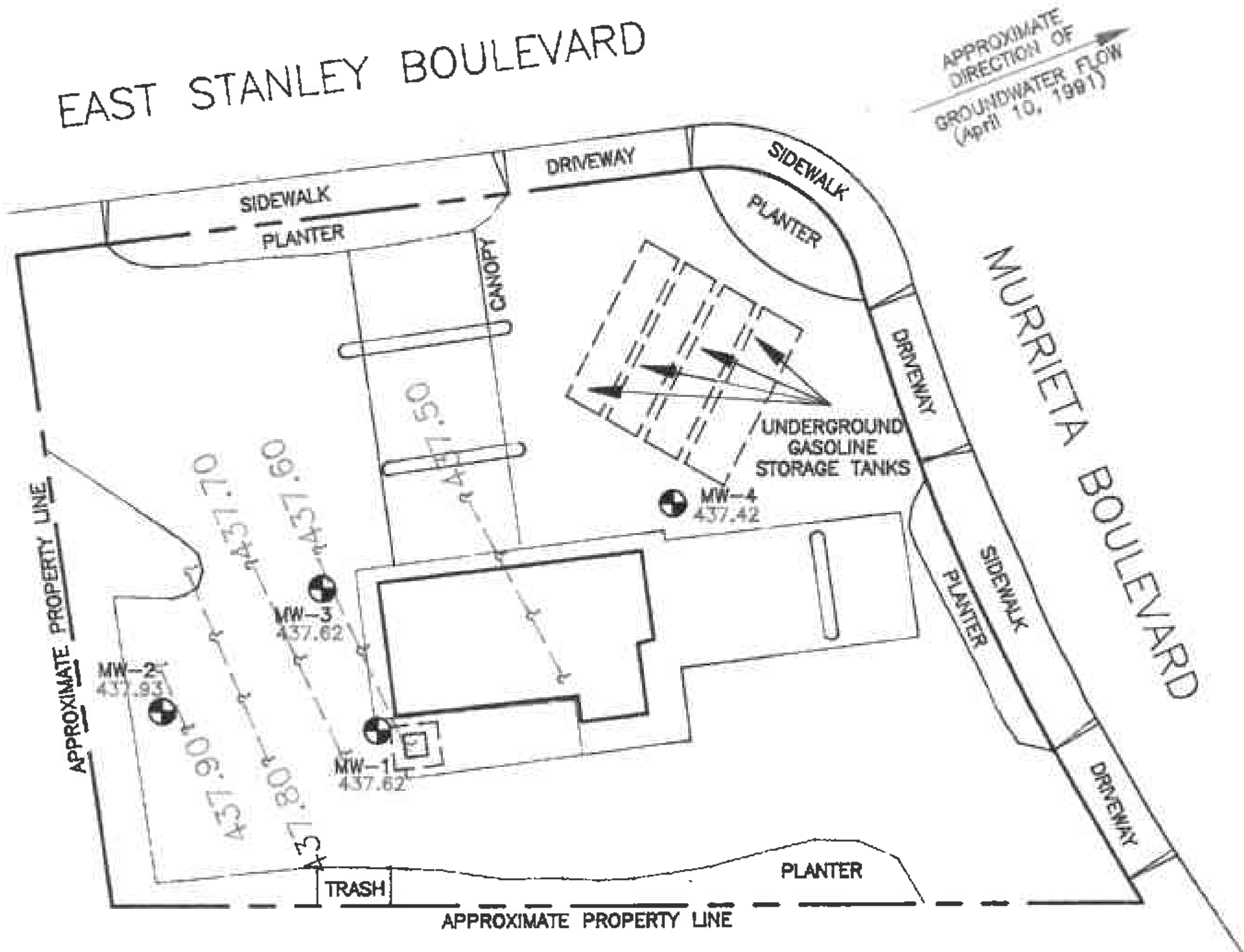
= Boring

= Initial water level in boring

= Static water level in well (March 20,1991)



RESNA	GEOLOGIC CROSS SECTION B-B' ARCO Service Station 6113 785 East Stanley Boulevard Livermore, California	PLATE 4
PROJECT 69028.06		



EXPLANATION

437.90 = Line of equal elevation of groundwater above Mean Sea Level (MSL)

437.93 = Elevation of groundwater in feet April 10, 1991

MW-4 = Boring/monitoring well (Applied GeoSystems, September 1989 and February 1991)

N

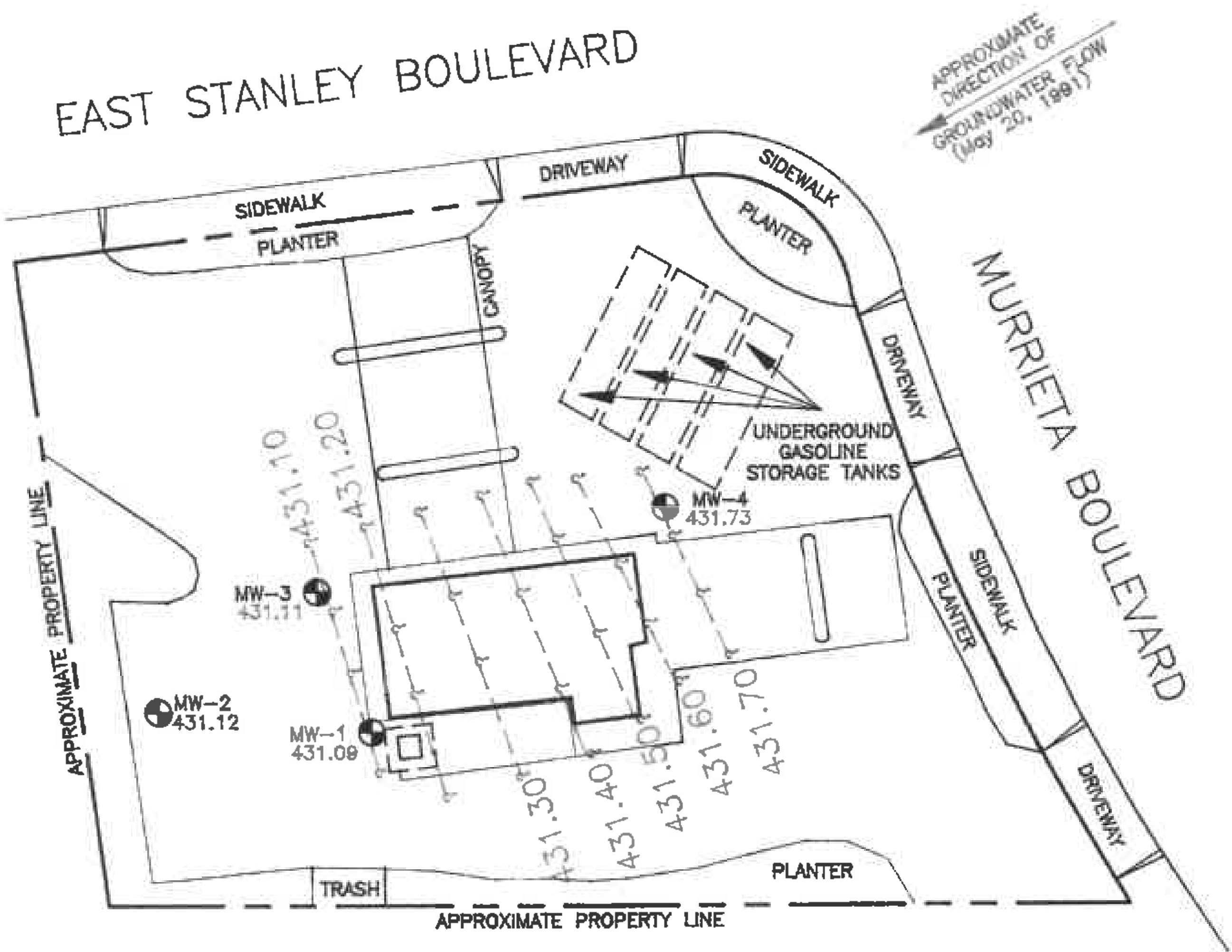
Approximate Scale

40 20 0 40 80

feet

Source: Modified from plan supplied by Ron Archer, Civil Engineer Inc., February 1991

RESNA	GROUNDWATER GRADIENT MAP ARCO Service Station 6113 785 East Stanley Boulevard Livermore, California	PLATE 5
PROJECT: 69028.06		



EXPLANATION

431.70 = Line of equal elevation of groundwater above Mean Sea Level (MSL)

431.73 = Elevation of groundwater in feet May 20, 1991

MW-4 = Boring/monitoring well (Applied GeoSystems, September 1989 and February 1991)

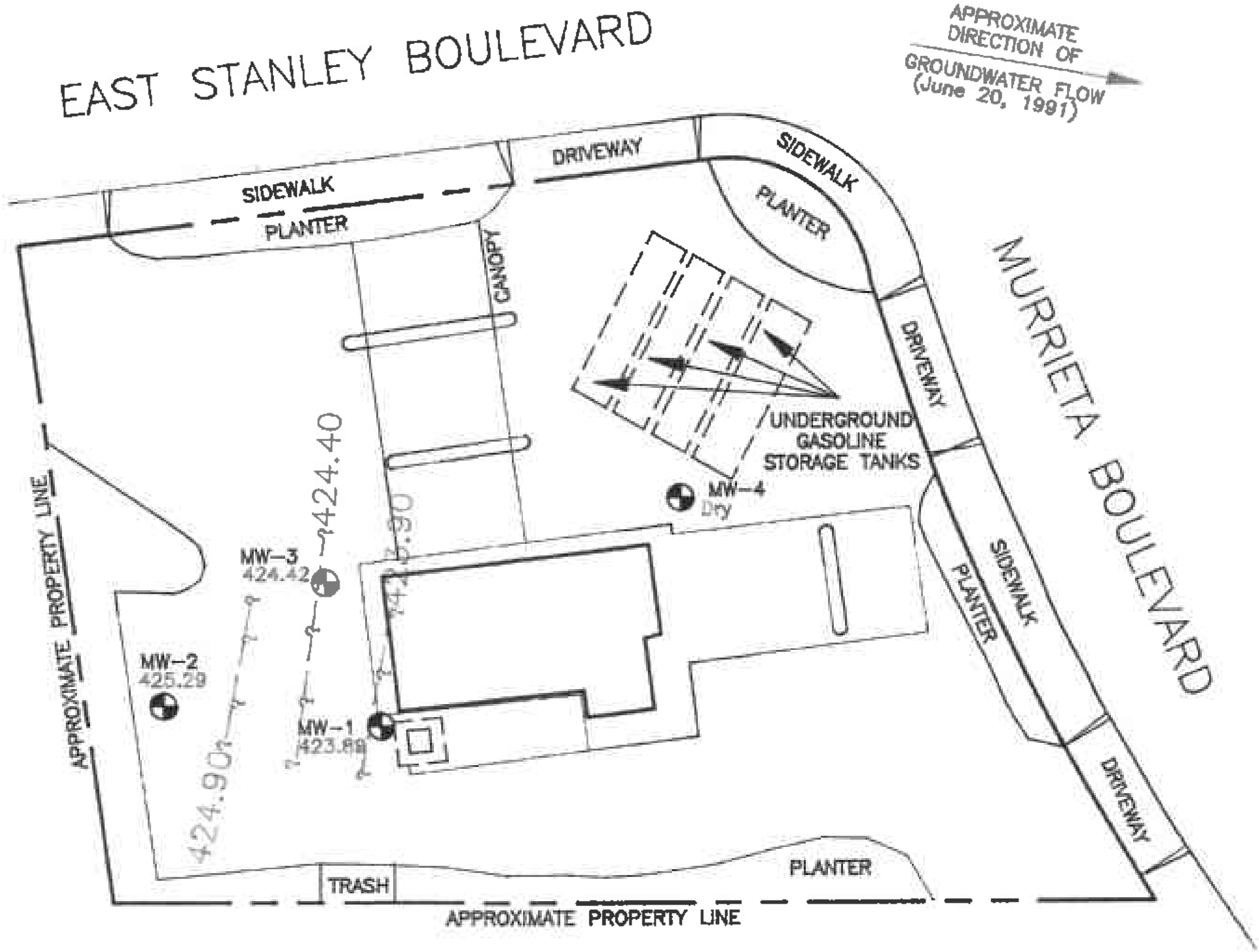
Approximate Scale

40 20 0 40 80

feet

Source: Modified from plan supplied by Ron Archer, Civil Engineer Inc., February 1991

RESNA	GROUNDWATER GRADIENT MAP ARCO Service Station 6113 785 East Stanley Boulevard Livermore, California	PLATE 6
PROJECT: 69028.06		



EXPLANATION

424.90 — = Line of equal elevation of groundwater above Mean Sea Level (MSL)

425.29 = Elevation of groundwater in feet June 20, 1991

MW-4 = Boring/monitoring well (Applied GeoSystems, September 1989 and February 1991)

N

Approximate Scale

40 20 0 40 80

feet

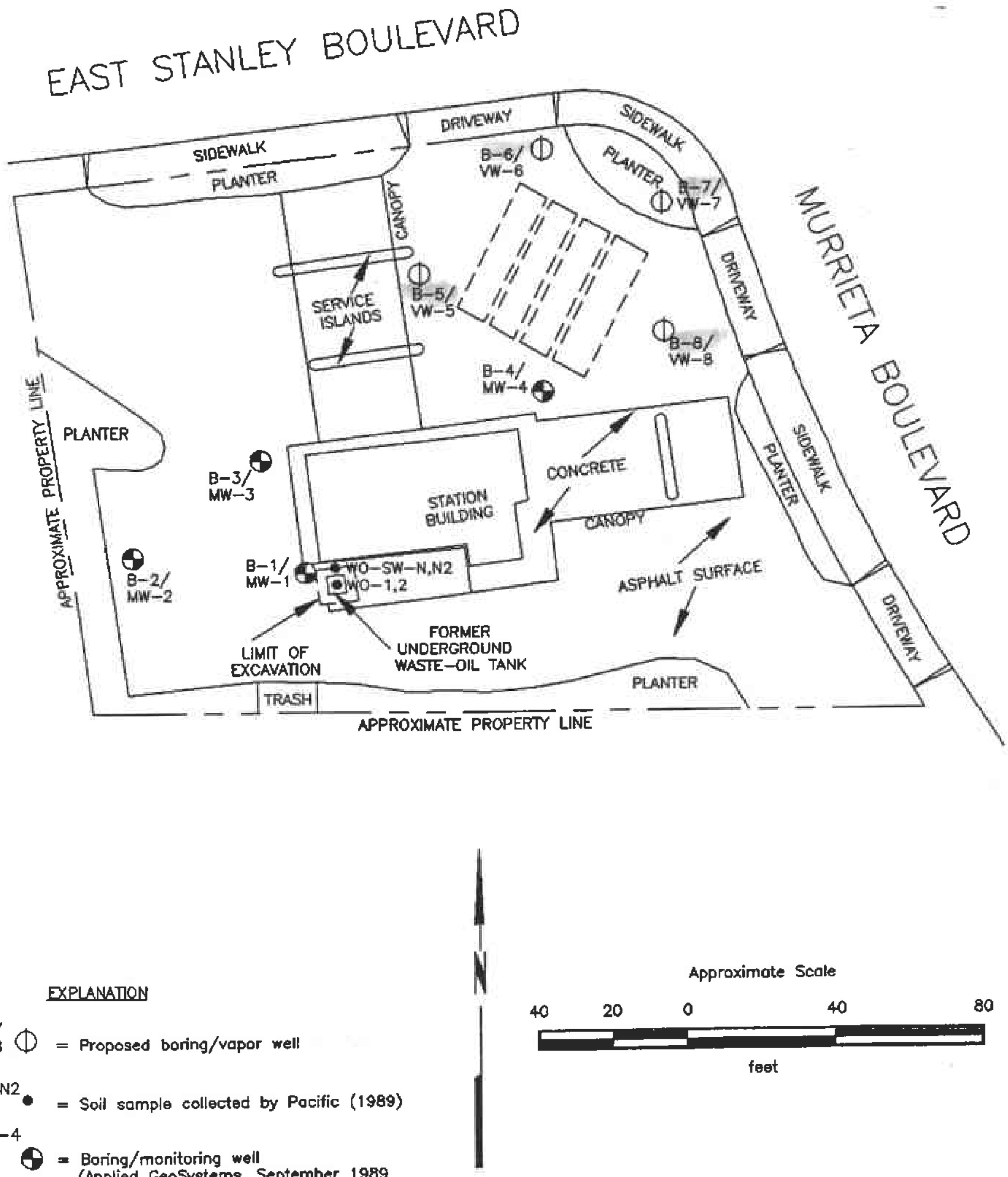
Source: Modified from plan supplied by Ron Archer, Civil Engineer Inc., February 1991

RESNA

PROJECT 69028.06

GROUNDWATER GRADIENT MAP
ARCO Service Station 6113
785 East Stanley Boulevard
Livermore, California

PLATE 7



EXPLANATION

B-8/ VW-8 = Proposed boring/vapor well

WO-SW-N,N2 = Soil sample collected by Pacific (1989)

B-4/MW-4 = Boring/monitoring well (Applied GeoSystems, September 1989 and February 1991)

Source: Modified from plan supplied by Ron Archer, Civil Engineer Inc., October 1988.

RESNA	**PROPOSED BORING/ VAPOR WELL LOCATIONS ARCO Service Station 6113 785 East Stanley Boulevard Livermore, California**	**PLATE** **8**
PROJECT: 69028.06		

STEP 1:
Permitting

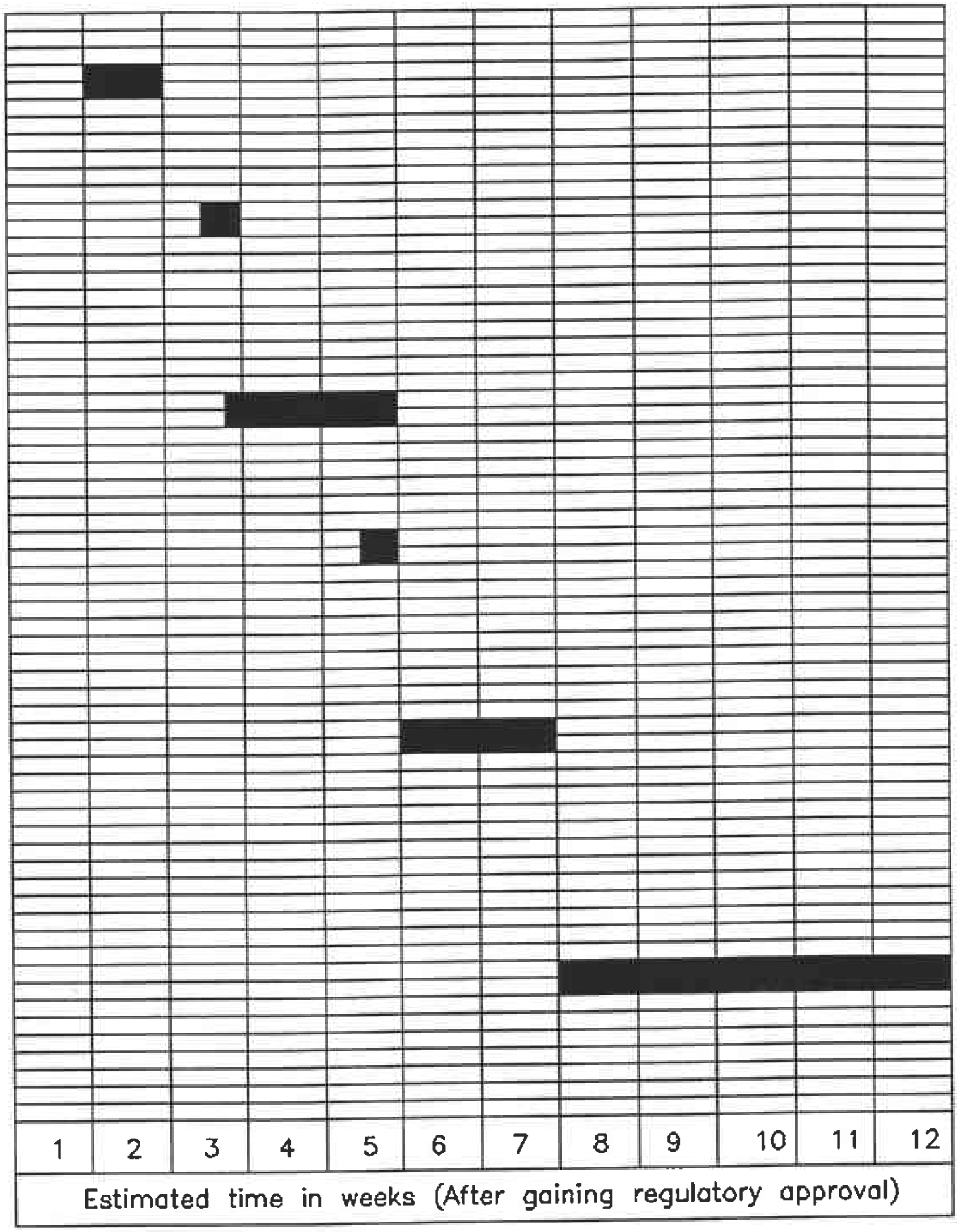
STEP 2:
Drill and install wells

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

STEP 4:
Survey wells

STEP 5:
Schedule and perform vapor extraction test (as necessary)

STEP 6:
Prepare Draft Report



Note: If wells are constructed as groundwater monitoring wells, development, sampling, and analysis may take up to 3 weeks longer.

RESNA

PROJECT 69028.06

PRELIMINARY TIME SCHEDULE
ARCO Station 6113
785 East Stanley Boulevard
Livermore, California

PLATE 9

TABLE 1
RESULTS OF LABORATORY ANALYSIS OF SOIL SAMPLES
FOR PETROLEUM HYDROCARBONS AND METALS FROM WASTE-OIL TANK PIT
ARCO Service Station No. 6113
785 East Stanley Boulevard
Livermore, California

Sample Identifier	TOG	HBHC DIESEL	HBHC OIL	ZN	PB	CD	CR
01/26/89							
W0-1	660	160	60	36	18	ND	35
W0SW-N	1700	490	790	43	16	ND	61
02/03/89							
W0-2	ND	ND	ND	NM	NM	NM	NM
W0SW-N2	1100	30	800	NM	NM	NM	NM

Results in parts per million (ppm).
Results from work performed by Pacific Environmental Group, April 25, 1989
TOG: Total oil and grease
HBHC: High boiling hydrocarbons
ZN: zinc PB: lead CD: cadmium CR: chromium

ND: Not detected NM: Not measured

TABLE 2
CUMULATIVE RESULTS OF LABORATORY ANALYSIS OF SOIL SAMPLES
ARCO Station 6113
785 East Stanley Boulevard
Livermore, California

Sample	B	T	E	X	TPHg	TPHd	TOG
S-14½-B1	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<30
S-34½-B1	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<30
S-44½-B1	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<30
S-19-B2	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<50
S-34-B2	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<50
S-41-B2	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<50
S-14-B3	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<50
S-34-B3	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<50
S-37½-B3	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<50
S-14½-B4	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<50
S-19½-B4	<0.005	<0.005	<0.005	<0.005	<1.0	<10	<50
S-29-B4	0.008	<0.005	<0.005	<0.005	<1.0	<10	<50
S-0221 -SP1(A-D)	<0.005	<0.005	<0.005	<0.005	<1.0	<10	NA

Results in parts per million (ppm).
<: Results reported as less than the detection limit.
NA: Not Analyzed
TPHg: Total petroleum hydrocarbons as gasoline by EPA method 5030/8015.
TPHd: Total petroleum hydrocarbons as diesel by EPA method 3550/8015.
B: Benzene, T: Toluene, E: Ethylbenzene, T: Total Xylene isomers
BTEX: Analyzed by EPA method 5030/8020.
TOG: Total Oil and Grease by Standard Method 5520 E&F.

Composite soil sample (S-0221-SP1(A-D)) consists of four soil samples taken from stockpiled soil.

Sample designation:
S-29-B4
- B4 — Boring number
- 29 — Sample depth in feet below ground surface
- S — Soil sample

TABLE 3
CUMULATIVE RESULTS OF GROUNDWATER LABORATORY ANALYSES
ARCO Station 6113
Livermore, California
(Page 1 of 2)

Well Date	TPHg	Benzene	Toluene	Ethyl-benzene	Total Xylenes
MW-1					
09/20/89	80	3.0	1.0	0.7	1
06/21/90	<20	<0.50	0.66	<0.50	<0.50
09/20/90	<50	<0.5	1.0	<0.5	1.8
12/18/90	<50	<0.5	1.8	<0.5	1.7
02/21/91	<50	1.2	2.3	<0.5	2.2
05/20/91	<30	<0.30	<0.30	<0.30	<0.30
08/13/91	NS	NS	NS	NS	NS
MW-2					
09/20/89	<50	<0.5	<0.5	<0.5	<1
06/21/90	<20	<0.50	<0.50	<0.50	<0.50
09/20/90	<50	<0.5	0.7	<0.5	1.4
12/18/90	<50	0.6	1.5	<0.5	1.9
02/21/91	<50	<0.5	<0.5	<0.5	<0.5
05/20/91	<30	<0.30	<0.30	<0.30	<0.30
08/13/91	NS	NS	NS	NS	NS
MW-3					
09/20/89	170	8.9	0.6	1.1	<1
06/21/90	<20	<0.50	1.0	<0.50	<0.50
09/20/90	<50	<0.5	1.0	<0.5	1.9
12/18/90	<50	<0.5	1.7	<0.5	2.0
02/21/91	<50	<0.5	<0.5	<0.5	<0.5
05/20/91	97	1.3	1.1	6.2	8.4
08/13/91	NS	NS	NS	NS	NS
MW-4					
02/21/91	3,500	410	7.6	30	47
05/20/91	1,400	150	6.0	4.4	3.1
08/13/91	NS	NS	NS	NS	NS
Jan. 1990					
MCLs	—	1.0	—	680	1,750
ALs	—	-.-	100	—	—

See Notes on Page 2 of 2

TABLE 3
CUMULATIVE RESULTS OF GROUNDWATER LABORATORY ANALYSES
ARCO Station 6113
Livermore, California
(Page 2 of 2)

Well Date	TPHd	TOG
MW-1		
09/20/89	<50	<5,000
06/21/90	<100	13,000
09/20/90	<50	<5,000
12/18/90	NA	<5,000
02/21/91	NA	<5,000
05/20/91	NA	<75,000
08/13/91	NS	NS
MW-2		
09/20/89	<50	<5,000
06/21/90	<100	<5,000
09/20/90	<50	<5,000
12/18/90	NA	<5,000
02/21/91	NA	<5,000
05/20/91	NA	<75,000
08/13/91	NS	NS
MW-3		
09/20/89	<50	<5,000
06/21/90	<100	10,000
09/20/90	<50	<5,000
12/18/90	NA	<5,000
02/21/91	NA	<5,000
05/20/91	NA	<75,000
08/13/91	NS	NS
MW-4		
02/21/91	NA	<5,000
05/20/91	NA	<75,000
08/13/91	NS	NS

Results in parts per billion (ppb).
TPHg = Total petroleum hydrocarbons as gasoline
TPHd = Total petroleum hydrocarbons as diesel
TOG = Total Oil and Grease
< = Less than the detection limits shown.
MCLs = Adopted Maximum Contaminant Levels in Drinking Water, DHS (October 1990)
Als = Recommended Drinking Water Action Levels, DHS (October 1990)
NA = Not Analyzed
NS = Not Sampled Due to Lack of Water in Well

TABLE 4
CUMULATIVE GROUNDWATER MONITORING DATA
ARCO Station 6113
Livermore, California
(Page 1 of 2)

Well Date	Elevation of Wellhead	Depth to Water	Elevation of Groundwater	Evidence of Product
MW-1				
09/20/89	457.04	21.03	436.01	NONE
10/12/89		19.64	437.40	NONE
06/21/90		21.72	435.32	NONE
09/20/90		19.79	437.25	NONE
12/18/90		19.28	437.76	NONE
02/21/91		22.45	434.59	NONE
03/20/91		19.87	437.17	NONE
04/10/91		19.42	437.62	NONE
05/20/91		25.95	431.09	NONE
06/20/91		32.55	424.49	NONE
07/25/91		38.22	418.82	NONE
08/13/91		40.74	416.30	NONE
09/12/91		43.16	413.88	NONE
MW-2				
09/20/89	457.74	20.67	437.07	NONE
10/12/89		18.98	438.76	NONE
06/21/90		21.88	435.86	NONE
09/20/90		19.90	437.84	NONE
12/18/90		19.32	438.42	NONE
02/21/91		23.02	434.72	NONE
03/20/91		20.01	437.73	NONE
04/10/91		19.81	437.93	NONE
05/20/91		26.62	431.12	NONE
06/20/91		33.15	424.59	NONE
07/25/91		37.10	420.64	NONE
08/13/91		37.20	420.54	NONE
09/12/91		38.44	420.38	NONE
MW-3				
09/20/89	456.97	20.98	435.99	NONE
10/12/89		19.66	437.31	NONE
06/21/90		21.72	435.25	NONE
09/20/90		19.72	437.25	NONE
12/18/90		19.21	437.76	NONE
02/21/91		22.36	434.61	NONE
03/20/91		19.79	437.18	NONE
04/10/91		19.35	437.62	NONE
05/20/91		25.86	431.11	NONE
06/20/91		32.45	424.52	NONE
07/25/91		38.06	418.91	NONE
08/13/91		38.40	418.57	NONE
09/12/91		DRY	DRY	DRY

See notes on Page 2 of 2.

TABLE 4
CUMULATIVE GROUNDWATER MONITORING DATA
ARCO Station 6113
Livermore, California
(Page 2 of 2)

Well Date	Elevation of Wellhead	Depth to Water	Elevation of Groundwater	Evidence of Product
MW-4				
02/21/91	456.97	22.01	434.96	ODOR
03/20/91		20.31	436.66	ODOR
04/10/91		19.55	437.42	ODOR
05/20/91		25.24	431.73	ODOR
06/20/91		DRY	DRY	DRY
07/25/91		37.93	419.04	ODOR
08/13/91		DRY	DRY	DRY
09/12/91		DRY	DRY	DRY

Wellhead Elevation based on benchmark: Top of pin set in concrete in the most westerly monument at the intersection of East Stanley Boulevard and Fenton Avenue. Elevation taken as 455.896 mean sea level, City of Livermore datum.
Depth-to-water measurements in feet below the top of the well casing.

FIELD PROTOCOL

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

Site Safety Plan

The Site Safety Plan describes the safety requirements for the evaluation of gasoline hydrocarbons in soil, ground-water, 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 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 organic vapor meter (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 10-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 ground-water 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 analysis 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 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 analysis 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 analysis, 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 analysis and/or well development data. The screened sections in ground-water monitoring wells are placed to allow monitoring during seasonal fluctuations of ground-water 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 analysis 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.

Ground-Water 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.

Ground-Water 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 ground water 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.