A RESNA Company

RESNA
Working To Restore Nature

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TRANSMITTAL

TO: MR RAVI ARULANANTHAN
ACHCSA
80 SWAN WAY, ROOM 200
OAKLAND, CA 94621

DATE: 9/3/91
PROJECT NUMBER: 60006.02
SUBJECT: CHECK FOR REVIEW FEES

FROM: JOEL COFFMAN
TITLE: PROJECT GEOLOGIST

WE ARE SENDING YOU [XX] Attached [ ] Under separate cover via ______ the following items:

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

[ ] Letters [ ] Change Orders [XX] CHECK #312 $500.00

COPIES	DATED	NO.	DESCRIPTION

THESE ARE TRANSMITTED as checked below:

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

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REMARKS:
ENCLOSED FIND A CHECK IN THE AMOUNT OF $500 FOR REVIEW AND OVERSIGHT OF ENVIRONMENTAL REPORTS AND WORK AT ARCO STATION 6041, DUBLIN, CA.

Copies: 1 to AGS project file no. 60006.02

SAN JOSE READER'S FILE

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

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Talked to Joel Coffman. Plan approved. Will inform me 48hrs. before well installation.
Ravi 8/28/91

WORK PLAN
for
SUBSURFACE INVESTIGATIONS AND REMEDIATION
at
ARCO Station 6041
7249 Village Parkway
Dublin, California

60006.02

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

8/22/91

by
RESNA

Also called Kyle Christie and left a phone message. Called Chuck Carmel and left a message on his voice mail (approved plan).

Joel Coffman
Project Geologist

Greg Barclay
General Manager

Joan E. Tiernan, Ph.D., P.E.
Engineering Manager
No. 044600

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

August 22, 1991

TABLE OF CONTENTS

PLATES

TABLES

APPENDICES

A RESNA Company

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WORK PLAN
for
SUBSURFACE INVESTIGATIONS AND REMEDIATION
at
ARCO Station 6041
7249 Village Parkway
Dublin, California
for
ARCO Products Company

INTRODUCTION

This Work Plan summarizes work previously performed by RESNA and others, and describes the project tasks proposed to evaluate the presence and delineate the lateral and vertical extent of gasoline hydrocarbons in the soil and ground water at the subject site. This work plan was initiated after an unauthorized release of gasoline was discovered at the site. On September 25, 1990, due to the fuel pump failure beneath one of the service island pumps, approximately 10 gallons of fuel was spilled on the ground beneath this pump in the southeastern part of the site. ARCO Products Company (ARCO) requested that RESNA prepare this work plan for submittal to the Regional Water Quality Control Board (RWQCB) and the Alameda County Health Care Services Agency (ACHCSA).

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 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 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); and
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 RESNA's Field Protocol in Appendix A and 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 and ACHCSA for their review and approval prior to continuing work at the site.

SITE DESCRIPTION AND BACKGROUND

ARCO Station 6041 is located at the northern corner of the intersection of Village Parkway and Amador Valley Boulevard in Dublin, California. The location is shown on Plate 1, Site Vicinity Map. Pertinent site features include four service islands, a station building, four underground gasoline-storage tanks (USTs) in a pit in the southern part of the site, and the former waste-oil tank pit adjacent to the northern wall of the station building in the northern part of the site. Pertinent site features are shown on Plate 2, Generalized Site Plan.

REGIONAL AND LOCAL HYDROGEOLOGY

ARCO Station 6041 is located in the northwestern end 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. In the vicinity of the site the valley floor slopes gently to the south-southeast. Elevation of the site is approximately 335 feet. Soils in the vicinity of the subject site are mapped as holocene alluvium that consists of unconsolidated, moderately to poorly sorted silt and clay rich in organic material interfingered with and graded into coarser grained stream deposits toward higher elevations (E.J. Helley, K.R. Lajoie, W.E. Spangle, and M.L. Blair; 1979). Holocene alluvium (10 to 50 feet thick) overlies pleistocene alluvium consisting of weekly consolidated poorly sorted, irregular interbedded clay, silt, sand and gravel, and older sedimentary deposits. Calaveras Fault is approximately 1/2-mile west of the site.

The Livermore Valley ground-water basin is divided into subbasins 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. The subject site is located within the Dublin ground-water subbasin. The ground water has been reported in this area to be at the depth of about 40 to 60 feet. Ground-water gradient is toward the south-southeast (ACFC&WCD, Zone 7; 1991). The principal streams in the vicinity of the site are Alamo Canal which flows 0.6 mile southeast of the site and Dublin Creek which connects with Alamo Canal 0.6 mile south of the site.

PREVIOUS WORK

June 1990

On June 6 and 7, 1990, one 550-gallon waste-oil tank of single wall steel construction was excavated and removed from its location adjacent to the northern wall of the station building at the site. A RESNA geologist examined the outer surface of the tank for signs of leakage, holes, pitting, and areas of weakness. The tank appeared to be in very good condition; the geologist observed light localized rusting on the surface of the tank, but no pitting, holes or cracks were observed. No signs of overfill staining were observed on the top and sides of the tank (Applied GeoSystems, September, 1990). Information supplied by the station manager indicated that the tank was at least 13 years old.

Soil excavated from the tank pit was screened for evidence of volatile hydrocarbons compounds, both visually and with a portable Organic Vapor Meter (OVM). Initial random screening of backfill material excavated from around the tank yielded OVM readings ranging from nondetectable to 0.8 parts per million (ppm). Upon removal of the tank, random grab samples of soil excavated from tank pit cavity yielded OVM readings ranging from nondetectable to 8.5 ppm. Excavation proceeded beneath the former tank location to a final depth of approximately 10-1/2 feet. At the limits of the excavation, random grab samples yielded nondetectable readings from the north, south, east and west walls and an OVM reading of 3.25 ppm from the center of the tank pit. No subjective evidence of hydrocarbons such as product odor or soil discoloration was noted in the backfill material or native soil during the excavation process.

Ten soil samples were collected from the tank pit excavation. Two samples were collected from each of the four sidewalls of the tank pit, and two samples were collected from the center of the tank pit floor at the limits of the excavation. The samples locations are shown on Plate 3, Tank Pit Sampling Locations. The samples were divided into two sets, A and B, each set consisting of five samples; one from each of the sidewalls and one from the floor of the tank pit. The samples in set A were analyzed for total oil and grease (TOG) and halogenated volatile organic compounds (HVOCs). The samples in set B were analyzed for total petroleum hydrocarbons as gasoline (TPHg), total petroleum hydrocarbons as diesel (TPHd), and the gasoline constituents benzene, toluene, ethylbenzene, and total xylenes (BTEX). Four soil samples for compositing and laboratory analysis were collected from the soil stockpile. The analysis of the soil samples collected from the waste-oil tank pit reported nondetectable levels of TOG, HVOCs, TPHg, TPHd, and BTEX. Results of laboratory analysis of the composite sample collected from the stockpiled soil indicated TOG at 110 ppm, TPHd at 180 ppm, TPHg at 10 ppm, total xylene at 0.25 ppm, and nondetectable concentrations of organic lead, benzene, toluene and ethylbenzene. Soil sample analytical results are shown in Table 1, Analytical Results of Soil Samples from Waste-Oil Tank Pit. Approximately 15 to 20 cubic yards of soil were excavated from the tank pit. According to information obtained from ARCO the soil stockpile was removed from the site by Dillard Trucking, Inc. of Hayward, California and admitted to Chem-Waste Management's facility in Kettleman City on June 12, 1990. On the basis of field observation and the results of analysis of tank pit soil samples RESNA concluded that no further excavation in the vicinity of the former waste-oil tank was necessary.

<u>September 1990</u>

On September 26, 1990, a RESNA geologist collected a soil sample at a reported fuel spill beneath a dispenser pump on the site. The OVM reading for the pea gravel sample collected from the depth of ½-foot beneath the pump, where the spillage occurred was 750 ppm. Tom Hathcox of Dogherty Regional Fire Department estimated that approximately 10 gallons of fuel spilled on the ground.

PROJECT TASKS

RESNA proposes the following project Tasks 1 through 10 listed below as a method of approach to work to evaluate the presence and 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 RESNA Field Protocol in Appendix A. Plate 4, Project Tasks Decision Tree for Tasks 1 through 10, graphically presents RESNA'S investigative site approach. The tasks shown in Plate 4 are discussed in detail below. A Remediation Options Decision Tree (Plate 5) 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 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 constituents BTEX and TPHg, using modified Environmental Protection Agency (EPA) methods 8020 and 5030/8015, 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 gasoline 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 5 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

On-site ground-water monitoring wells will be installed, developed, and sampled to delineate the lateral and vertical extent of gasoline 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 above at a State-certified laboratory.

TASK 6

Hydrogeologic tests and research will be performed as necessary to evaluate the potential migration of gasoline 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 gasoline 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 gasoline 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 5 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 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. RESNA 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 6, Preliminary Time Schedule.

PROJECT STAFF

Dr. Joan E. Tiernan, Ph.D., a Registered Civil Engineer (C.E. 044600) 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, Project

Geologist, will be responsible for the day-to-day field and office operations of the project. RESNA employs a staff of geologists, engineers and technicians who will assist with the project.

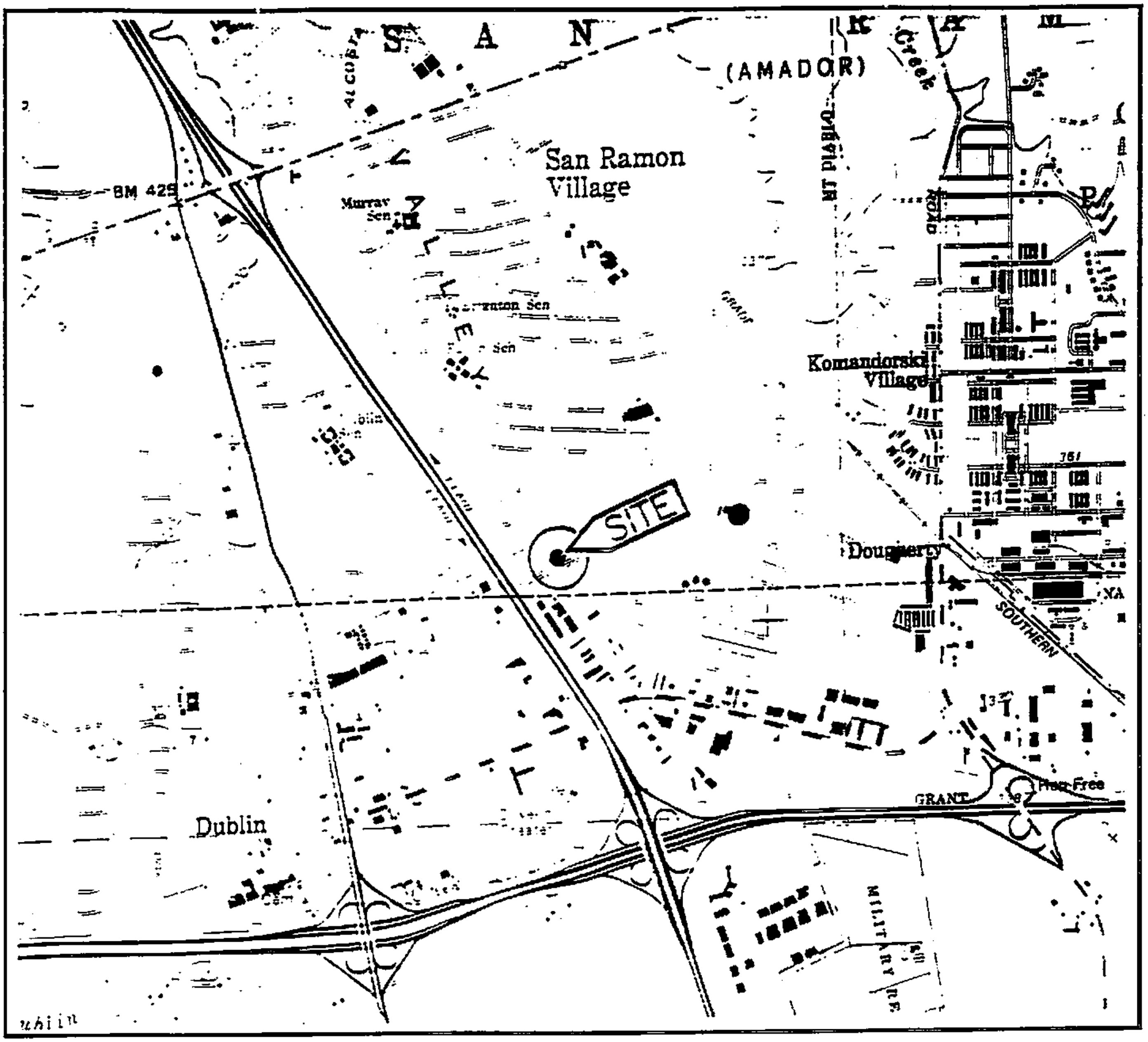
REFERENCES

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

Applied GeoSystems. September 19, 1990. Letter Report Limited Environmental Related to the Removal of Waste-Oil Tank at ARCO Station 6041, 7249 Village Parkway, Dublin, California. RESNA Report No. 60006-1.

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

Helley E.J., 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.



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

Approximate Scale

2000 1000 0 2000 4000

feet

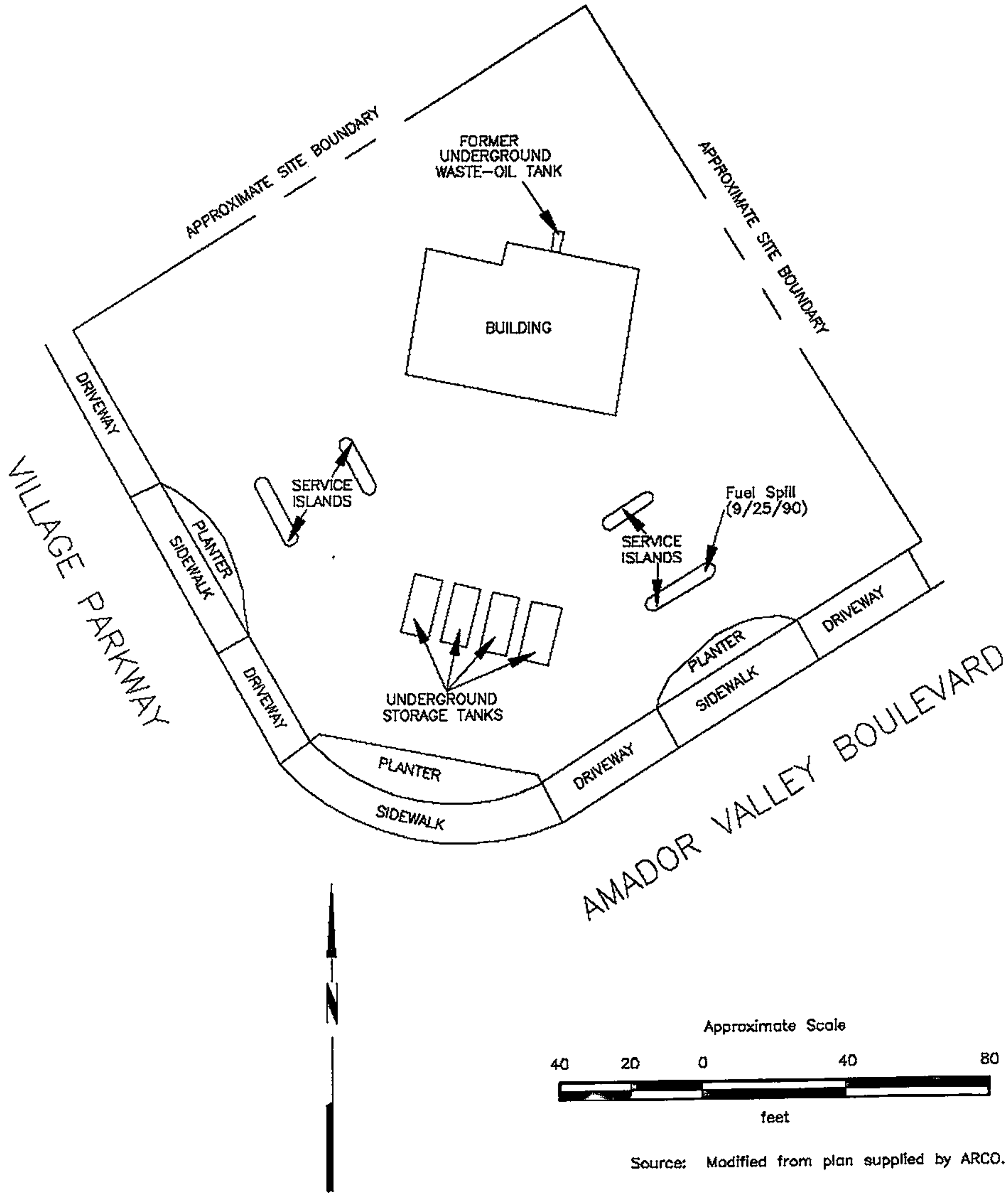
Applied GeoSystems

PROJECT 60006.02

SITE VICINITY MAP
ARCO Service Station 6041
7249 Village Parkway
Dublin, California

PLATE

1



Source: Modified from plan supplied by ARCO.

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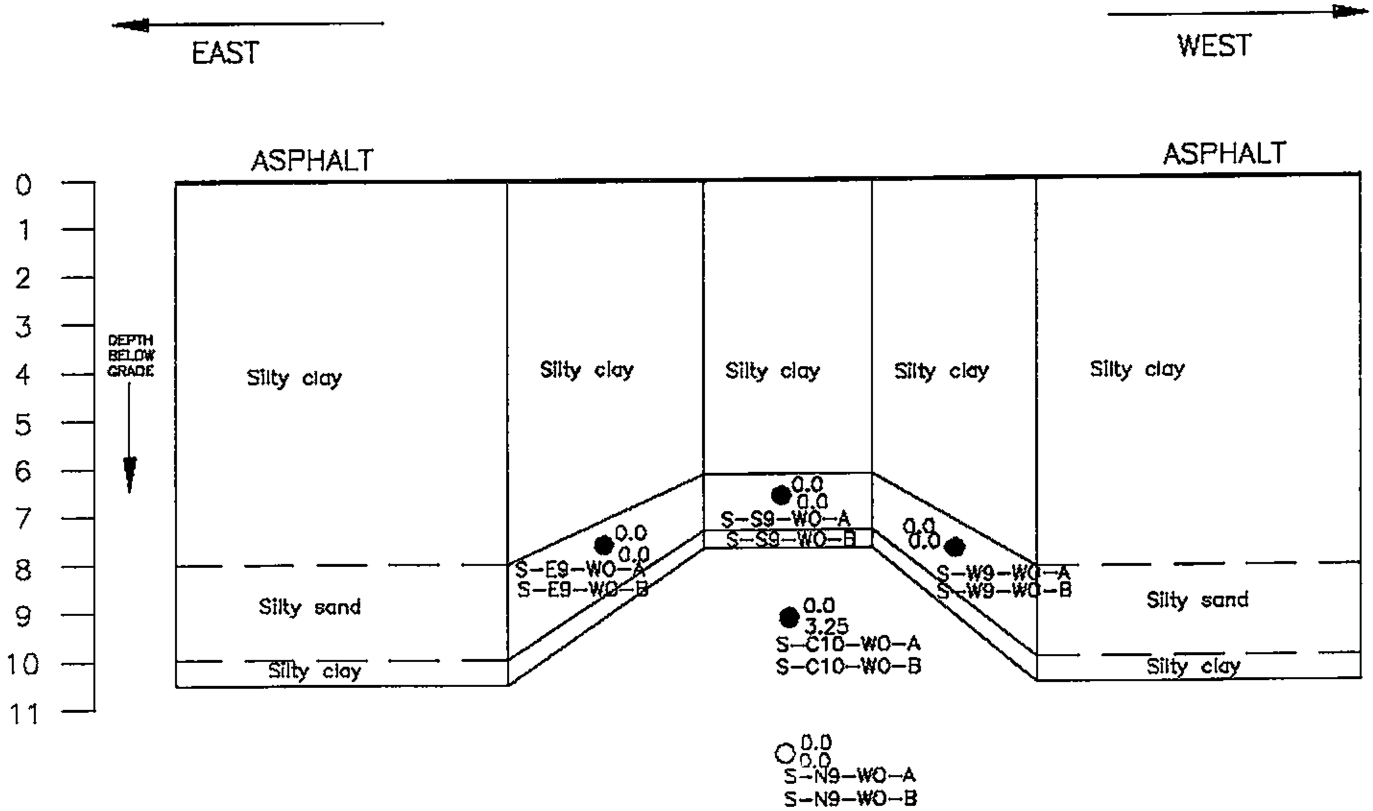
PROJECT 60006.02

GENERALIZED SITE PLAN
ARCO Service Station 6041
7249 Village Parkway
Dublin, California

PLATE 2



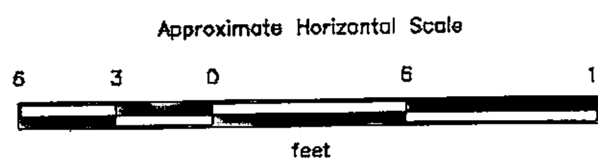
SIDE VIEW

EXPLANATION

● = Soil sample
S-S9-WO-A (Applied GeoSystems, June 1990)

0.0 = Laboratory results (TPHg, TOG, BTEX) in ppm

3.5 = OVM reading in ppm



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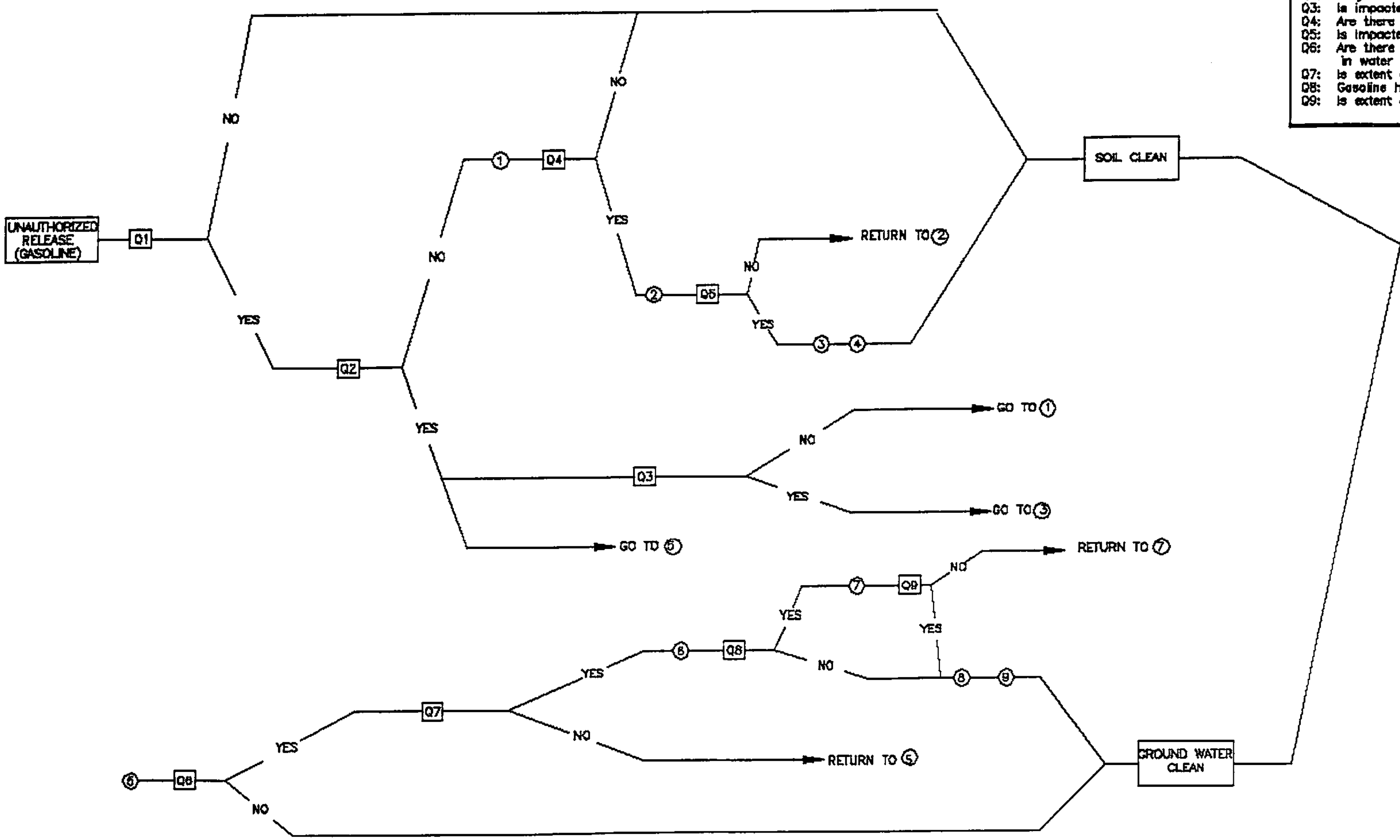
PROJECT **60006.02**

TANK PIT SAMPLING LOCATIONS
ARCO Service Station 6041
7249 Village Parkway
Dublin, California

PLATE

3



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

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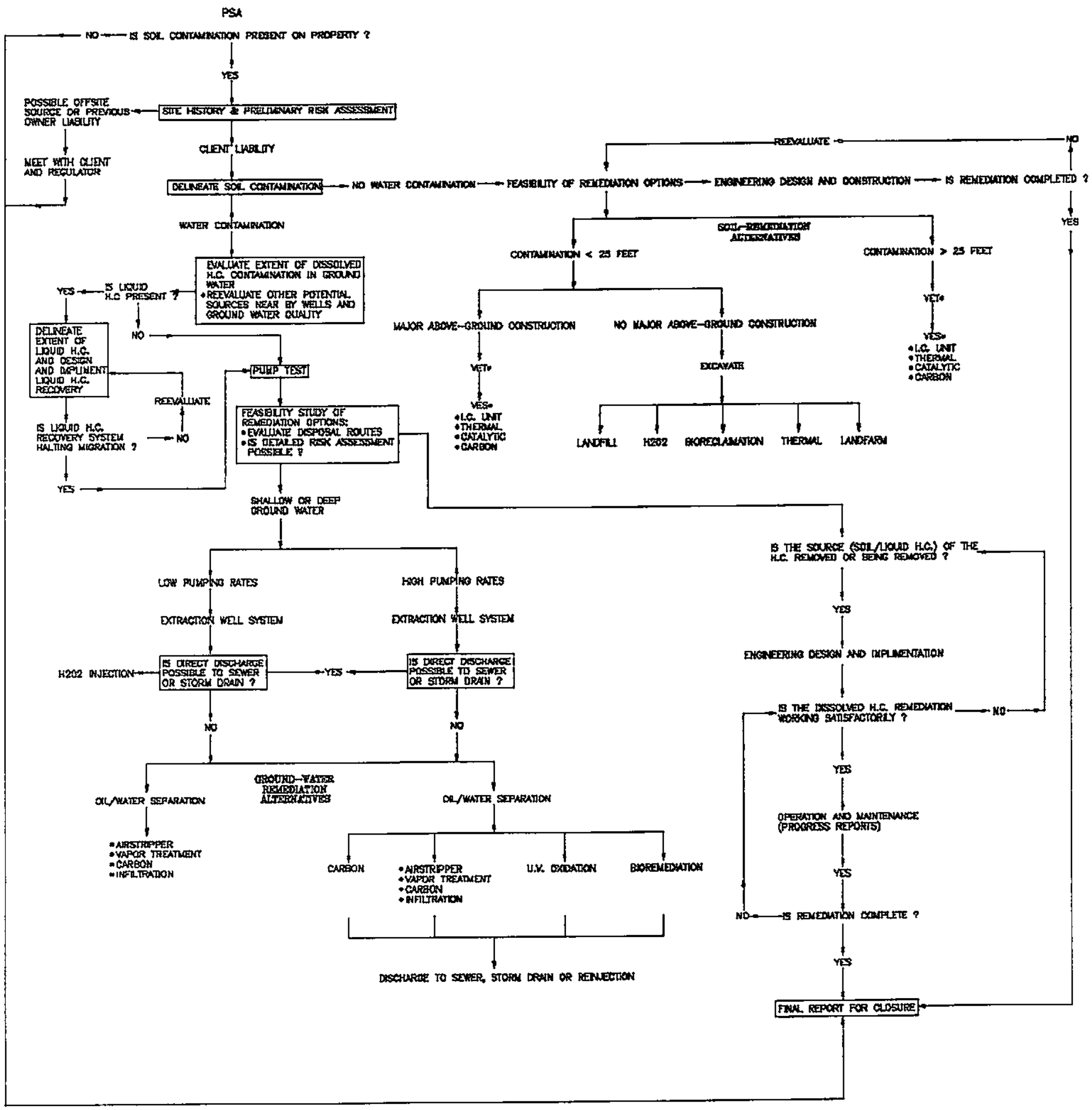
PROJECT 60006.02

PROJECT TASK DECISION TREE
ARCO Service Station 6041
7249 Village Parkway
Dublin, California

PLATE 4



VET* = Vapor Extraction Test

VES* = Vapor Extraction System

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PROJECT 60006.02

REMEDIATION OPTIONS DECISION TREE

ARCO Service Station 6041
7249 Village Parkway
Dublin, California

PLATE 5

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

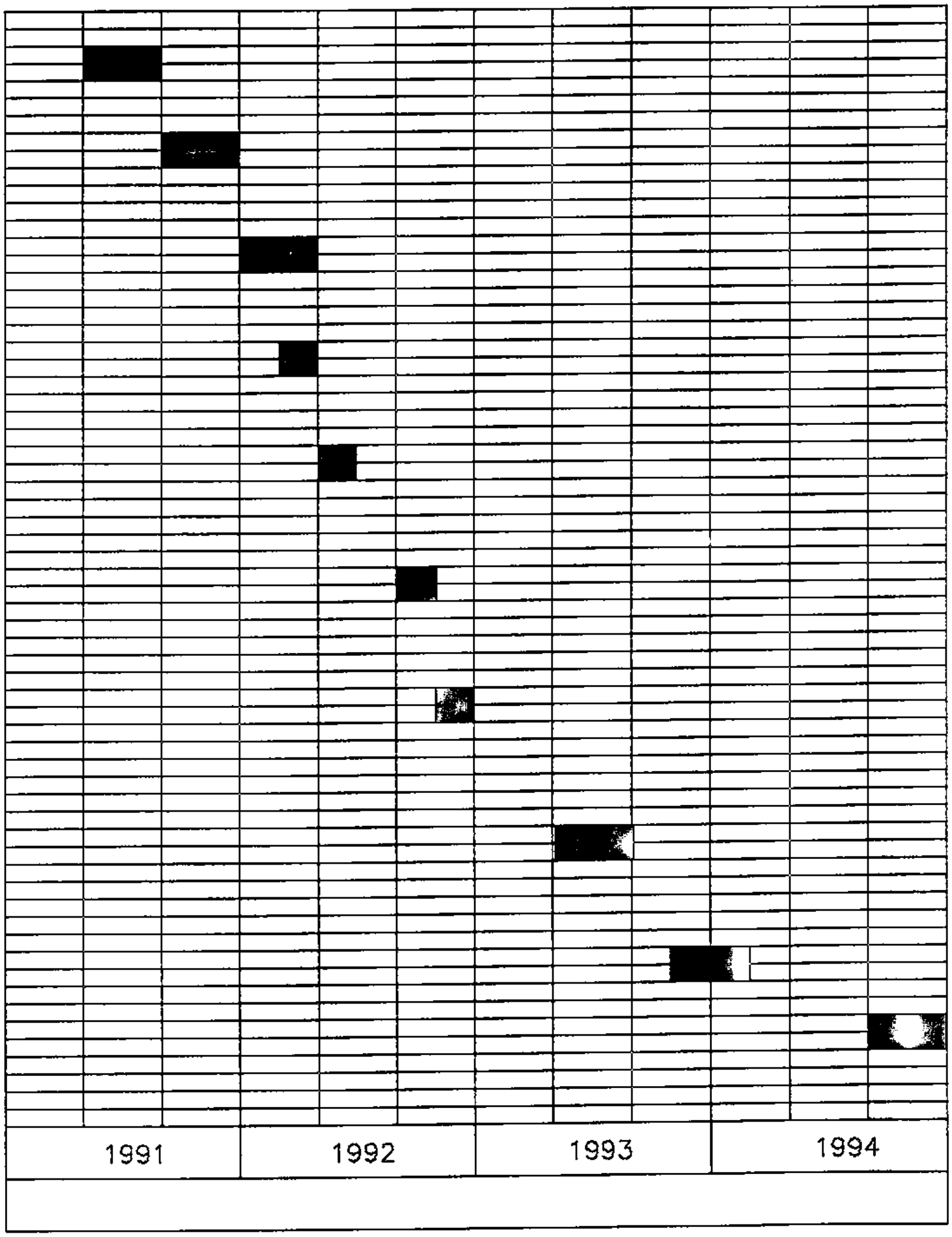
TASK 6:
Conduct Hydrology Tests and Research

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 **60006.02**

PRELIMINARY TIME SCHEDULE
ARCO Service Station 6041
7249 Village Parkway
Dublin, California

PLATE
6

TABLE 1
ANALYTICAL RESULTS OF SOIL SAMPLES
FROM WASTE-OIL TANK PIT
ARCO Station 6041
7249 Village Parkway
Dublin, California

Sample	TPHg	TPHd	B	T	E	X	TOG	HVOCs	OL
S-N9-WOB	<2.0	<10	<0.050	<0.050	<0.050	<0.050	NA	NA	NA
S-S9-WOB	<2.0	<10	<0.050	<0.050	<0.050	<0.050	NA	NA	NA
S-E9-WOB	<2.0	<10	<0.050	<0.050	<0.050	<0.050	NA	NA	NA
S-W9-WOB	<2.0	<10	<0.050	<0.050	<0.050	<0.050	NA	NA	NA
S-C10-WOB	<2.0	<10	<0.050	<0.050	<0.050	<0.050	NA	NA	NA
S-N9-WOA	NA	NA	NA	NA	NA	NA	<50	<0.005	NA
S-S9-WOA	NA	NA	NA	NA	NA	NA	<50	<0.005	NA
S-E9-WOA	NA	NA	NA	NA	NA	NA	<50	<0.005	NA
S-W9-WOA	NA	NA	NA	NA	NA	NA	<50	<0.005	NA
S-C10-WOA	NA	NA	NA	NA	NA	NA	<50	<0.005	NA
S-0607-SP	10	180	<0.050	<0.050	<0.050	0.25	110	NA	<0.08
MDL	2.0	10	0.050	0.050	0.050	0.050	50	0.005	0.08

Results are in parts per million (ppm).
TPHg: Total petroleum hydrocarbons as gasoline.
TPHd: Total petroleum hydrocarbons as diesel.
B: Benzene, T: Toluene, E: Ethylbenzene, X: Total Xylene Isomers.
TOG: Total oil and grease.
HVOCs: Halogenated volatile organic compounds.
OL: Organic lead.
<: Below the reporting limits of the analytical method.
NA: Not analyzed.
MDL: Method detection limit

APPENDIX A

FIELD PROTOCOL

FIELD PROTOCOL

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

Site Safety Plan

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

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". Stockpiled soil is placed on plastic and covered with plastic, and remains the responsibility of the client. 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 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.