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

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

[redacted]

at

ARCO Station 601

712 Lewelling Boulevard

San Leandro, California

AGS 69034-4W [redacted]

Prepared for

ARCO Products Company

P.O. Box 5811

San Mateo, California 94402

by

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[redacted]

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

WORK PLAN
for
SUBSURFACE INVESTIGATIONS AND REMEDIATION
at
ARCO Station 601
712 Lewelling Boulevard
San Leandro, California
for
ARCO Products Company

INTRODUCTION

This Work Plan summarizes work previously preformed by AGS and others, and describes the project tasks proposed to evaluate and remediate the lateral and vertical extent of gasoline and other hydrocarbons in the soil and ground water at the subject site. [illegible] purpose of subsurface investigations at the site is to evaluate the extent of hydrocar[illegible] other constituents related to the gasoline and waste-oil storage tanks in the subsurface soil and ground water. ARCO Products Company (ARCO) requested that AGS prepare this work plan for submittal to the Regional Water Quality Control Board (RWQCB) and the Alameda County Health Agency.

[illegible] includes the following tasks:

Task 1: drill and sample soil borings;
Task 2: drill step-out borings to further delineate the extent of gasoline 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 laboratory analyze water samples from the wells;
Task 6: conduct hydrogeologic tests and research (as necessary);
Task 7: install, develop, and sample off-site 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. Specified 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. 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 Regional Water Quality Control Board and Alameda County Health Agency for their review and approval prior to continuing work at the site.

SITE DESCRIPTION AND BACKGROUND

General

The subject site is on the southwestern corner of the intersection of Lewelling Boulevard and Washington Avenue in San Leandro, California, as shown on the Site Vicinity Map (Plate 1). The site is an operating ARCO service station. The elevation of the site is approximately 22 feet above mean sea level (msl). The site is bounded by residential and professional buildings to the west-southwest and south, commercial buildings across

Washington avenue to the east northeast, and an operating service station across Lewelling Boulevard to the north-northwest.

During January 1990, two 6,000-gallon underground gasoline-storage tanks (T2 and T4), two 4,000-gallon underground gasoline-storage tanks (T1 and T3), and one underground 550 gallon waste-oil storage tank were excavated and removed from the site by Gettler-Ryan Inc. of Hayward, California. According to the report related to tank excavation and removal at the site by GeoStrategies, Inc., of Hayward, California (GeoStrategies, June 29, 1990), the tanks were installed in 1974. The approximate locations of the former and existing underground storage tanks and other features at the site are shown on the Generalized Site Plan (Plate 2).

Geology

The ARCO station is within the East Bay Plain, located in the west-central portion of the San Leandro Cone (Hickenbottom and Muir, 1988). Helley et. al.(1979) mapped the earth materials underlying the site area as Quaternary bay mud deposits composed primarily of dark plastic clay and silty clay rich in organic material. The site is located approximately 700 feet north of the San Lorenzo Creek (which has been channelized in a concrete aqueduct in this area), approximately 1,400 feet east of the Estudillo Canal, and approximately 1-3/4 miles northeast of Roberts Landing on the eastern shoreline of the San Francisco Bay. The active Hayward Fault is approximately 2-1/2 miles east of the site.

PREVIOUS WORK

August 1989

Applied GeoSystems performed a limited environmental site assessment at the request of ARCO to evaluate possible hydrocarbons in the soil in the vicinity of the underground storage tanks prior to removal of the four underground gasoline-storage tanks and one underground waste-oil-storage tank (AGS, November 1989). Work performed during this limited assessment included: drilling and obtaining soil samples for laboratory analysis from five soil borings (B-1 through B-5) to depths to or just above the first-encountered ground-water; analyzing selected soil samples from each of the borings for total petroleum hydrocarbons as gasoline (TPHg) and the gasoline constituents benzene, toluene, ethylbenzene, and total xylenes (BTEX); analyzing selected soil samples from the boring located near the waste-oil tank for total oil and grease (TOG) and halogenated volatile organics (VOC); and preparation of a report including results, conclusions and recommendations for future work.

The soil borings were drilled to depths from approximately 10-1/2 to 15-1/2 feet below the ground surface. Ground water was first encountered at depths of 14-1/2 feet and 11-1/2 feet in borings B-1 and B-2, respectively, and stabilized after a period of approximately one hour at a depth of approximately 11 feet below the ground surface. Borings B-3, B-4, and B-5 were drilled to total depths of approximately 10-1/2 feet below the ground surface, and were completed prior to encountering ground water. The soil encountered during this limited assessment consisted primarily of silty clay with lesser amounts of sandy clay and clayey silt.

Results of laboratory analyses of selected soil samples from borings B-1 through B-4, drilled in the area of the gasoline-storage tanks, indicated concentrations of TPHg up to 12,000 parts per million (ppm) and concentrations of BTEX up to 60 ppm, 450 ppm, 110 ppm, and 660 ppm, respectively. Results of laboratory analyses of selected soil samples from boring B-5, drilled adjacent to the waste-oil tank, indicated TPHg at concentrations up to 2,600 ppm, total oil and grease up to 4,800 ppm, and BTEX up to 10 ppm, 90 ppm, 21 ppm, and 130 ppm, respectively. No halogenated volatile organic compounds (VOC) were detected in samples analyzed from boring B-5. The laboratory results are summarized in Table 4.

Applied GeoSystems concluded that the shallow soil in the area of the four underground gasoline-storage tanks and the underground waste-oil-storage tank had been affected by elevated levels of hydrocarbons.

<u>November 1989</u>

GeoStrategies Inc., of Hayward, California, prepared a work plan for ARCO (GSI, November 1989). This Work Plan included: excavation of contaminated soils during tank and product-line removal and replacement; observation of excavation and obtaining soil samples for laboratory analysis from tank excavations, product-line trenches, and soil stockpiles as specified by the California Department of Health Services LUFT Manual and San Leandro Fire Department guidelines; drilling three soil borings, obtaining soil samples for laboratory analysis, installing three ground-water monitoring wells, developing the monitoring wells and sampling ground water for laboratory analysis, surveying wellhead elevations and obtaining ground-water elevations to determine the ground-water flow direction and gradient magnitude, and preparing a report to include results, conclusions and recommendations for future work at the site.

January 1990

GSI observed removal of four underground gasoline-storage tanks and one underground waste-oil-storage tank, noted contaminant distribution within the subsurface, and assisted in directing soil excavation (GSI, June 1990). GSI also obtained soil samples for laboratory analysis from the tank excavations (including the new tank excavation), the product-line trenches, and soil stockpiles, and prepared a report summarizing field procedures and results for ARCO.

Approximately 600 cubic yards of soil were removed from the former underground gasoline-storage tank and product-line trench excavations, approximately 950 cubic yards of soil were removed from the new underground gasoline-storage tank excavation, and approximately 15 cubic yards of soil were removed from the former waste-oil tank excavation. According to GSI, the size of the former gasoline-storage tank excavation was limited by the presence of existing structures on the site. Laboratory analysis of composite soil samples obtained from the soil stockpiles reported TPHg concentrations above 1000 ppm for approximately 200 cubic yards, and above 100 ppm for approximately 350 cubic yards of soil removed from the former tank excavation. This approximately 550 cubic yards of soil was removed to disposal facilities operated by GSX (as identified by GSI, presently Laidlaw Environmental Services, Inc., Limited Class I Disposal Facility, Button Willow, California). Laboratory analysis of composite soil samples obtained from the soil stockpiles reported TPHg concentrations of less than 100 ppm for approximately 50 cubic yards of soil removed from the former gasoline tank excavation, and for approximately 950 cubic yards of soil removed from the new gasoline tank excavation. This approximately 1,000 cubic yards of soil was removed to a Class III landfill. Approximately 15 cubic yards of soil removed from the former waste-oil tank excavation were removed to a disposal facility operated by GSX. Excavations were backfilled with clean pea gravel. In addition, a 6-inch diameter 0.020 slot size PVC casing product recovery well (RW-1) was installed in the backfill of the former waste-oil tank excavation, at the approximate location shown on the Generalized Site Plan (Plate 2) of this work plan. The results of laboratory analysis of native soil samples obtained from the former gasoline tank excavation, former product line trenches, former waste-oil tank excavation, and new tank excavation are included in Table 2, and on cross sections A-A'and B-B', Plates 7 and 8.

June 1990

In June, 1990 AGS performed a Limited Subsurface Investigation (AGS, December 1990) at the site including drilling borings B-6 through B-8 and installing ground-water monitoring wells MW-1 through MW-3 in the borings. The monitoring wells were developed and sampled as part of this investigation and selected soil samples collected from the borings and ground-water samples were sent to a state-certified laboratory for analyses. Laboratory analytical results for soil and ground water are shown in Tables 3 and 4, respectively. Geologic Cross sections showing subsurface geology and soil sample results are shown on Plates 3 and 4. The ground-water gradient was reported to be to the southwest during July and August, 1990 (Plates 5 and 6, respectively). Table 5 presents the measured ground-water elevations utilized to calculate the ground-water gradient.

AGS concluded that the majority of gasoline and waste-oil hydrocarbons at concentrations above 100 ppm in the soil at the site outside the immediate areas of the former gasoline and waste-oil storage tanks appear to be within or just above the interbedded clayey sand to silty clay at depths between approximately 8 and 12 feet below the ground surface. The lateral extent of hydrocarbons in the soil associated with the former gasoline and waste-oil storage tanks at the site has not been delineated below 100 ppm, with the exception of gasoline hydrocarbons which have been delineated to 15 ppm TPHg northeast of the former tank excavation; however, the vertical extent of hydrocarbons in the soil has been delineated to nondetectable (<1.0 ppm) in soil samples obtained from 15-1/2 to 16-1/2 feet below ground surface in soil borings B-6 through B-8 and to nondetectable (<10 ppm) in soil samples obtained by GSI approximately 14 feet deep in the excavation beneath the former gasoline tanks. The vertical extent of hydrocarbons remains to be delineated in the eastern and southwestern vicinity of the former gasoline tanks, near the former waste-oil tank, and near the new gasoline-storage tanks. Laboratory analysis of soil samples obtained from soil boring B-6 near the former waste-oil tank for the total metals cadmium, chromium, lead, and zinc reported levels below the levels of Total Threshold Limit Concentration Values of Title 22 of the California State Administrative Code, recorded January 1988, for these respective metals. Laboratory analysis of the ground-water sample obtained from well MW-2 reported levels of the metals cadmium, chromium, lead, and zinc at or below the respective DHS drinking water action levels. The lateral and vertical extents of hydrocarbons in the ground water have not been delineated at the site. A source of gasoline hydrocarbons reported in the ground water may be the gasoline hydrocarbons reported in the soil north and northwest of the former gasoline-storage tank excavation. An additional offsite source of gasoline hydrocarbons may be indicated by the presence of a product sheen in well MW-3, which is located relatively cross-gradient from the former gasoline-storage tanks.

PROJECT TASKS

AGS proposes the following project Tasks 1 through 10 listed below as a method of approach to work to delineate the vertical and horizontal extent of gasoline hydrocarbons and to remediate gasoline 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. Plate 7, Project Tasks Decision Tree for Tasks 1 through 10, graphically presents AGS investigative site approach. The tasks shown in Plate 7 are discussed in detail below. A Remediation Options Decision Tree (Plate 8) 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 petroleum hydrocarbons at the site. Specific locations of these soil borings will be selected and presented as needed in Addenda to this Work Plan for regulatory approval. Soil samples will be submitted for laboratory analyses for BTEX, TPHg, TPHd, and TOG using modified Environmental Protection Agency (EPA) methods 8020, 5030/8015, 3550/8015, and 5520 B&F, respectively. These laboratory analyses will be performed at a State-certified laboratory.

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 off-site, 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 petroleum hydrocarbons in soil. This study will include remediation options and recommendations for the apparent best remediation alternative to be implemented. Plate 8 lists some of the typical soil remediation options which might be applicable to this site.

Two or three disposal or treatment and disposal alternatives would be selected for an 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

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, TPHg, and TPHd using the EPA methods discussed in Task 1 above at a State-certified laboratory.

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.

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 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 action of petroleum hydrocarbons in ground-water, including two to three alternatives for treatment and two to three alternatives for treated ground-water disposal, would be analyzed for technical and cost-effectiveness feasibility. Plate 8 lists some typical ground-water remediation alternatives which may be applicable to this site.

TASK 9

After regulatory approval of the ground-water remediation Feasibility Study and addendum to 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 one 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 two to five years and depicted in Plate 9, Preliminary Time Schedule.

PROJECT STAFF

Ms. Diane Barclay, a Certified Engineering Geologist in the State of California, will be in overall charge of hydrogeologic facets, and Ms. Joan E. Tiernan, Ph.D., a Registered Civil Engineer will be in overall charge of engineering facets 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, engineers and technicians who will assist in completing the project.

REFERENCES

Applied GeoSystems, August 1, 1989, Site Safety Plan, Subsurface Environmental Investigation at ARCO Service Station 601, AGS Report 69034-1S.

Applied GeoSystems, November 9, 1989, Limited Environmental Site Assessment at ARCO Service Station 601, San Leandro, California, AGS Report 69034-1.

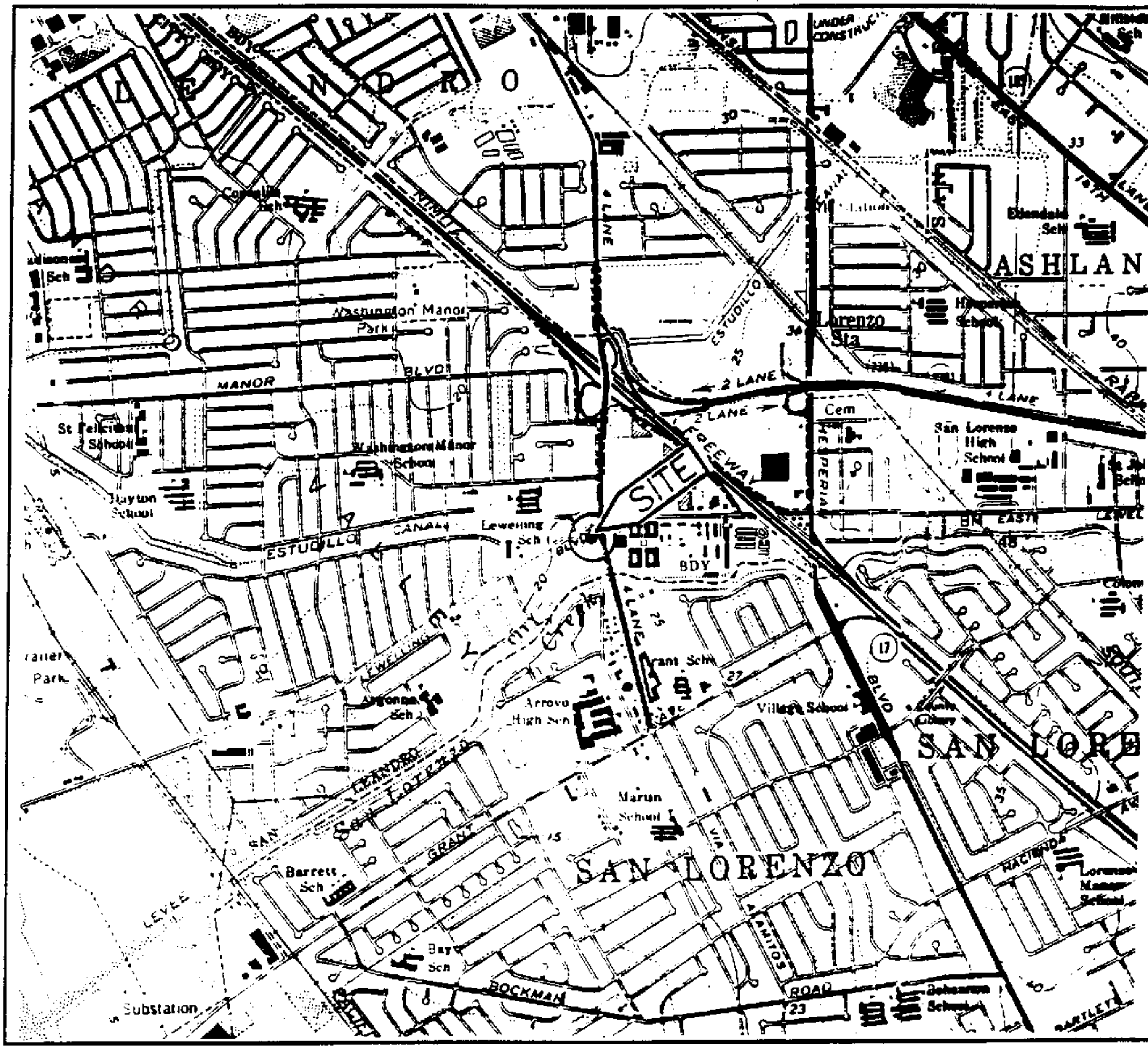
Applied GeoSystems, December 14, 1990, Subsurface Environmental Assessment at ARCO Station 601, San Leandro, California, AGS Report 69034-2.

GeoStrategies, Inc., November 14, 1989, Proposed Scope of Work, ARCO Service Station #601, San Leandro, California, GSI Report 7918-1.

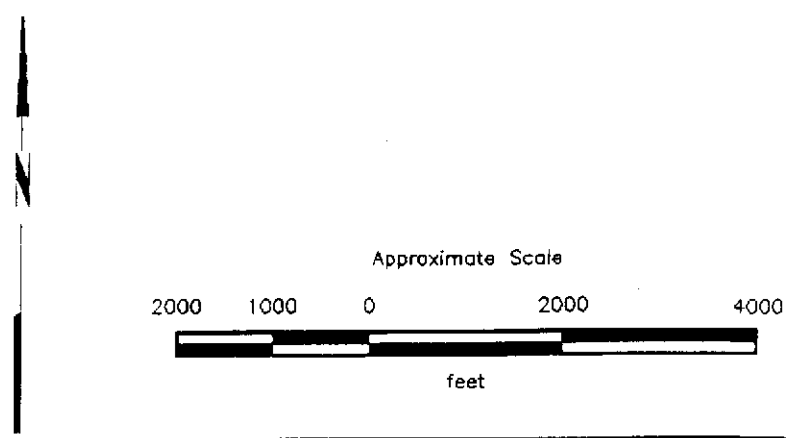
GeoStrategies, Inc., June 29, 1990, Tank Replacement Report, ARCO Service Station #601, San Leandro, California, GSI Report 7918-2.

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

Hickenbottom, Kelvin and Muir, Kenneth, June 1988, Geohydrology and Groundwater-Quality Overview of the East Bay Plain Area, Alameda County, California, Alameda County Flood Control and Water Conservation District, Report 205 (j).



Source: U.S. Geological Survey
7.5-Minute Quadrangles
Hayward/San Leandro,
California.
Photorevised 1984



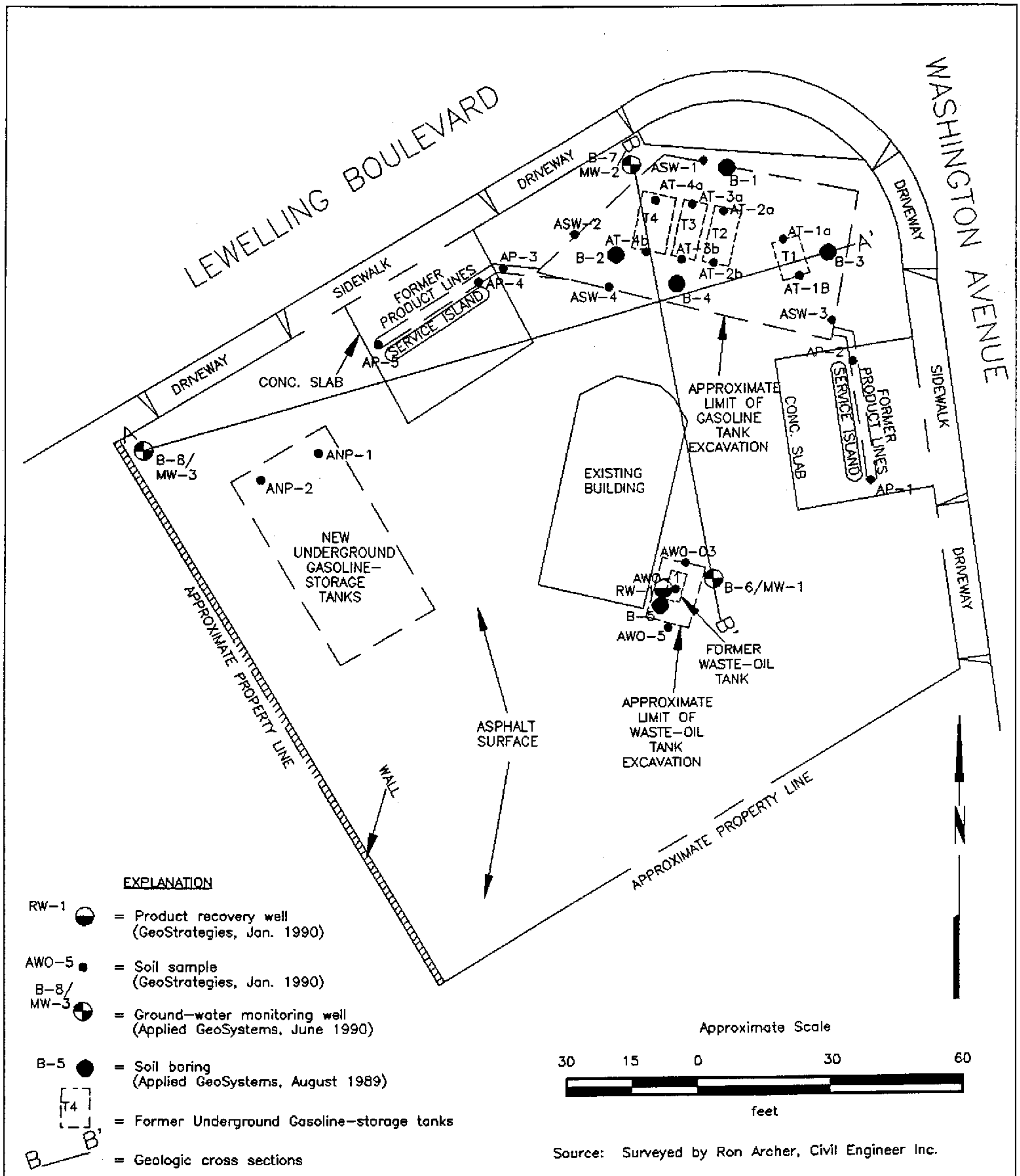
Applied GeoSystems

PROJECT **69034-4W**

SITE VICINITY MAP
ARCO Station 601
712 Lewelling Boulevard
San Leandro, California

PLATE

1

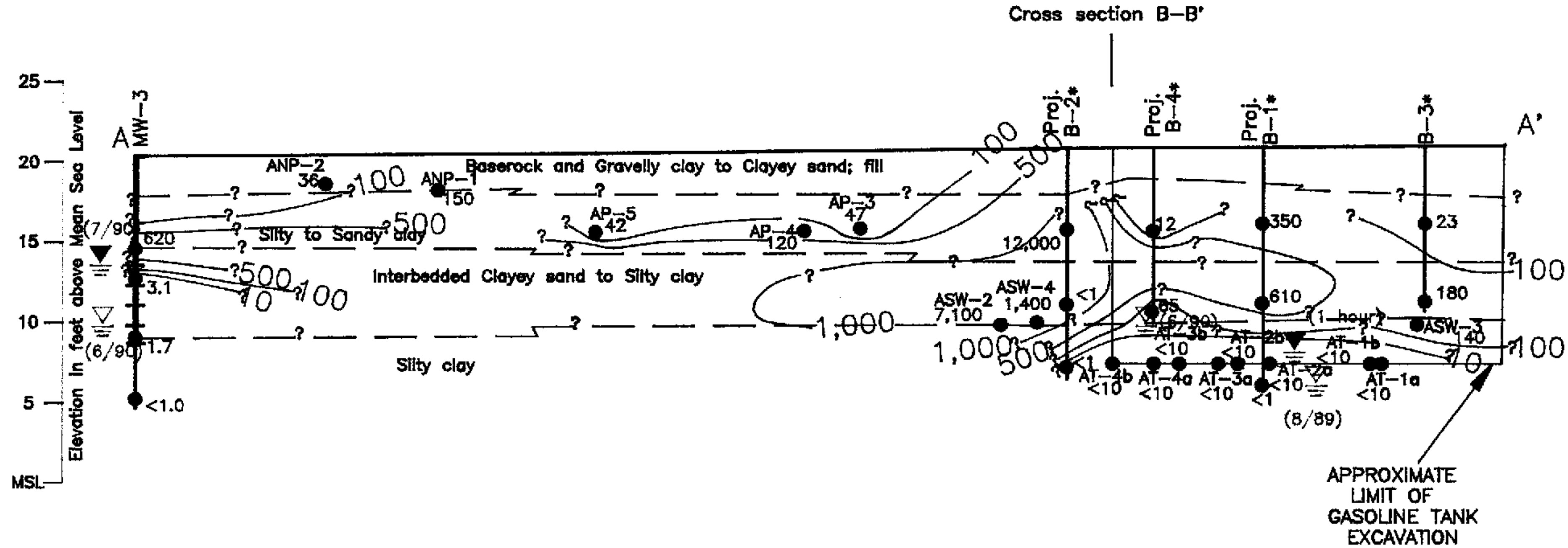


Applied GeoSystems

PROJECT 69034-4W

GENERALIZED SITE PLAN
ARCO Station 601
712 Lewelling Boulevard
San Leandro, California

PLATE 2



EXPLANATION

1,000 = Line of equal concentration of TPHg in soil

12,000 = Laboratory analyzed soil sample showing concentration of TPHg (green) in parts per million

= Well casing

= Well screen

= Boring

= Initial water level in boring

= Static water level in well

* = Boring in subsequently excavated soil

ASW–4 = Excavation sidewall soil sample

AT–4b = Excavation soil sample beneath former tank

AP–5 = Former product line trench soil sample

ANP–2 = New tank excavation soil sample

Approximate Horizontal Scale

20 10 0 20 40

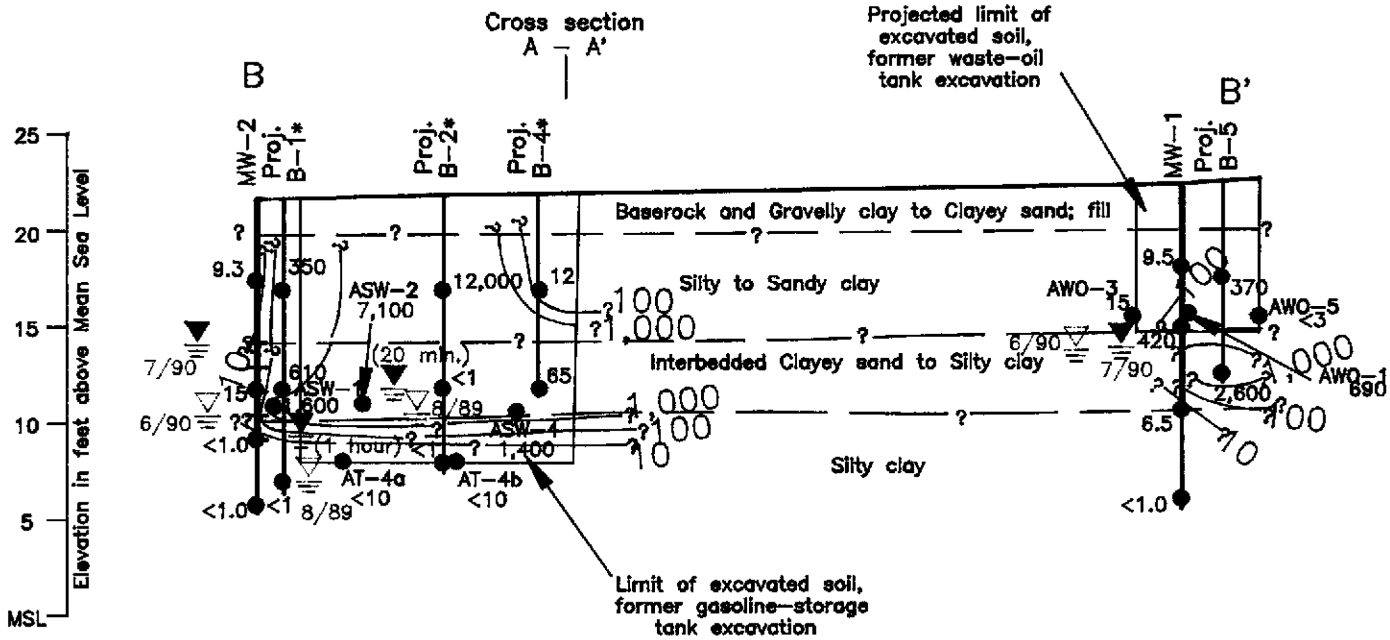
feet

Approximate Vertical Scale

10 5 0 10 20

feet

PLATE 3	GEOLOGIC CROSS SECTION A - A' ARCO Station 601 712 Lewelling Boulevard San Leandro, California	Applied GeoSystems PROJECT 69034-4W



EXPLANATION

1,000 = Line of equal concentration of TPHg in soil

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= Boring

= Initial water level in boring

= Static water level in well

* = Boring in subsequently excavated soil

ASW-4 = Excavation sidewall soil sample

AT-4b = Excavation soil sample beneath former tank

AWO-5 = Former waste-oil tank excavation soil sample

Approximate Horizontal Scale

20 10 0 20 40

feet

Approximate Vertical Scale

10 5 0 10 20

feet

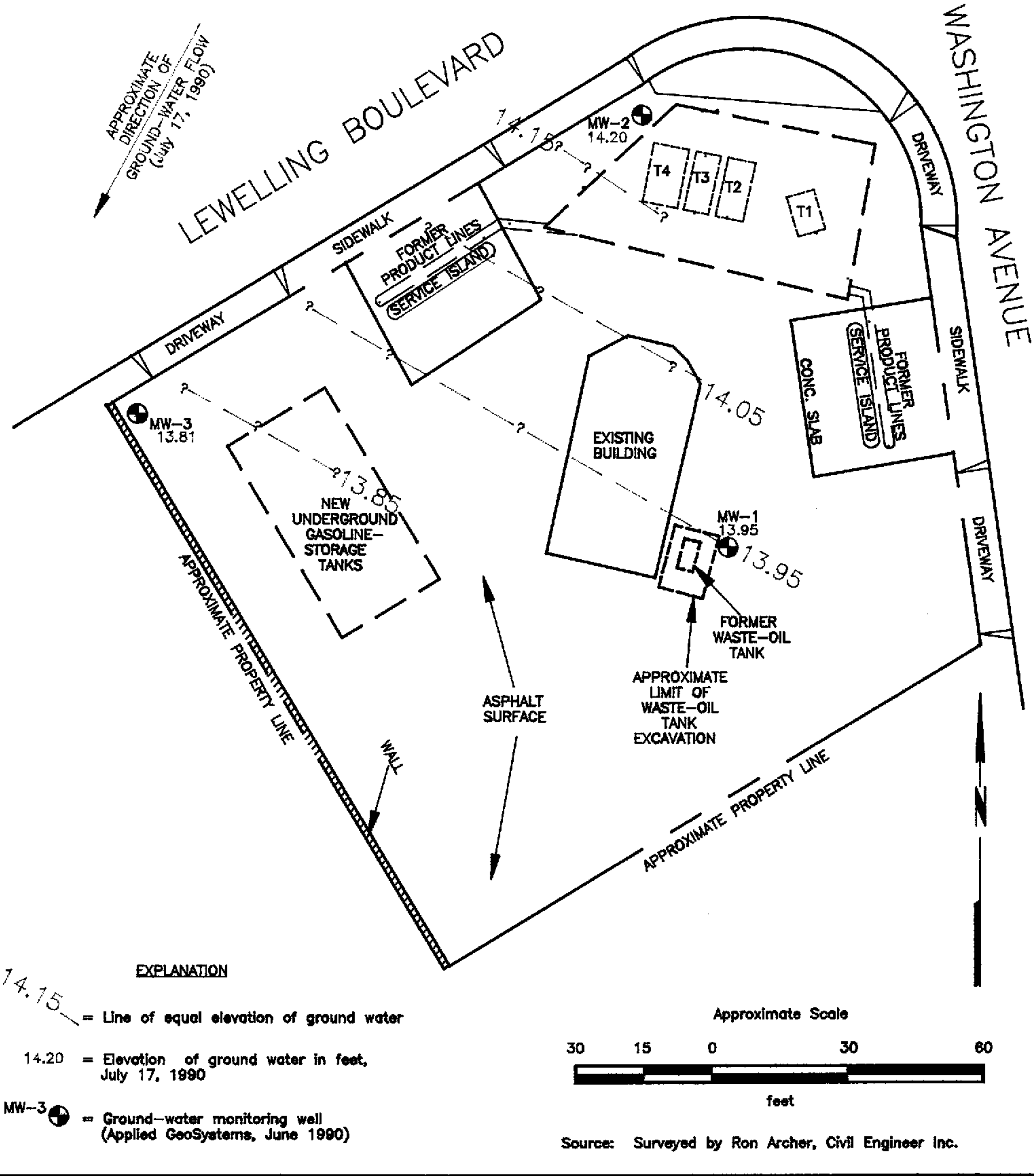
Applied GeoSystems

PROJECT 69034-4W

GEOLOGIC CROSS SECTION B-B'
ARCO Station 601
712 Lewelling Boulevard
San Leandro, California

PLATE

4



EXPLANATION

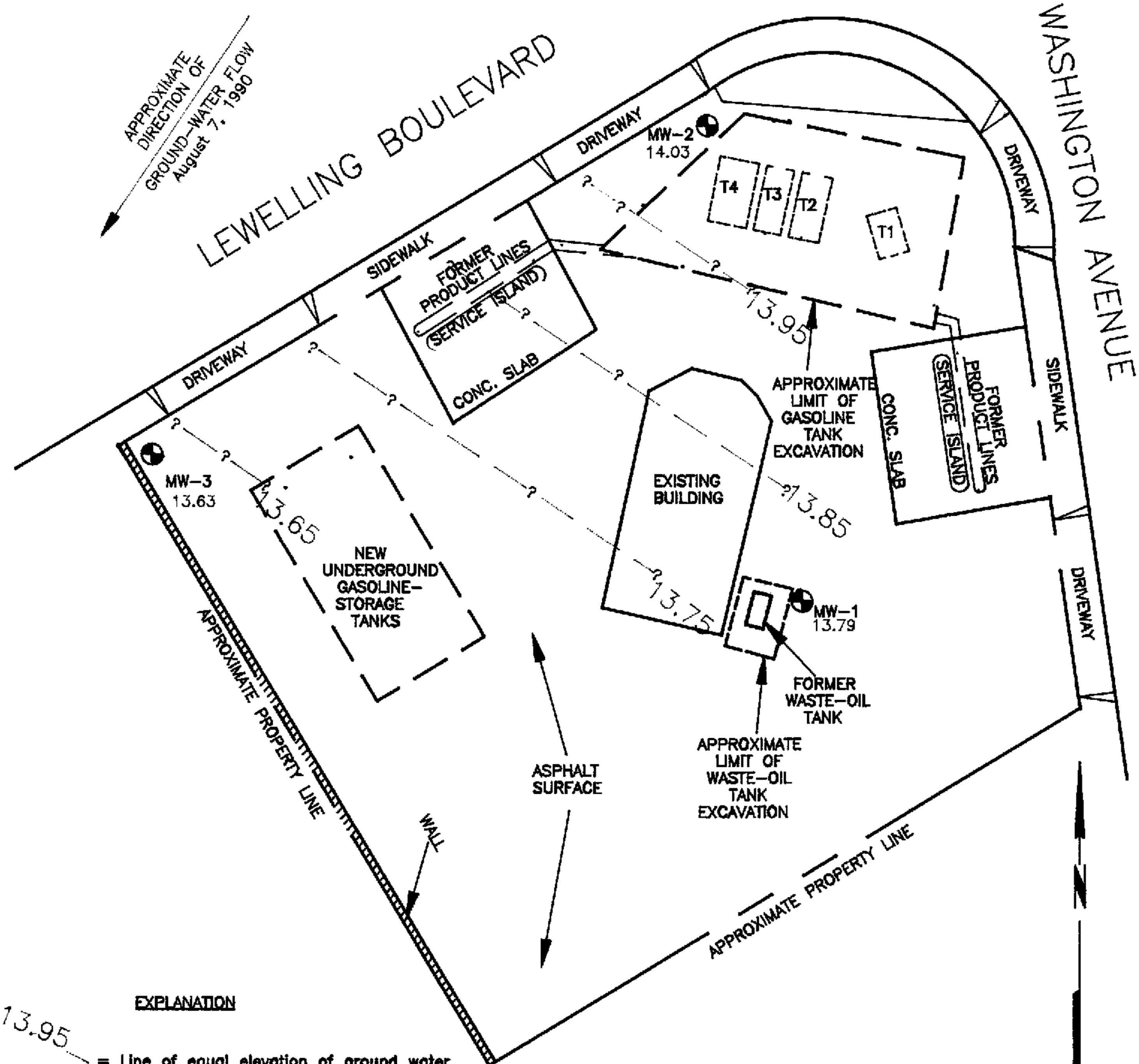
14.15 = Line of equal elevation of ground water

14.20 = Elevation of ground water in feet, July 17, 1990

MW-3 = Ground-water monitoring well (Applied GeoSystems, June 1990)

Source: Surveyed by Ron Archer, Civil Engineer Inc.

Applied GeoSystems	**GROUND-WATER GRADIENT MAP** **ARCO Station 601** **712 Lewelling Boulevard** **San Leandro, California**	**PLATE** **5**
PROJECT 69034-4W		



EXPLANATION

13.95 = Line of equal elevation of ground water

14.03 = Elevation of ground water in feet, August 7, 1990

MW-3 = Ground-water monitoring well (Applied GeoSystems, June 1990)

Approximate Scale

30 15 0 30 60

feet

Source: Surveyed by Ron Archer, Civil Engineer Inc.

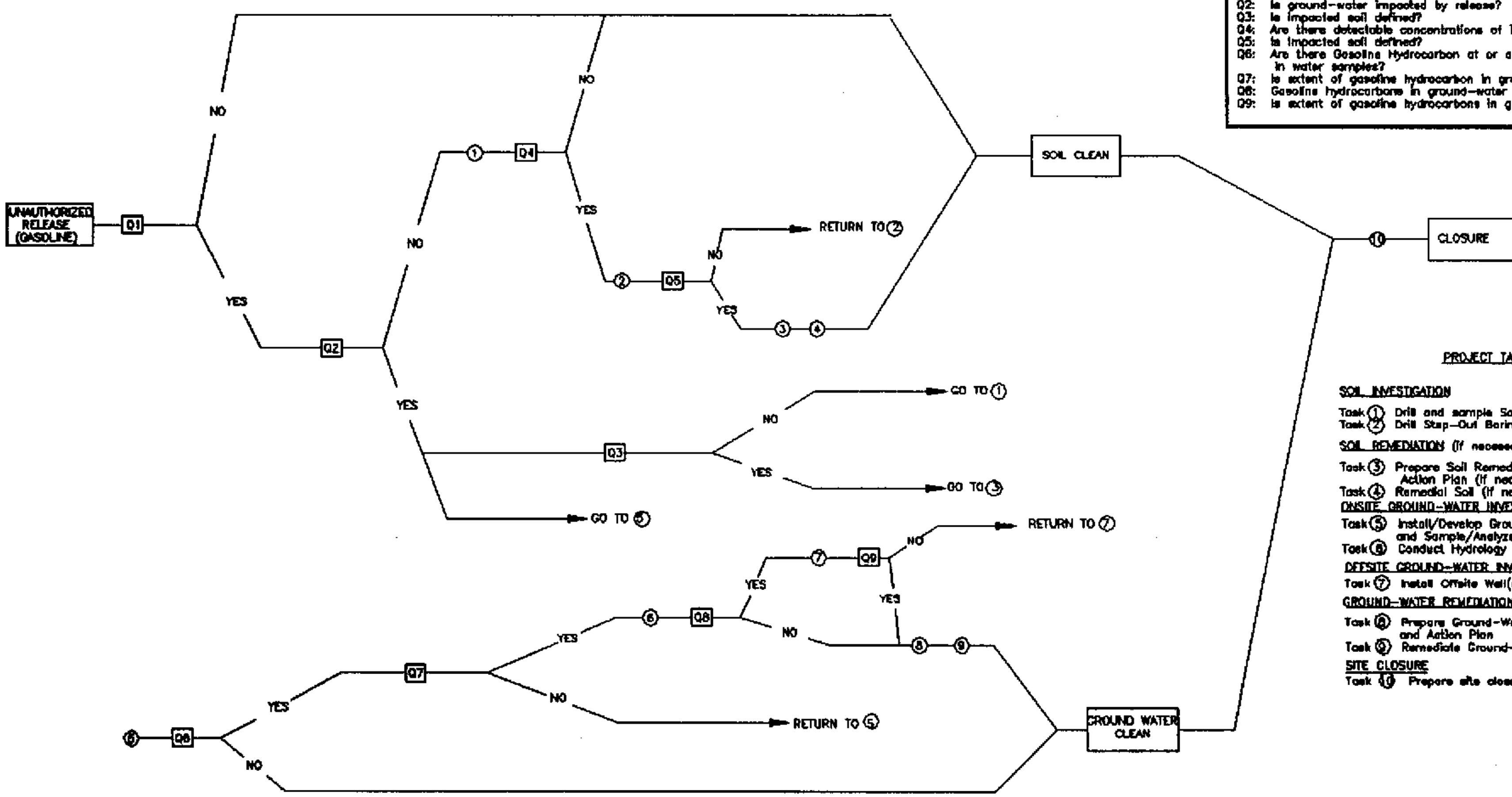
Applied GeoSystems

PROJECT 69034-4W

GROUND-WATER GRADIENT MAP
ARCO Station 601
712 Lewelling Boulevard
San Leandro, California

PLATE

6



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

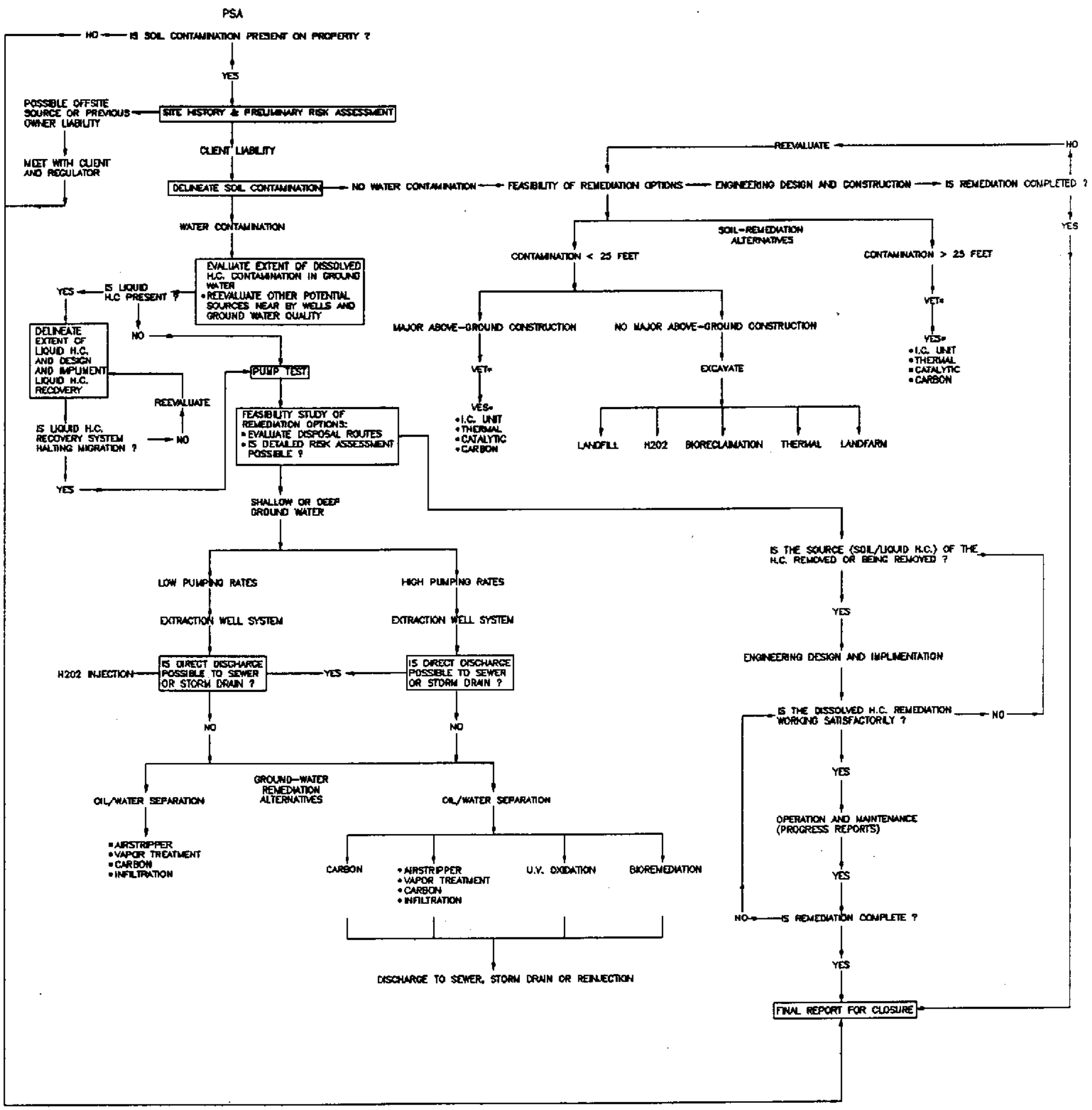
GROUND-WATER REMEDIATION (if necessary)

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 TASK DECISION TREE** **ARCO Station 601** **712 Lewelling Boulevard** **San Leandro, California**	**PLATE** **7**
PROJECT 69034-4W		



VET* = Vapor Extraction Test

VES* = Vapor Extraction System

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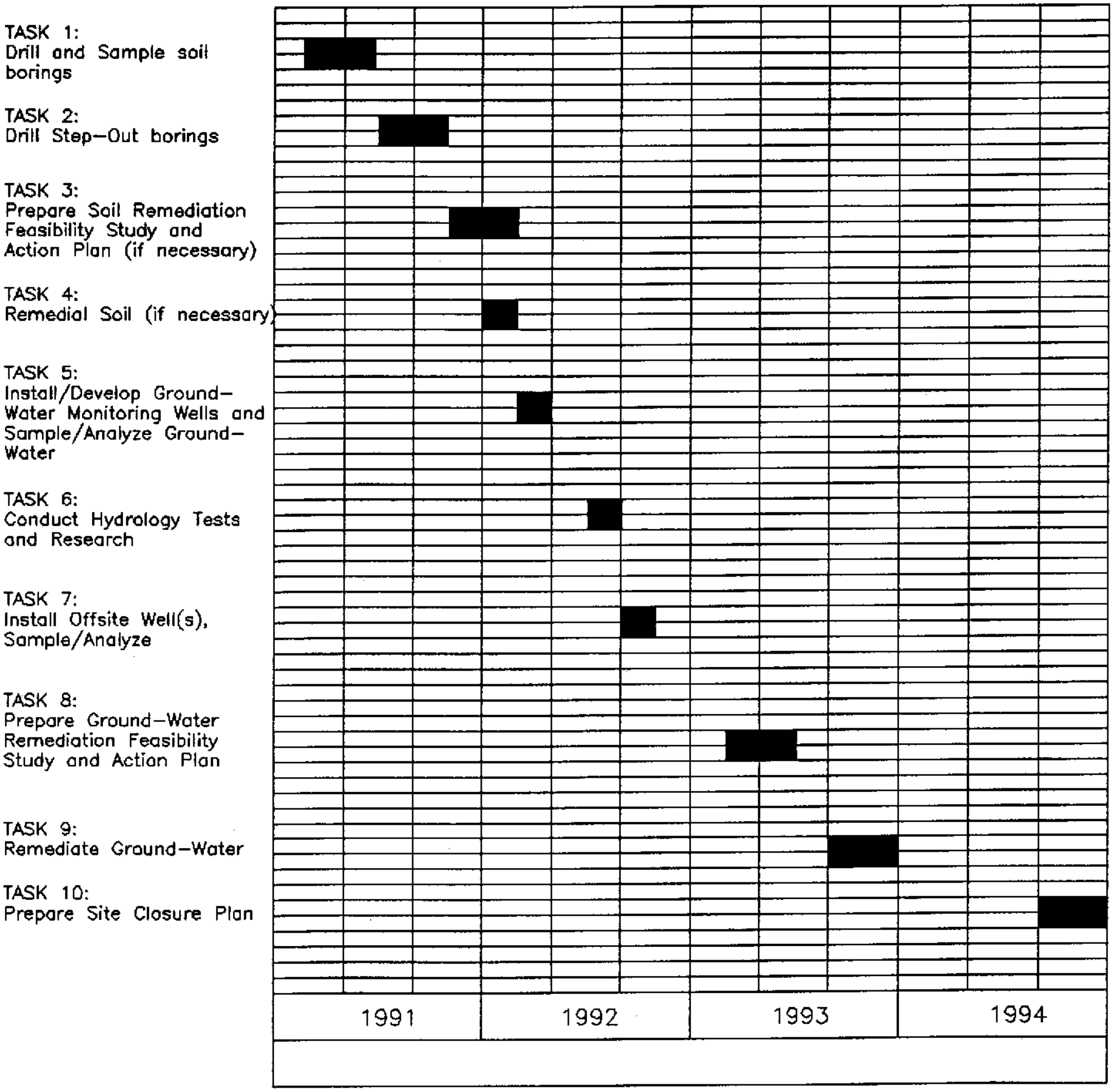
PROJECT 69034-4W

REMEDIATION OPTIONS DECISION TREE

ARCO Station 601
712 Lewelling Boulevard
San Leandro, California

PLATE 8



Applied GeoSystems

PROJECT 69034-4W

PRELIMINARY TIME SCHEDULE
ARCO Station 601
712 Lewelling Boulevard
San Leandro, California

PLATE
9

TABLE 1
LABORATORY ANALYSIS OF SOIL SAMPLES
ARCO Station 601
San Leandro, California

Sample	TPHg	TOG	B	T	E	X	VOCs
August 1989							
S-5-B1	350	NA	8.3	19	5.1	26	NA
S-10-B1	610	NA	10	37	6	48	NA
S-15-B1	<10	NA	0.007	0.011	<0.005	0.012	NA
S-5-B2	12,000	NA	60	450	110	660	NA
S-10-B2	<1	NA	0.015	0.016	<0.005	0.018	NA
S-14-B2	<1	NA	0.015	0.030	<0.005	0.035	NA
S-5-B3	23	NA	0.710	<0.05	0.40	0.034	NA
S-10-B3	180	NA	0.700	3.2	1.4	9.6	NA
S-5-B4	12	NA	0.33	0.37	<0.05	0.75	NA
S-10-B4	65	NA	1.9	2.0	0.7	4.6	NA
S-5-B5	370	4,800	2.1	3.8	0.8	2.8	brl
S-10-B5	2,600	130	10	90	21	130	

Results are in parts per million (ppm)
TPHg = total petroleum hydrocarbons as gasoline
B = benzene; T = toluene; E = ethylbenzene; X = total xylenes
VOCs = volatile organic compounds
< = Below indicated laboratory reporting limit
brl = below laboratory reporting limit for respective compounds
NA = Not Analyzed

Sample Number explanation:

S-12-B6
- B6 — Boring number
- 12 — Sample depth in feet below ground surface
- S — Soil sample

Reference: AGS, November 1989

TABLE 2
LABORATORY ANALYSIS OF SOIL SAMPLES BY GEOSTRATEGIES
ARCO Station 601
San Leandro, California

Sample Number	TPHg	TPHd	TPHo	TOG	B	T	E	X
January 1990								
AP-1	6.8	NA	NA	NA	0.13	<0.025	<0.025	0.20
AP-2	12	NA	NA	NA	0.71	0.049	0.31	0.60
AP-3	47	NA	NA	NA	1.1	2.1	0.63	5.5
AP-4	120	NA	NA	NA	5.1	10	2.8	18
AP-5	42	NA	NA	NA	1.5	3.9	0.95	14
AT-1a	<10	NA	NA	NA	0.043	0.072	0.013	0.085
AT-1b	<10	NA	NA	NA	0.014	0.035	0.0079	0.046
AT-2a	<10	NA	NA	NA	<0.005	0.0068	<0.005	<0.005
AT-2b	<10	NA	NA	NA	0.0071	<0.005	<0.005	<0.005
AT-3a	<10	NA	NA	NA	0.023	0.041	0.013	0.036
AT-3b	<10	NA	NA	NA	0.016	<0.005	<0.005	0.0077
AT-4a	<10	NA	NA	NA	0.068	0.17	<0.005	0.014
AT-4b	<10	NA	NA	NA	<0.005	0.048	<0.005	0.08
ASW-1	1,600	NA	NA	NA	36	111	50	210
ASW-2	7,100	NA	NA	NA	175	509	220	980
ASW-3	140	NA	NA	NA	3.1	3.1	3.8	15
ASW-4	1,400	NA	NA	NA	12	46	26	129
ANP-1	150	NA	NA	NA	8.1	3.9	5.8	20
ANP-2	36	NA	NA	NA	2	0.8	1.4	5.1
AWO-1	690	630	4,400	NA	<0.010	0.027	0.019	0.69
AWO-3	15	11	<50	<20	1.5	0.08	0.25	0.88
AWO-5	<3.0	<5	<50	<20	0.11	0.11	<0.03	0.10

Results are in parts per million (ppm)
TPHg = total petroleum hydrocarbons as gasoline
TPHd = Total Petroleum Hydrocarbons as diesel
TPHo = Total Petroleum Hydrocarbons as oil
TOG = Total Oil and Grease
B = benzene T = toluene E = ethylbenzene X = total xylenes
< = Below indicated laboratory reporting limit
NA = Not Analyzed

Sample Number explanation:

AP-5 = Product line soil sample
AT-4b = Former product tank number base soil sample
ASW-4 = Former product tank excavation sidewall soil sample
ANP-2 = New product tank excavation soil sample
AWO-5 = Former waste-oil tank excavation soil sample

Reference: GeoStrategies, Inc., November 1989

TABLE 3
LABORATORY ANALYSIS OF SOIL SAMPLES
ARCO Station 601
San Leandro, California

Sample Number	TPHg	TPHd	TOG	B	T	E	X	Organic Lead
June 1990								
S-4 1/2-B6	9.5	<10	190	1.4 (0.490)	0.099 (0.038)	0.25 (0.120)	1.3 (0.650)	NA
S-7 1/2-B6	420	280	130	6.0 (5.800)	27 (33.000)	8.8 (19.000)	52 (130.000)	NA
S-12-B6	6.5	<10	130	0.062 (<0.010)	0.29 (0.037)	0.10 (0.011)	0.60 (0.097)	<0.01
S-16 1/2-B6	<1.0	<10	63	<0.0050 (<0.010)	0.040 (0.015)	0.011 (<0.010)	0.069 (0.041)	NA
S-4 1/2-B7	9.3	NA	NA	0.71	0.040	0.18	0.68	NA
S-10-B7	15	NA	NA	0.99	0.71	0.50	1.3	<0.01
S-12 1/2-B7	<1.0	NA	NA	0.056	0.015	<0.0050	0.011	NA
S-16-B7	<1.0	NA	NA	0.0085	0.0071	<0.0050	0.0094	NA
S-6-B8	620	NA	NA	11	30	16	82	NA
S-9-B8	3.1	NA	NA	0.18	0.25	0.094	0.43	<0.01
S-12-B8	1.7	NA	NA	0.034	0.039	0.0098	0.046	NA
S-15 1/2-B8	<1.0	NA	NA	0.082	0.076	<0.0050	0.079	NA

Sample Number	BNAs	VOCs	Cadmium	Chromium	Lead	Zinc
S-4 1/2-B6	brl	brl	9.4	63.0	287.1	63.9
S-7 1/2-B6	2.9[a], 2.6[b]	brl	4.5	49.8	242.0	51.3
S-12-B6	brl	brl	13.2	61.2	105.1	55.0
S-16 1/2-B6	brl	brl	13.5	64.8	100.5	53.0
TTLC			100	2,500	1,000	5,000

Results are in parts per million (ppm)
< = Below indicated laboratory reporting limit
brl = below laboratory reporting limit for respective compounds
NA = Not Analyzed
TPHg = total petroleum hydrocarbons as gasoline
B = benzene, T = toluene, E = ethylbenzene, X = total xylenes
( ) = BTEX results analyzed as VOCs
BNAs = base neutral and acid extractables including polynuclear aromatics ([a] = naphthalene, [b] = 2-methylnaphthalene)
VOCs = volatile organics except for BTEX
TTLC = Total threshold limit concentration values (Title 22 of the California Administrative Code, January 1988)

See notes on Page 2 of 2.

TABLE 3
LABORATORY ANALYSIS OF SOIL SAMPLES
ARCO Station 601
San Leandro, California

Sample Number	TPHg	TPHd	TOG	B	T	E	X	Organic Lead

Sample Number explanation:
S-12-B6
- B6 — Boring number
- 12 — Sample depth in feet below ground surface
- S — Soil sample

Reference: AGS, December 1990

TABLE 4
LABORATORY ANALYSES OF GROUND-WATER SAMPLES
ARCO Station 601
San Leandro, California

Well Number	TPHg	TPHd	TOG	Benzene	Toluene	Ethyl-benzene	Total xylenes
July 1990							
MW-2	35,000	850*	<5,000	3,800 (3,200)	2,900 (2,400)	690 (270)	3,600 (2,900)
MW-3	N/A	N/A	<5,000	N/A	N/A	N/A	N/A

Well Number	BNAs	VOCs	Cadmium	Chromium	Lead	Zinc
MW-2	340[a],170[b]	39[c]	<20	50	50	120
DWAL	--	40[c]	10	50	50	5000

Results are in parts per billion (ppb)

- TPHg = total petroleum hydrocarbons as gasoline
- TPHd = total petroleum hydrocarbons as diesel (* Applied Analytical laboratories reports the chromatograph resembled gasoline and not diesel)
- TOG = total oil and grease
- ( ) BTEX results analyzed as VOCs
- BNAs = base neutral and acid extractables including polynuclear aromatics. Concentrations are below laboratory reporting limits for respective compounds except as indicated. ([a] = naphthalene, [b] = 2-methylnaphthalene)
- VOCs = volatile organics except for BTEX. Concentrations are below laboratory reporting limits for respective compounds except as indicated. ([c] = methylene chloride)
- < = Below indicated laboratory reporting limit
- brl = below laboratory reporting limit for respective compounds
- NA = Not Analyzed
- DWAL = California Department of Health Services recommended drinking water action levels (July 1990)

Reference: AGS, December 1990

TABLE 5
GROUND-WATER MONITORING DATA
ARCO Station 601
San Leandro, California

Date Well Measured	Depth of Well	Well Elevation	Depth-to-Water	Water Elevation	Product Evidence
MW-1					
07/17/90	11.20	22.98	9.03	13.95	emulsion
08/07/90	11.18	22.98	9.19	13.79	NA
MW-2					
07/17/90	12.33	22.06	7.86	14.20	odor
08/07/90	12.24	22.06	8.03	14.03	NA
MW-3					
07/17/90	11.99	20.84	7.03	13.81	sheen
08/07/90	11.98	20.84	7.21	13.63	NA

Measurements in feet.
Datum mean sea level.
Depth-to-Water measured in feet below top of casing.
NA = Not analyzed.

Reference: AGS, December 1990

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 concentration by digging approximately one to two feet into the stockpile and placing the intake probe of a field calibrated OVM against the surface of the soil; and then collecting one sample from the "high" reading area, and three samples from the "average" areas. Samples are collected by removing the top one to two feet of soil, then driving laboratory-cleaned brass sleeves into the soil. The samples are sealed in the sleeves using aluminum foil, plastic caps, and aluminized duct tape; labeled; and promptly placed in iced storage for transport to the laboratory, where compositing will be performed.

Soil Borings

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

The borings are drilled by a truck-mounted drill rig equipped with 8- or 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 soil, plastic caps, and aluminized duct tape. The samples are then be labeled, promptly placed in iced storage, and delivered to a laboratory certified by the State of California to perform the analyses requested.

One of the samples in brass sleeves not selected for laboratory 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 NTU's) 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.