CALIFORNIA REGIONAL WATER

MAY 16 1991

QUALITY CONTROL BOARD

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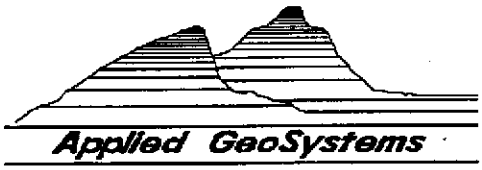


3315 Almaden Expressway, Suite 34
San Jose, California 95118
(408) 264-7723 FAX (408) 264-2435

TO: MR TOM CALLAGHAN
RWQCB
SAN FRANCISCO BAY REGION
2101 WEBSTER STREET, STE 500
OAKLAND CA 94612

DATE: 5/15/91
PROJECT NUMBER: 60000.06
SUBJECT: WORK PLAN AND ADDENDUM TO WORK PLAN

FROM: JOEL COFFMAN
TITLE: ASST. 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	5/15/91	60000.06	WORK PLAN FOR ARCO STATION 771
1	5/15/91	60000.06	ADDENDUM ONE TO WORK PLAN FOR ARCO STATION 771

THESE ARE TRANSMITTED as checked below:

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

[XX] As requested [ ] Approved as noted [ ] Submit___ copies for distribution

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

[ ] For your files [ ] _____

REMARKS:
PER ARCO'S AUTHORIZATION COPY OF REPORT HAS BEEN FORWARDED FOR YOUR REVIEW.

COURIER SERVICE (SAME DAY DELIVERY)

Copies: 1 to AGS project file no. 60000.06

SAN JOSE READER'S FILE

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

Applied GeoSystems 3315 Almaden Expressway, Suite 34, San Jose, CA 95118 (408) 264-7723

• FREMONT • IRVINE • HOUSTON • BOSTON • SACRAMENTO • CULVER CITY • SAN JOSE

May 15, 1991
AGS 60000.06

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

Subject: Transmittal of Work Plan for Subsurface Investigations and Remediation at ARCO Station 771, 899 Rincon Avenue, Livermore, California.

Mr. Carmel:

As requested by ARCO Products Company (ARCO), RESNA/Applied GeoSystems (AGS) has prepared the attached Work Plan for review and approval by ARCO, the Regional Water Quality Control Board (RWQCB), the Alameda County Department of Environmental Health (ACDEH), and the City Livermore Fire Department. This Work Plan summarizes previous work performed at the subject site and AGS' approach, field methods, and project tasks recommended to perform subsurface investigations and remediation at this site. The proposed work includes drilling and sampling additional soil borings, installing ground-water monitoring wells, developing and sampling the monitoring wells, laboratory analysis of soil and ground-water samples, performing hydrogeologic investigations, remediating soil and ground water, if needed, and preparing reports of our findings, interpretations, and conclusions. Recommendations will be included under separate cover as requested by ARCO.

AGS recommends performing these project tasks to delineate the lateral and vertical extent of gasoline and waste-oil hydrocarbons in the soil and ground water and to remediate these compounds in both soil and ground water at the site as needed. The work involved to perform the proposed project tasks will be described in detail in addenda to this work plan submitted to ARCO prior to performing additional subsurface work. Modifications to these tasks may be made depending on information obtained from subsequent investigations at the site.

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

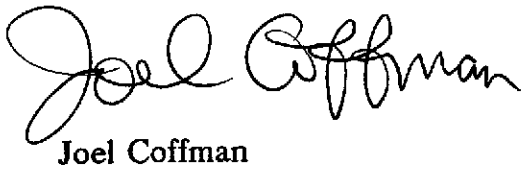
Mr. Tom Callaghan
Regional Water Quality Control Board
San Francisco Bay Region
2101 Webster Street, Suite 500
Oakland, California 94612

Mr. Gil Wistar
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\Applied GeoSystems



Joel Coffman
Assistant Project Geologist

Enclosure: Work Plan

cc: H.C. Winsor, ARCO Products Company

Applied GeoSystems 3315 Almaden Expressway, Suite 34, San Jose, CA 95118 (408) 264-7723

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WORK PLAN
for
SUBSURFACE INVESTIGATIONS AND REMEDIATION
at
ARCO Station 771
899 Rincon Avenue
Livermore, California

AGS 60000.06

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

Joel Coffman
Assistant Project Geologist

Greg Barclay
General Manager

Joan E. Tiernan #044600
Ph.D., P.E.
Engineering Manager

May 15, 1991

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Applied GeoSystems 3315 Almaden Expressway, Suite 34, San Jose, CA 95118 (408) 264-7723

• FREMONT • IRVINE • HOUSTON • BOSTON • SACRAMENTO • CULVER CITY • SAN JOSE

WORK PLAN
for
SUBSURFACE INVESTIGATIONS AND REMEDIATION
at
ARCO Station 771
899 Rincon Avenue
Livermore, California
for
ARCO Products Company

INTRODUCTION

This Work Plan summarizes work previously performed by RESNA/Applied GeoSystems (AGS) and others, and describes the project tasks proposed to delineate and remediate the lateral and vertical extent of gasoline and waste-oil hydrocarbons in the soil and ground water (as necessary) at the subject site. ARCO Products Company (ARCO) requested that AGS prepare this work plan for review and approval by the Regional Water Quality Control Board (RWQCB), the Alameda County Department of Environmental Health (ACDEH), and the City of Livermore Fire Department.

The proposed work includes the following tasks:

Task 1: drill and sample soil borings;
Task 2: drill step-out borings to further delineate the extent of gasoline and waste-oil hydrocarbons in soil (as necessary);
Task 3: prepare a soil remediation feasibility study and addendum to work plan (if necessary);
Task 4: design and construct soil remediation facilities (if necessary);

Task 5: install, develop, and sample ground-water monitoring wells, and submit ground-water samples for laboratory analysis from the wells, and perform quarterly ground-water monitoring of wells;
Task 6: conduct hydrogeologic tests and research (as necessary);
Task 7: install, develop, and sample offsite wells (if necessary);
Task 8: prepare a ground-water remediation feasibility study and addendum to work plan (if necessary);
Task 9: design and construct ground-water remediation facilities (if necessary);
Task 10: prepare and implement site closure plan.

This Work Plan is intended to serve as a general technical guide to approach site remediation and closure. Specific work descriptions for each project phase, and any necessary modifications to these tasks, will be included in addenda to this Work Plan which will be submitted prior to performing each phase of site work. Field tasks described above will be performed in accordance with AGS Field Protocol in Appendix A and an AGS Site Safety Plan. The work plan addenda, investigation report(s), remediation feasibility study(ies), and remediation plan(s) will be submitted as separate documents. These documents will also be submitted to the RWQCB, ACDEH, and the City of Livermore Fire Department for their review and approval prior to continuing work at the site.

SITE DESCRIPTION AND BACKGROUND

ARCO Station 771 is located on the southwestern corner of the intersection of Rincon Avenue and Pine Street in Rincon Avenue, Livermore, California, as shown on the Site Vicinity Map, Plate 1. The station is an operating gasoline station and mini-market which retails regular leaded and regular and supreme unleaded gasoline. Residential homes are present to the north of the site and east of the site across Rincon Avenue. A shopping center is to the south and west of the site. The site is on a relatively flat lot at an elevation of approximately 450 feet above mean sea level.

It is our understanding from information provided by ARCO that one 10,000-gallon underground gasoline-storage tank (designated T1), one 6,000-gallon underground gasoline-storage tank (designated T2) and two 4,000-gallon underground gasoline-storage tanks (designated T3 and T4) are present at the site. We also understand that tanks T2, T3, and T4 were installed approximately 25 years ago, tank T1 was installed approximately 15 years ago, and that only gasoline is known to have been stored in the tanks. A 240-gallon waste-oil tank was removed from the site in 1987 (Brown and Caldwell, 1987). The locations of these tanks and other site features are shown on the Generalized Site Plan, Plate 2.

REGIONAL AND LOCAL HYDROGEOLOGY

The site is in the north-central portion of the Livermore Valley, within the Coast Ranges Geomorphic Province of Northern California. The Livermore Valley is approximately 13 miles long oriented in an east-west direction, approximately 4 miles wide, and is surrounded by hills of the Diablo Range (California Department of Water Resources, 1974). The valley 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 1/10 mile south-southwest of the site, and Arroyo Valley is approximately 2-3/4 miles southwest of the site.

The Livermore Valley ground-water basin is divided into sub-basins on the basis of fault traces or other hydrogeologic discontinuities (California Department of Water Resources, 1974). The ground-water system in Livermore Valley is a multi-layered system with an unconfined aquifer overlying a sequence of leaky or semiconfined aquifers. Ground water in the basin flows downslope toward the east-west-trending axis of the valley and then flows generally to the west. Regional ground water is inferred to flow to the west-northwest and is approximately 30 feet below the ground surface (Alameda County Flood Control, Zone

7, 1986). Local ground-water flow is to the northwest based on ground-water monitoring data collected at the site (AGS, April 1991).

PREVIOUS WORK

August 1987

In August 1987, a 240-gallon underground waste-oil storage tank was removed from the site by Crosby and Overton Environmental Management, Inc., of Oakland, California. The waste-oil tank pit was excavated to a depth of 10 feet and a soil sample (AL-1) was collected by Brown and Caldwell (B&C) of Sacramento, California, for laboratory analyses. Results of analyses indicated 378 parts per million (ppm) total petroleum fuel hydrocarbon levels. Volatile organic compounds (VOCs) and benzene, toluene, and total xylene isomers (BTX), and polychlorinated biphenols (PCBs) were not detected. One sample of the waste-oil sludge from the tank and two samples from the stockpiled soil were also collected and analyzed by B&C. In September 1987, the waste-oil tank pit was further excavated and B&C collected a soil sample (AL-2) from a depth of 12 feet. Petroleum fuel hydrocarbons were not detected in the sample. In October 1987, soil containing waste-oil was transported to a Class I landfill in Casmalia, California (Brown and Caldwell, 1987).

February 1990

AGS performed a limited environmental site assessment (AGS, June 1990) to evaluate the presence of gasoline hydrocarbons in the subsurface soil in the area adjacent to the four underground gasoline-storage tanks prior to ARCO's planned tank replacement at the site. This work involved drilling and sampling three soil borings (B-1 through B-3), performing laboratory analyses of 12 soil samples from the borings, and preparing a report. The

locations of the borings are shown on Plate 2, Generalized Site Plan. Ground water was first encountered at a depth of approximately 33 feet below the ground surface in boring B-1. Borings B-2 and B-3 were terminated before encountering ground water. Results of laboratory analyses of soil samples indicated the highest concentration (190 ppm) of total petroleum hydrocarbons as gasoline (TPHg) in the soil sample collected from a depth of approximately 32 feet below ground surface in boring B-3. The results of laboratory analysis of soil samples are presented in Table 1, Cumulative Results of Laboratory Analyses of Soil Samples. A layer of floating product approximately 1/8-inch thick was noted on the surface of a ground-water "grab" sample obtained from boring B-1.

December 1990 through March 1991

AGS performed a Supplemental Subsurface Investigation to evaluate the vertical and lateral extent of gasoline hydrocarbons in soil and first ground water in the area near the four onsite underground gasoline-storage tanks. This investigation included drilling and sampling three additional soil borings (B-4 through B-6) and installing three 4-inch diameter ground-water monitoring wells (MW-1 through MW-3) in the borings, laboratory analysis of soil and ground-water samples, measuring depth-to-water levels in the wells and performing a well search within a 1/2-mile radius of the site. According to ARCO, the existing underground gasoline-storage tanks are scheduled for replacement in 1991. Locations of soil borings/monitoring wells were therefore not drilled/installed immediately adjacent to the underground gasoline storage-tanks since they would likely be damaged or destroyed during removal of the tanks. Locations of borings/monitoring wells are shown on Plate 2, Generalized Site Plan. A total of 37 soil samples were collected from the soil borings. The earth materials encountered during this investigation consisted primarily of clayey to sandy gravel interbedded with some gravelly and sandy clay. Ground water was first encountered within sandy gravel in borings B-4 through B-6 at a depths of approximately 36 to 38 feet

below the ground surface. A stratum of 5 feet of moist sandy clay, which may be a perching or confining layer, was encountered at approximately 38 to 41 feet below the ground surface in borings B-4 through B-6. Graphic interpretations of the soil stratigraphy encountered in the borings are shown on Geologic Cross Sections A-A' and B-B' (Plates 3 and 4). The locations of the cross section s are shown in Plate 2. The highest concentrations of TPHg were found in boring B-4: 14 ppm at a depth of 36-1/2 feet and 3,800 ppm at 43 feet.

The ground-water monitoring wells MW-1 through MW-3 were developed and sampled as part of the investigation. Depth-to water measurements were measured in ground-water monitoring wells MW-1 through MW-3 and ground-water samples were collected and visually inspected for floating product on January 15, 1991 and February 27, 1991. Water level data are presented in Table 2, Cumulative Ground-Water Monitoring Data. The ground-water gradient has been interpreted to be to the north-northeast. The interpreted ground-water gradients for January 15, and February 27, 1991 are shown on Plates 5 and 6, Ground-Water Gradient Maps. On January 15, 1991, initial water samples collected from well MW-1 exhibited an obvious odor and a product sheen, and approximately 0.16 feet of floating product was measured in well MW-2. Initial water samples from well MW-3 showed no subjective evidence of hydrocarbon product. Well MW-3 was purged and sampled on January 15, 1990; however, water samples were not collected for laboratory analysis from wells MW-1 and MW-2 due to the presence of hydrocarbon product and sheen in these wells. TPHg was reported in the sample collected from MW-3 at 230 ppb concentration. Laboratory analytical results of ground-water samples are presented in Table 3, Results of Laboratory Analysis of Ground-Water Samples. In February 1991, 0.02 feet of free product was present in MW-2, but was not present in MW-1 and MW-3.

A search of records obtained from Alameda County Flood Control and Water Conservation District Zone 7 (ACFCWCD) of active, inactive, and destroyed water supply and monitoring

wells within a 1/2-mile radius of the site indicated the existence of 14 ground-water monitoring wells and 4 supply wells within 1/2-mile radius of the site. The approximate locations of these wells are shown on Plate 7, Well Location Map. No well construction details were made available at the time of this investigation.

PROJECT TASKS

AGS proposes Project Tasks 1 through 10 listed below as a method of approach to delineate the vertical and horizontal extent of petroleum hydrocarbons and to remediate petroleum hydrocarbons in soil and ground water at the site. Field work involved with the following project tasks will be performed in accordance with the attached AGS Field Protocol in Appendix A and the Site Safety Plan. Reports summarizing work performed, field work and procedures, laboratory methods and results, and conclusions and recommendations will be prepared following each phase of work. The Project Tasks Decision Tree, Plate 8, graphically presents the AGS investigative site approach for Tasks 1 through 10. The tasks shown are discussed in detail below. A Remediation Options Decision Tree, Plate 9, is also attached and depicts potential remediation alternatives for soil and ground water at this site.

TASK 1

Additional soil borings will be drilled and sampled as necessary to evaluate the lateral and vertical extent of gasoline and waste-oil hydrocarbons at the site. Specific locations of these soil borings will be selected and presented as needed for regulatory review. Soil samples will be submitted for laboratory analyses for the gasoline components benzene, toluene, ethylbenzene, and total xylenes (BTEX) and TPHg using modified Environmental Protection Agency (EPA) methods 8020 and 5030/8015, respectively. Soil samples collected near the former waste-oil tank will be analyzed for total oil and grease (TOG) by Standard Method

5520 D&F and for the metals cadmium (Cd), chromium (Cr), lead (Pb), and zinc (Zn), as necessary, by EPA methods 7130, 7190, 7420, and 7450, respectively. Volatile organic compounds (VOC) will also be analyzed in a representative soil sample collected from the boring near the former waste-oil tank using EPA method 8010. These laboratory analyses will be performed at a State-certified laboratory. Chain of Custody protocol will be followed for all samples submitted for analysis.

TASK 2

Additional step-out borings will be drilled and soil samples tested as necessary to further delineate the extent of petroleum hydrocarbons in the soil at the site (and offsite, if necessary).

TASK 3

If it is found that remediation of the soil is necessary at the site, a Feasibility Study and addendum to Work Plan will be prepared to evaluate clean-up levels and corrective actions for gasoline hydrocarbons in soil. This study will include remediation options and recommendations for the apparent best remediation alternative to be implemented. Plate 9 lists some of the typical soil remediation options which might be applicable to this site. A minimum of two viable disposal or treatment and disposal alternatives would be selected for cost analysis.

TASK 4

After regulatory approval of the recommended remediation alternative and addendum to Work Plan for the site, construction Plans and Specifications will be prepared as needed.

In some instances, simple excavation and disposal of contaminated soil to an appropriate landfill may be adequate, with clean backfill used to replace the excavated soil. If construction of treatment facilities is necessary, construction permits and operating permits will be obtained and Plan and Specification approval will be secured from the local Public Works Department, as necessary. A soil remediation system will then be installed and soil remediation will be performed.

TASK 5

Onsite ground-water monitoring wells will be installed, developed, and sampled to delineate the lateral and vertical extent of petroleum hydrocarbons in ground water onsite. Ground-water samples will be submitted for laboratory analysis for BTEX and TPHg using the EPA methods discussed in Task 1 at a State-certified laboratory. Water samples obtained from wells near the waste-oil tank will be analyzed for TOG (as necessary) using Standard method 5520 C&F, for VOC using EPA method 601, and for the metals Cd, Cr, Pb, and Zn by EPA methods 7130, 7190, 7420, and 7450, respectively. Quarterly ground-water sampling, monthly water-level measurements and removal of floating product was conducted at the site in April 1991 to evaluate changes in petroleum hydrocarbon concentrations in ground water and changes in ground-water gradient and flow direction over time.

TASK 6

Hydrogeologic tests and research will be performed as necessary to evaluate the potential migration of petroleum hydrocarbons, potential beneficial use of ground water, and general hydrogeologic characteristics as they pertain to possible ground-water remediation and investigation.

TASK 7

After regulatory approval of an offsite ground-water investigation plan (addendum to Work Plan), offsite wells will be installed, developed, and sampled as described in Task 5 above.

TASK 8

As necessary, a ground-water remediation Feasibility Study and addendum to the Work Plan will be prepared to evaluate corrective actions for petroleum hydrocarbons in ground water. Task 8 can be conducted in conjunction with Task 3, the soil remediation Feasibility Study and Work Plan. Clean-up levels and corrective actions for petroleum hydrocarbons in ground-water, including a minimum of two to three alternatives for treatment and two alternatives for treated ground-water disposal, would be analyzed for technical and cost-effectiveness feasibility. Plate 9 lists some typical ground-water remediation alternatives which may be applicable to this site.

TASK 9

After regulatory approval of the remediation Feasibility Study and addendum to the Work Plan, a ground-water remediation system will be designed and installed; the necessary permits will be obtained; and ground-water remediation will be performed and monitored.

TASK 10

After soil and ground-water remediation has been performed to clean-up levels, a site closure plan will be prepared for regulatory review and approval.

SCHEDULE OF OPERATIONS

Preliminary time schedules to perform additional phases of work will be included with the addenda to work plans presented for regulatory review. AGS can initiate work at the site within 1 week after receiving authorization to proceed. A preliminary estimate to perform the tasks described in this Work Plan, including remediation (Task 1 through Task 10), is approximately 2 to 5 years and is depicted in the Preliminary Time Schedule, Plate 10.

PROJECT STAFF

Dr. Joan E. Tiernan, a Registered Civil Engineer in the state of California (C.E. 044600) 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, Assistant Project Geologist, will be responsible for the day-to-day field and office operations of the project. AGS employs a staff of geologists and technicians who will assist with the project.

REFERENCES

Alameda County Flood Control and Water Conservation District, Zone 7, Water Resources Engineering. 1986. Water Level Contours. 1 inch = 3000 feet scale map.

Applied GeoSystems. January 20, 1990. Site Safety Plan Subsurface Environmental Assessment at the ARCO Service Station No. 771, 899 Rincon Avenue, Livermore, California: AGS Report No. 60000-1S.

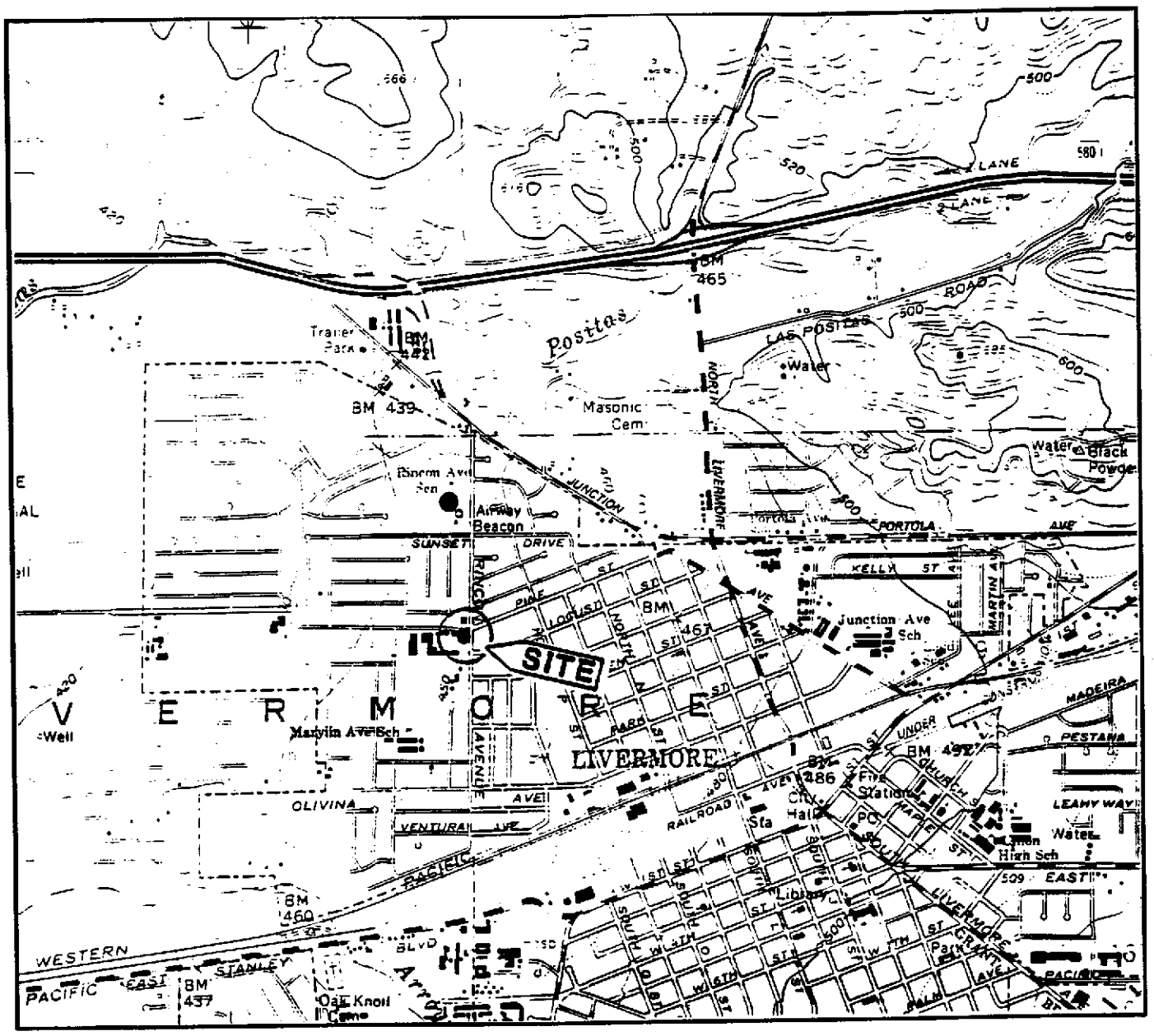
Applied GeoSystems. June 22, 1990. Limited Subsurface Environmental Assessment at ARCO Station 771, 899 Rincon Avenue, Livermore, California. Report No. 60000-1.

Applied GeoSystems. September 20, 1990. Work Plan for Supplemental Subsurface Investigation at ARCO Station 771, 899 Rincon Avenue, Livermore, California: AGS 60000-3.

Applied GeoSystems. April 12, 1991. Report Supplemental Subsurface Investigation at ARCO Station 771, 899 Rincon Avenue, Livermore, California. AGS Report No. 60000.04.

Brown and Caldwell. September 16, 1987. Soil Sample Results for Waste Oil Tank Removal, ARCO Station 771: Report No. 17/3456-02/3.

California Department of Water Resources. 1974. Evaluation of Ground-Water Resources Engineering Livermore and Sunol Valleys: Bulletin No. 118-2, Appendix A.



Source: U.S. Geological Survey
7.5-Minute Quadrangle
Livermore,
California.
Photorevised 1980

Approximate Scale

2000 1000 0 2000 4000

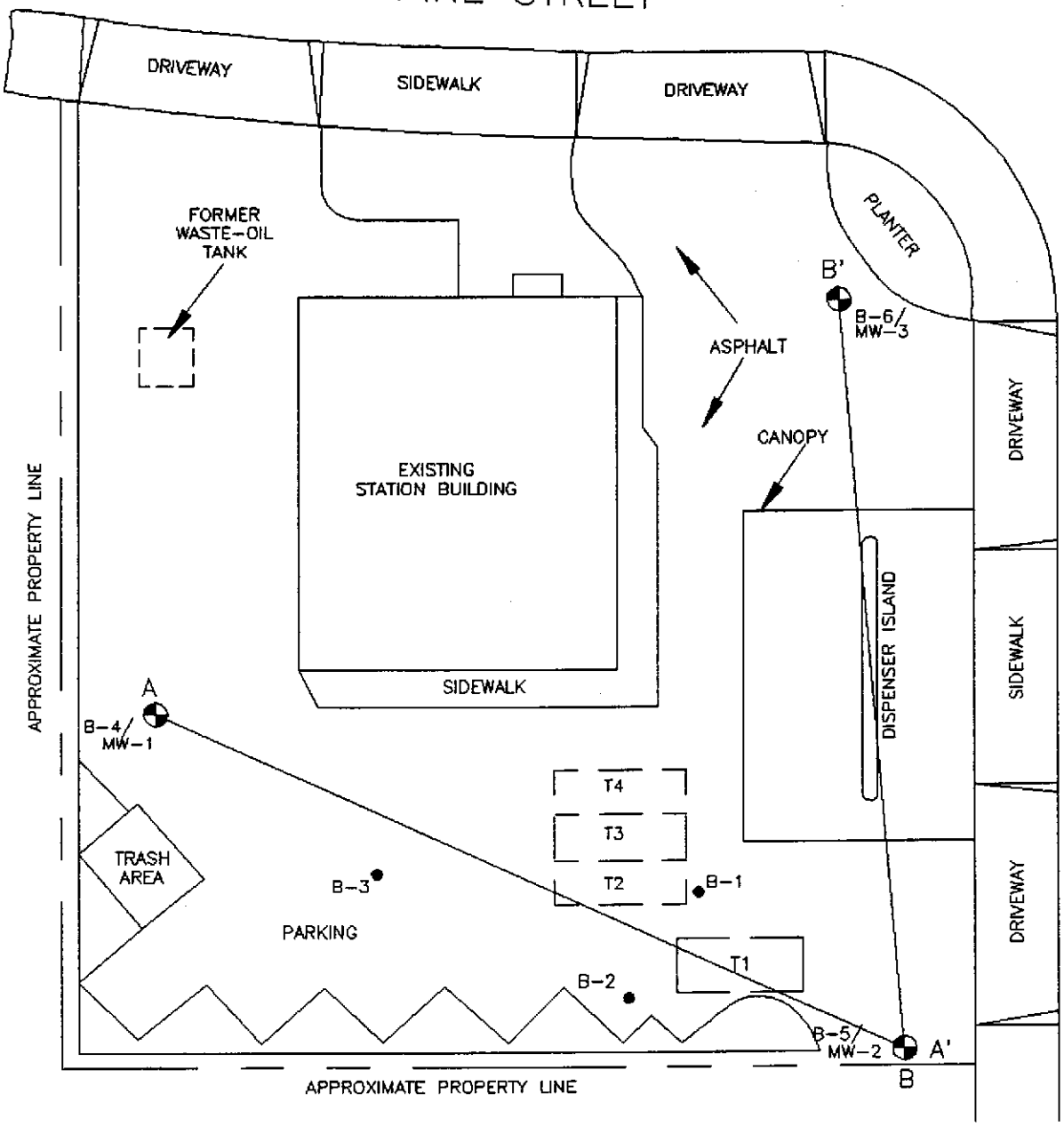
feet

Applied GeoSystems

PROJECT 60000-6

SITE VICINITY MAP
ARCO Station 771
899 Rincon Avenue
Livermore, California

PLATE 1



EXPLANATION

B — B' = Geologic cross sections

B-6/MW-3 = Monitoring well (Applied GeoSystems, December 1990)

B-3 = Soil boring (Applied GeoSystems, February 1990)

T4 = Underground gasoline-storage tank

N

Approximate Scale

20 10 0 20 40

feet

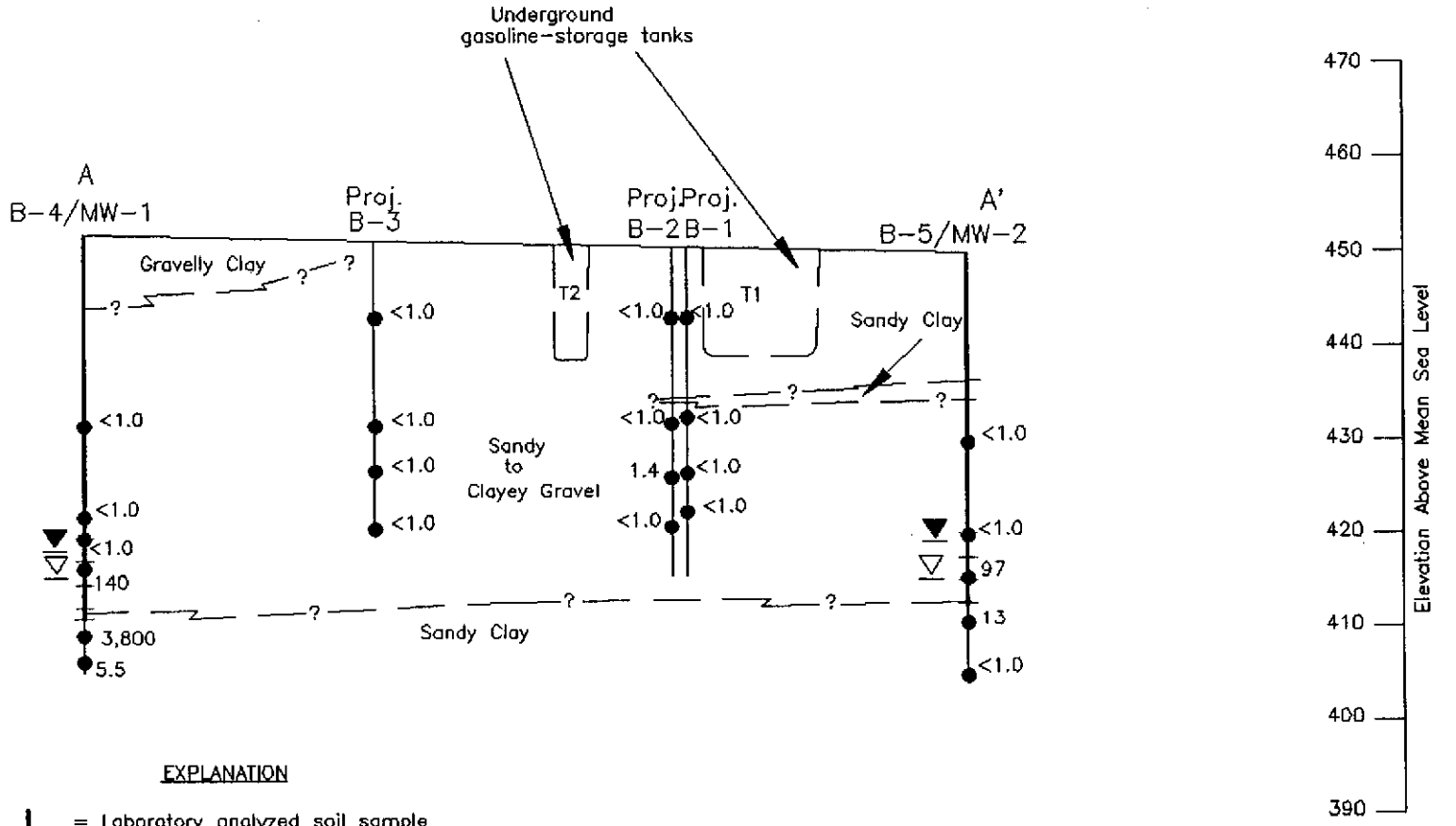
Source: Surveyed by Ron Archer Civil Engineer, Inc.

Applied GeoSystems

PROJECT 60000-6

GENERALIZED SITE PLAN
ARCO Station 771
899 Rincon Avenue
Livermore, California

PLATE 2



EXPLANATION

3,800 = 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

Approximate Horizontal and Vertical Scale

20 10 0 20 40

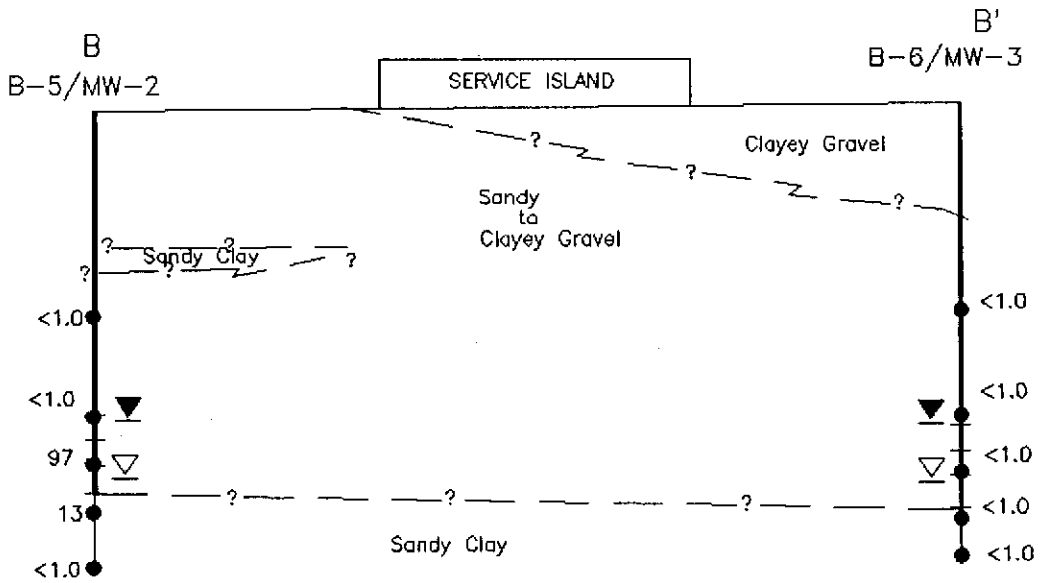
feet

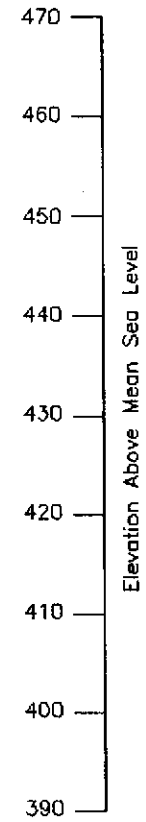
PLATE 3

GEOLOGIC CROSS SECTION A - A'
ARCO Station 771
899 Rincon Avenue
Livermore, California

Applied GeoSystems

PROJECT 60000-6





EXPLANATION

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

= Well casing

= Well screen

= Boring

= Initial water level in boring

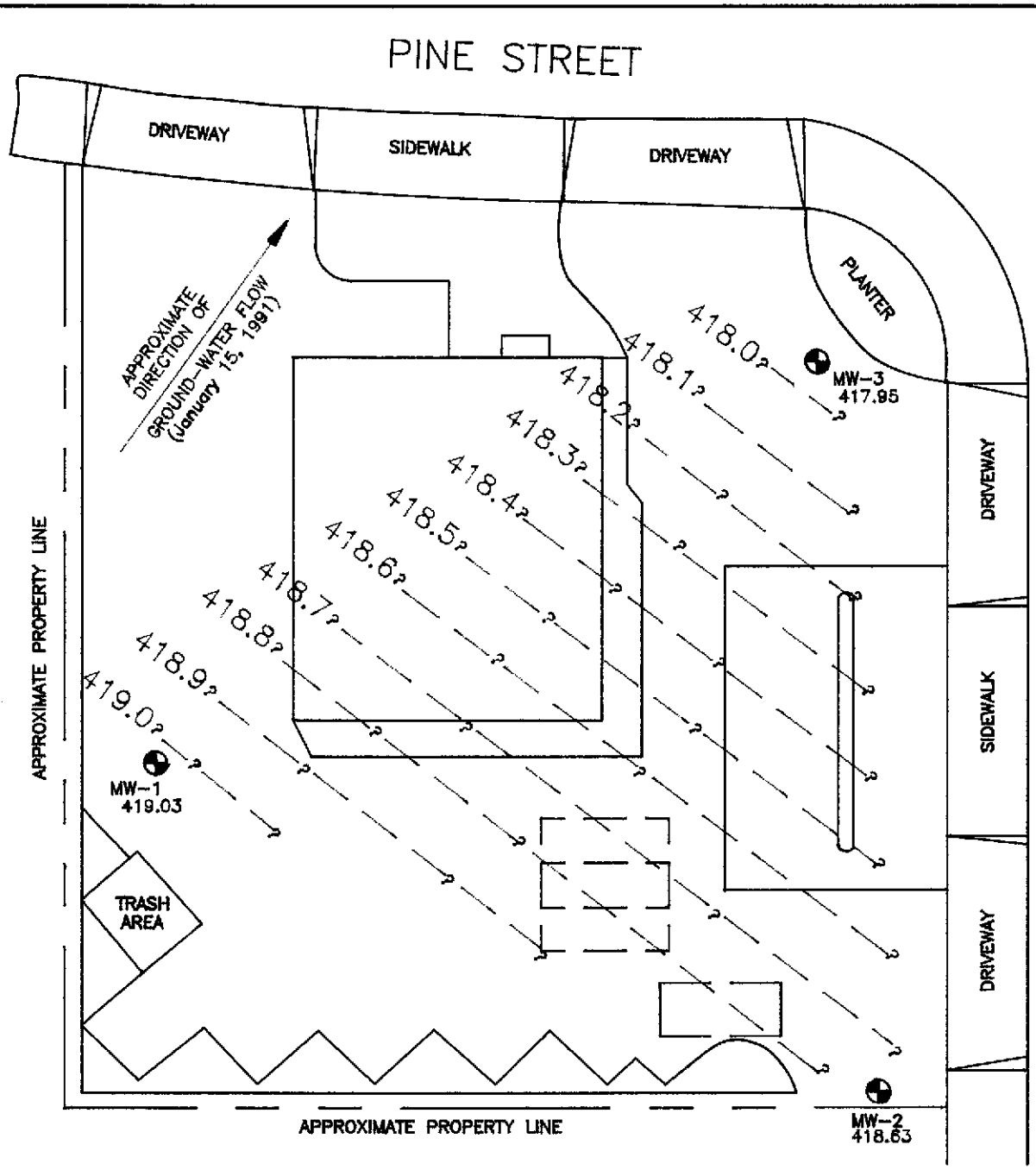
= Static water level in well

Approximate Horizontal and Vertical Scale

20 10 0 20 40

feet

PLATE 4	**GEOLOGIC CROSS SECTION B - B'** **ARCO Station 771** **899 Rincon Avenue** **Livermore, California**	Applied GeoSystems PROJECT 60000-6



EXPLANATION

419.0 — = Line of equal elevation of ground water above mean sea level (MSL)

419.03 = Elevation of ground water in feet (MSL) January 15, 1991

MW-3 = Monitoring well (Applied GeoSystems, December 1990)

Approximate Scale

20 10 0 20 40

feet

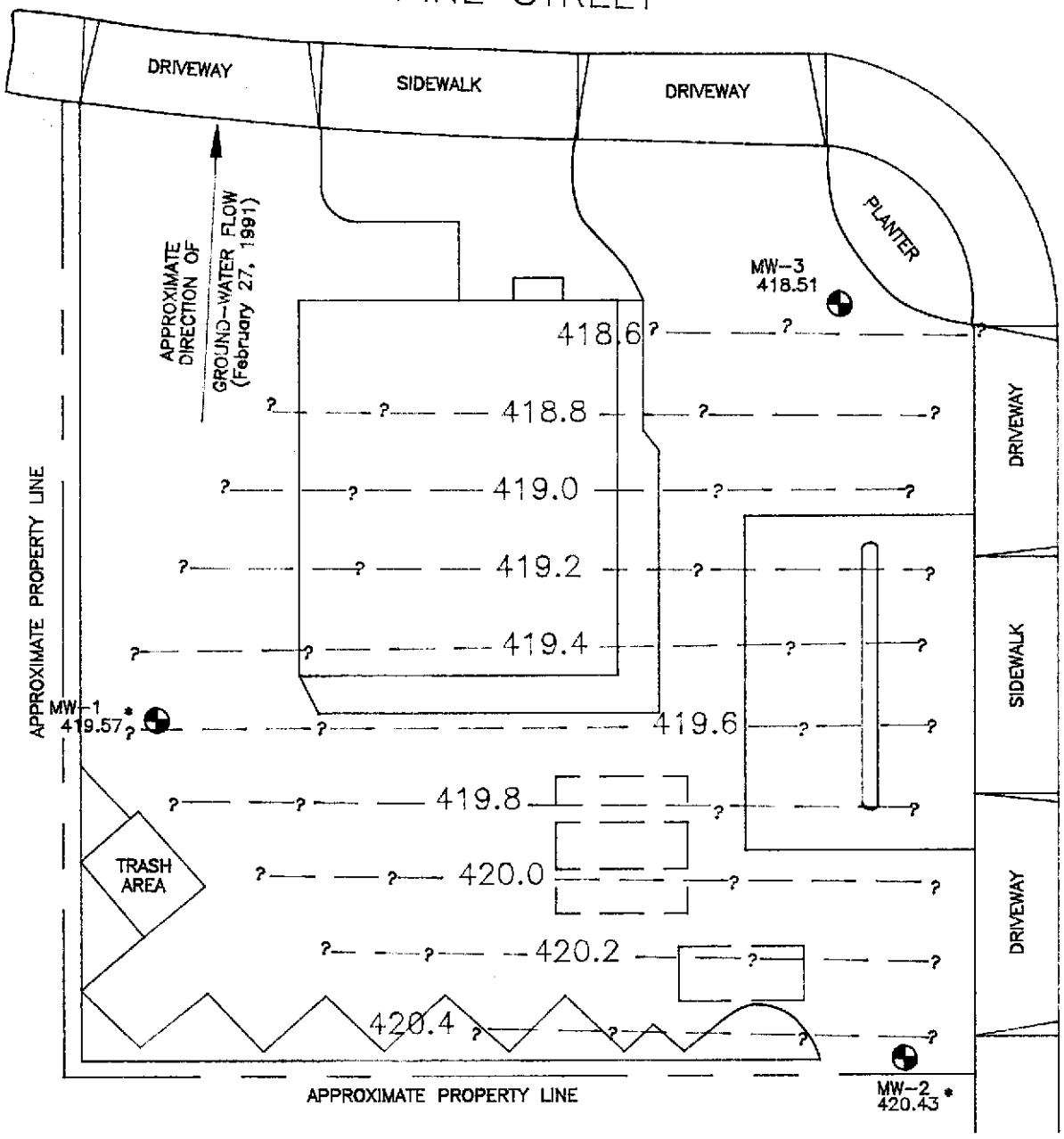
Source: Surveyed by Ron Archer Civil Engineer, Inc.

Applied GeoSystems

PROJECT 60000-6

GROUND-WATER GRADIENT MAP
ARCO Station 771
899 Rincon Avenue
Livermore, California

PLATE
5



EXPLANATION

* = Floating product or product sheen

420.4 = Line of equal elevation of ground water above mean sea level (MSL)

420.43 = Elevation of ground water in feet (MSL) February 27, 1991

MW-3 = Monitoring well (Applied GeoSystems, December 1990)

N

Approximate Scale

20 10 0 20 40

feet

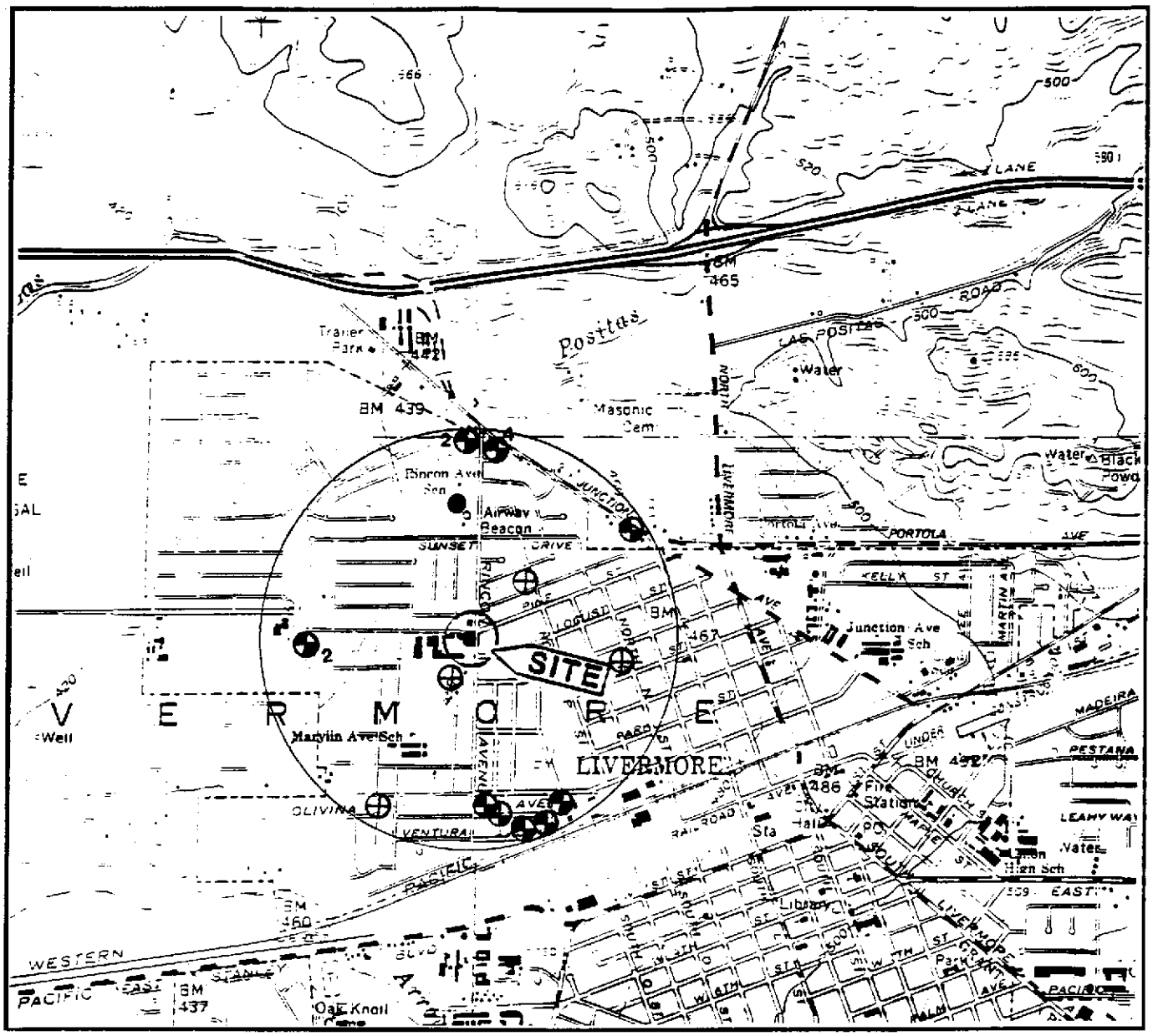
Source: Surveyed by Ron Archer Civil Engineer, Inc.

Applied GeoSystems

PROJECT 60000-6

GROUND-WATER GRADIENT MAP
ARCO Station 771
899 Rincon Avenue
Livermore, California

PLATE
6



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

○ = Water supply wells

◔ = Monitoring wells

N

Approximate Scale

2000 1000 0 2000 4000

feet

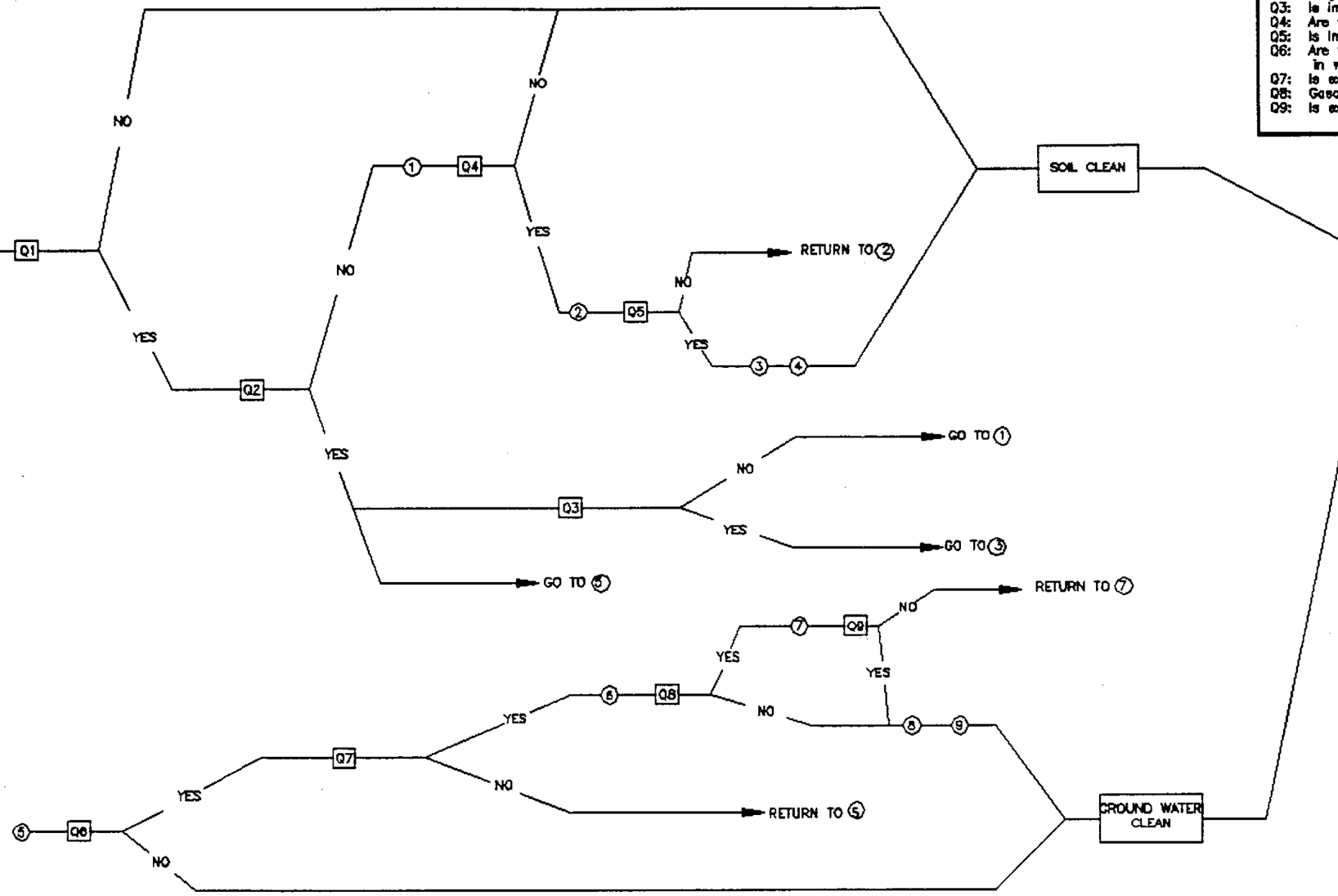
Applied GeoSystems

PROJECT 60000-6

WELL LOCATION MAP
ARCO Station 771
899 Rincon Avenue
Livermore, California

PLATE

7



QUESTION

Q1: Is soil impacted by release?
Q2: Is ground-water impacted by release?
Q3: Is impacted soil defined?
Q4: Are there detectable concentrations of TPHg in the soil?
Q5: Is impacted soil defined?
Q6: Are there Gasoline Hydrocarbon at or above detectable concentrations in water samples?
Q7: Is extent of gasoline hydrocarbon in ground-water characterized onsite?
Q8: Gasoline hydrocarbons in ground-water extend offsite?
Q9: Is extent of gasoline hydrocarbons in ground-water characterized offsite?

PROJECT TASKS

SOIL INVESTIGATION

Task (1) Drill and sample Soil Borings
Task (2) Drill Step-Out Borings

SOIL REMEDIATION (if necessary)

Task (3) Prepare Soil Remediation Feasibility Study and Action Plan (if necessary)
Task (4) Remedial Soil (if necessary)

ONSITE GROUND-WATER INVESTIGATION

Task (5) Install/Develop Ground-water Monitoring wells and Sample/Analyze Ground-water
Task (6) Conduct Hydrology Tests and Research

OFFSITE GROUND-WATER INVESTIGATION (if necessary)

Task (7) Install Offsite Well(s), Sample/Analyze

GROUND-WATER REMEDIATION (if necessary)

Task (8) Prepare Ground-Water Remediation Feasibility Study and Action Plan
Task (9) Remediate Ground-Water

SITE CLOSURE

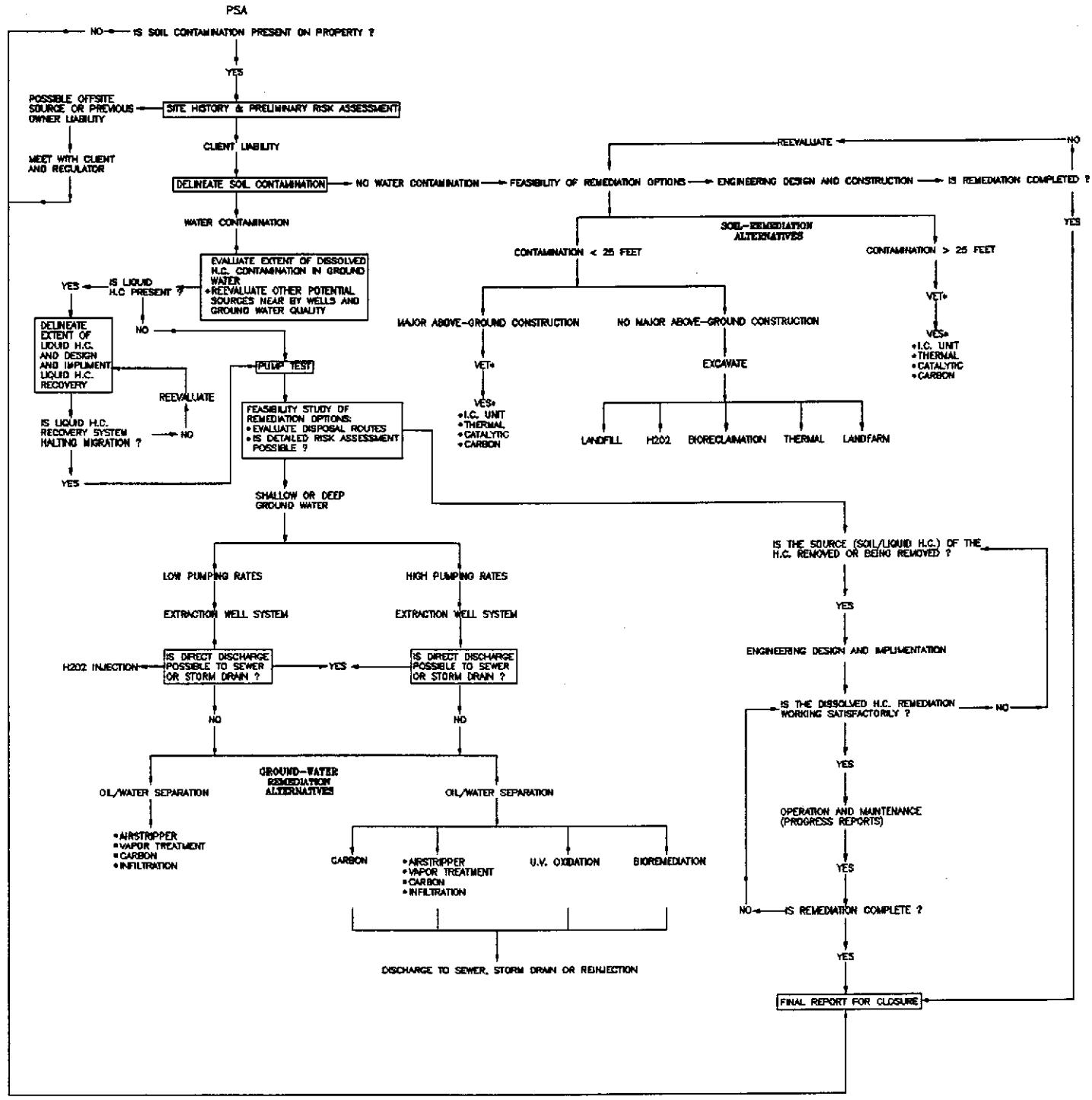
Task (10) Prepare site closure plan

Applied GeoSystems

PROJECT 60000-6

PROJECT TASK DECISION TREE
ARCO Station 771
898 Rincon Avenue
Livermore, California

PLATE
8



VET• = Vapor Extraction Test

VES• = Vapor Extraction System

Applied GeoSystems

PROJECT 60000-6

REMEDIATION OPTIONS DECISION TREE

ARCO Station 771
899 Rincon Avenue
Livermore, California

PLATE 9

TASK 1:
Drill and Sample soil borings

TASK 2:
Drill Step-Out borings

TASK 3:
Prepare Soil Remediation Feasibility Study and Action Plan (if necessary)

TASK 4:
Remediate Soil (if necessary)

TASK 5:
Install/Develop Ground-Water Monitoring Wells and Sample/Analyze Ground-Water

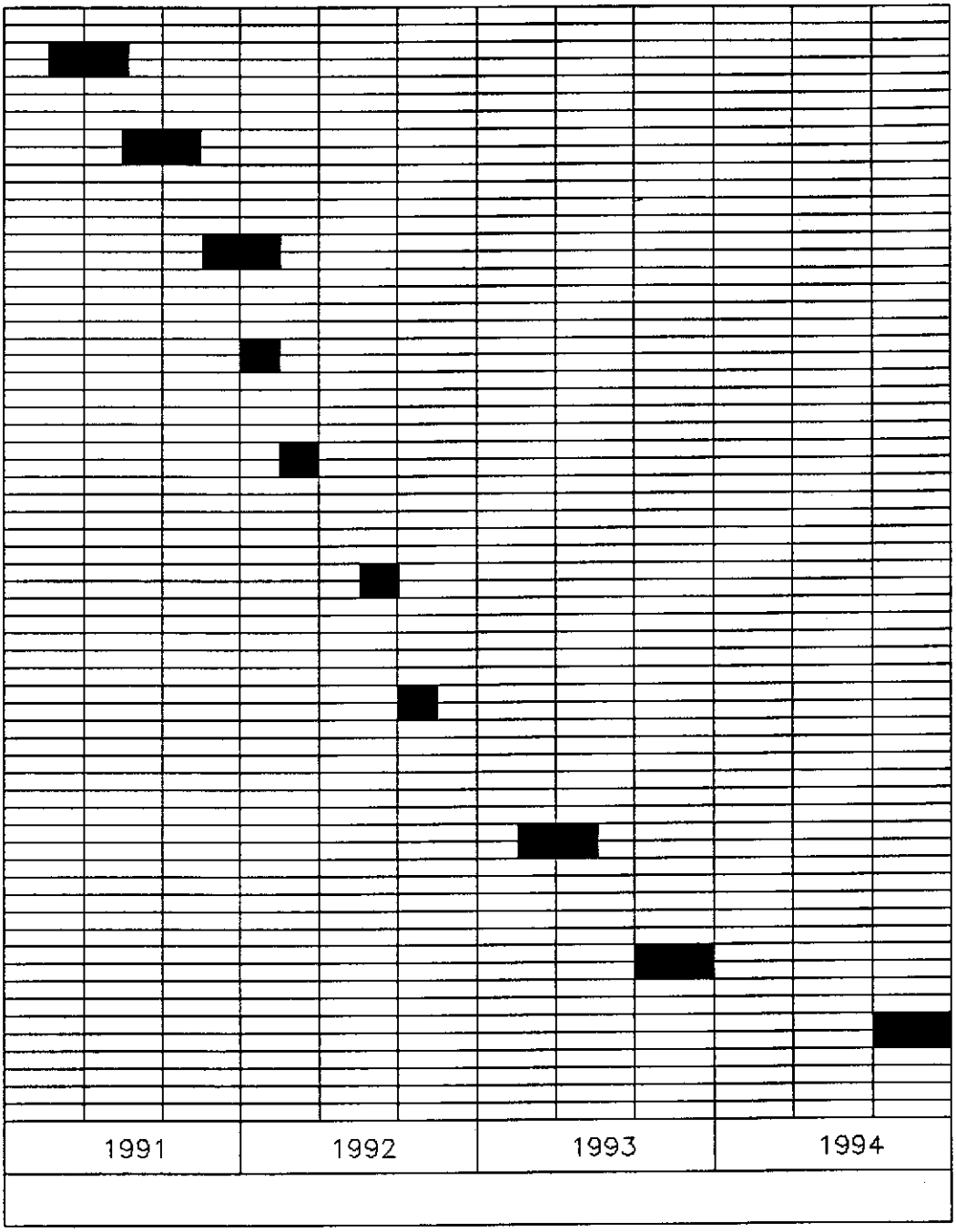
TASK 6:
Conduct Hydrology Tests and Research

TASK 7:
Install Offsite Well(s), Sample/Analyze

TASK 8:
Prepare Ground-Water Remediation Feasibility Study and Action Plan

TASK 9:
Remediate Ground-Water

TASK 10:
Prepare Site Closure Plan



Applied GeoSystems

PROJECT 60000-6

PRELIMINARY TIME SCHEDULE
ARCO Station 771
899 Rincon Avenue
Livermore, California

PLATE
10

TABLE 1
CUMULATIVE RESULTS OF LABORATORY ANALYSIS OF SOIL SAMPLES
ARCO Station 771
Livermore, California

Sample Identification	TPHg	Benzene	Toluene	Ethyl-benzene	Total Xylenes
February 1990					
S-10-B1	<1.0	<0.005	<0.005	<0.005	<0.005
S-19.5-B1	<1.0	0.022	0.024	<0.005	0.022
S-24.5-B1	<1.0	0.022	0.015	0.010	0.048
S-29.5-B1	<1.0	<0.005	<0.005	<0.005	<0.005
S-10-B2	<1.0	<0.005	<0.005	<0.005	<0.005
S-20-B2	<1.0	0.016	0.020	<0.005	0.025
S-25-B2	1.4	<0.01	<0.01	<0.01	0.018
S-31-B2	<1.0	<0.005	<0.005	<0.005	<0.005
S-10-B3	<1.0	<0.005	<0.005	<0.005	<0.005
S-19.5-B3	<1.0	0.028	<0.005	<0.005	0.017
S-25-B3	4.5	0.047	<0.01	0.011	0.038
S-32.5-B3	190	<1.0	<1.0	<1.0	1.7
December 1990					
S-20-B4	<1.0	0.006	<0.005	<0.005	<0.005
S-30-B4	<1.0	<0.005	<0.005	<0.005	<0.005
S-32-1/2-B4	<1.0	<0.005	<0.005	<0.005	<0.005
S-36-1/2-B4	140	<0.15	0.80	1.7	4.2
S-43-B4	3,800	<1.5	130	50	280
S-45-1/2-B4	5.5	0.16	0.51	0.11	0.82
S-20-B5	<1.0	0.068	0.013	0.009	0.026
S-30-B5	<1.0	<0.005	<0.005	<0.005	<0.005
S-34-1/2-B5	97	<0.005	0.13	0.087	0.22
S-39-1/2-B5	13	0.15	0.66	0.16	1.5
S-45-B5	<1.0	<0.005	0.006	<0.005	0.009
S-20-B6	<1.0	<0.005	<0.005	<0.005	<0.005
S-30-B6	<1.0	<0.005	<0.005	<0.005	<0.005
S-36-1/2-B6	<1.0	<0.005	<0.005	<0.005	0.006
S-41-B6	<1.0	<0.005	<0.005	<0.005	<0.005
S-44-1/2-B6	<1.0	<0.005	<0.005	<0.005	<0.005
S-011591-1ABCD*	31	0.25	0.67	0.34	2.8

Results measured in part per million (ppm).
<: Less than the laboratory detection limit.
TPHg: Total petroleum hydrocarbons as gasoline (analyzed by EPA Method 5030/8015.
BTEX: Analyzed by EPA Method 5030 and 8020/602.
*: Composite sample of four soil samples obtained from stockpiled soil.

Sample Identification: S-44-1/2-B6
- S: Soil sample
- 44: Depth of boring in feet
- 1/2: Boring number
- B6

TABLE 2
CUMULATIVE GROUND-WATER MONITORING DATA
ARCO Station 771
Livermore, California

Date Well Measured	Well Elevation	Depth to Water	Water Elevation	Floating Product	Adjusted Water Elevation
MW-1					
1-15-91	451.80	32.77	419.03	—	—
2-27-91		32.23	419.57	—	—
MW-2					
1-15-91	449.52	30.89*	418.63*	0.16	418.76
2-27-91		29.11*	420.41*	0.02	420.43
MW-3					
1-15-91	450.29	32.34	417.95	—	—
2-27-91		31.78	418.51	—	—

Measurements in feet.
Calculated depth to water when floating product is present is calculated using the attached protocol (Appendix A).
* = Floating product present in well.

TABLE 3
RESULTS OF LABORATORY ANALYSIS OF GROUND-WATER SAMPLES
ARCO Station 771
Livermore, California
(January 15, 1991)

Sample ID	TPHg	Benzene	Toluene	Ethyl-benzene	Total xylenes	Product Evidence
MW1	N/S	N/S	N/S	N/S	N/S	Sheen present
MW2	N/S	N/S	N/S	N/S	N/S	Floating product
MW3	230	<0.5	<0.5	2.2	2.1	None

Results in parts per billion (ppb)
<: Less than the laboratory detection limit.
N/S: Not Sampled due to presence of floating product.
BTEX: Measured by EPA Method 8020/602.
TPHg: Total petroleum hydrocarbons as gasoline (measured by EPA Method 5030/8015).

Sample Identification: MW3 — Monitoring well number

APPENDIX A

FIELD PROTOCOL

FIELD PROTOCOL

The following presents Applied GeoSystems' 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 Applied GeoSystems and its subcontractors. Applied GeoSystems personnel and subcontractors of Applied GeoSystems 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.

Soil Excavation

Permits are acquired prior to the commencement of work at the site. Excavated soil is evaluated using a field calibrated (using isobutylene) Thermo-Environmental Instruments Model 580 Organic Vapor Meter (OVM). This evaluation is done upon arrival of the soil at the ground surface in the excavator bucket by removing the top portion of soil from the bucket, and then placing the intake probe of the OVM against the surface of the soil in the bucket. Field instruments such as the OVM are useful for measuring relative concentrations of vapor content, but cannot be used to measure levels of hydrocarbons with the accuracy of laboratory analysis. Samples are taken from the soil in the bucket by 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. If field subjective analyses suggest the presence of hydrocarbons in the soil, additional excavation and soil sampling is performed, using similar methods. If ground water is encountered in the excavation, ground water samples are collected from the excavation using a clean Teflon® bailer. The ground water samples are collected as described below under "Ground-Water Sampling". The excavation is backfilled or fenced prior to departure from the site.

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

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.

Vadose-Zone Sampling

Vapor readings are made with a field calibrated OVM, which has a lower detection limit of 0.1 ppm. Prior to purging each vadose-zone monitoring well, an initial reading is taken inside the well by connecting the tubing of the OVM to a tight fitting at the top of the well. Each vadose-zone monitoring well is then purged for approximately 60 seconds using an electric vacuum pump connected to the tight fitting. Ambient readings of the air at the site are taken with the OVM after each well is purged. The OVM is then connected to the well fitting, and the reading recorded. The well is then again purged for approximately 30 seconds, and again measured using the OVM. These purging and measuring procedures are repeated until two consecutive OVM readings are within ten percent of each other.

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

Bailer Test

The initial water level is measured in the test well, and water bailed from the test well using a Teflon® bailer and cable cleaned with Alconox® and water. Pressure transducers are used to measure water levels in the test well during drawdown and partial recovery phases, over a minimum period of approximately one to two hours. The bailing rate for the designated test well is recorded.

Pumping 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 pumping rate, and water levels allowed to recover to initial levels. Pumping then begins, and the starting time of pumping is recorded. Drawdowns in observation wells are recorded at intervals throughout pumping using pressure transducers. 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 ground water levels.