A·C·C
ENVIRONMENTAL
CONSULTANTS

March 29, 1995

Mr. Steve Chrissanthos
Alameda Cellars
1702 Lincoln Avenue
Alameda, CA 94501

RE: Interim Remedial Work Plan
2425 Encinal Avenue,
Alameda, California

Dear Mr. Chrissanthos:

This Remedial Work Plan has been prepared by ACC Environmental Consultants Inc. (ACC) for Alameda Cellars for remedial activity to be performed at the above-referenced site. The document describes the selected remediation method to remove petroleum hydrocarbons identified in soil and groundwater and the interim groundwater remediation system design for the site. The primary purpose of this document is to competitively bid this scope of remedial work for purposes of reimbursement by the State of California Leaking Underground Storage Tank Cleanup Fund.

If you have any comments regarding this report, please call me at (510) 522-8188.

Sincerely,

Misty C. Kaltreider
Project Geologist

cc: Susan Bayne Churchill, Principal
Juliet Shin, Alameda County

RECEIVED
MAR 31 1995
By________

A·C·C ENVIRONMENTAL CONSULTANTS

REMEDIAL WORK PLAN
at
2425 ENCINAL AVENUE
ALAMEDA, CALIFORNIA

March 1995
Job Number 94-6039-2.4

Prepared for:

Mr. Steve Chrissanthos
Alameda Cellars
1702 Lincoln Avenue
Alameda, California

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By

Prepared by:

Misty C. Kaltreider
Project Geologist

Reviewed by:

David R. DeMent, RG #5874
Senior Project Geologist

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REMEDIAL WORK PLAN
at
2425 Encinal Avenue
Alameda, California

1.0 INTRODUCTION

On behalf of Alameda Cellars, ACC Environmental Consultants, Inc. (ACC) has prepared this Remedial Work Plan (RWP) for the above-referenced site (Fiqure 1). The document describes the selected remediation methods to remove petroleum hydrocarbons identified in groundwater and soil. This plan is designed to be a guidance document but may be appended or modified in the future based on new information or observations made in the field. Some assumptions are incorporated into the Remedial Action Plan and may require modification based on future data. Any modification to this plan will be done with the approval of Alameda Cellars and the Alameda County Environmental Health Department - Environmental Health Protection Division.

The site is located at the north corner of Encinal Avenue and Park Avenue in Alameda, California (Figure 1), and is currently occupied by Alameda Cellars.

1.1 Background

The site is presently occupied by Alameda Cellars, a commercial liquor store, located on the north corner of Park Avenue and Encinal Avenue (Figure 2). On March of 1990, two 10,000-gallon gasoline tanks were removed from the above-referenced site. According to a ACHCSA letter, dated October 7, 1992, analysis of the soil samples collected from beneath the two gasoline tanks indicated up to 1,500 parts per million (ppm) of Total Petroleum Hydrocarbons as gasoline (TPHg). In addition, groundwater was observed in the tank pit during excavation, but no groundwater samples were collected.

1.2 Initial Site Investigation

Between December 23, 1992 and January 6, 1993, ACC Environmental Consultants, Inc, (ACC) performed an environmental subsurface investigation (Appendix A). Five soil borings were drilled onsite, three of which were converted to groundwater monitoring wells. The screen interval of well MW-2 was damaged during well development, and therefore was properly destroyed and replaced by well MW-2a. A maximum of 1,365 ppm TPHg was detected in soil at a depth of 10 feet below ground surface (bgs) in boring B-2. Benzene was detected at a concentration of 18.9 ppm in the same sample. Initial groundwater sampling from January 9, 1993, indicated up to 5,680 ppb TPHg in well MW-2a, and 1,560 ppb benzene in well MW-1.

1.3 Additional Site Investigations

An additional investigation was conducted on May 11, 1993 (Appendix C). Nine exploratory boring (S1 through S9) were drilled to evaluate the extent of petroleum hydrocarbons in the soil and groundwater onsite and offsite along Park Avenue (Appendix B). Trace concentrations of petroleum hydrocarbons were detected in soil borings S5 and S6 only, collected from just above the soil/water interface or approximately 10 feet bgs; TPHg was found in boring S6 at a concentration of 8.7 ppm, and benzene (0.13 ppm) was detected in boring S5. Hydrocarbon-impacted soil appeared to be primarily concentrated to the area around the former tank excavation and dispenser island at a depth of approximately 4 to 10 feet below bgs.

Laboratory analysis of "grab" groundwater samples collected from borings S1, S4, S5, and S6 indicated detectable levels of TPHg with BTEX constituents. The highest concentration of TPHg was reported in sample S6-H20 at 18,000 ppb. Concentrations of benzene at 230 and 200 ppb were reported in samples S4-H20 and S1-H20, respectively. Other BTEX compounds were reported in samples S1-H20, S4-H20, and S5-H20 below the maximum contaminant levels (MCLs) established by Title 22 of the California Code of Regulations or action levels recommended by the California Department of Health Services.

ACC installed additional wells (MW-4 through MW-6) in December 1993. Laboratory analysis of soil samples collected between 5.5 and 11 feet bgs indicated below detectable levels of gasoline hydrocarbon constituents. Analysis of water samples collected from the newly installed wells showed dissolved gasoline compounds (580 ppb TPHg) in well MW-4 only. Analytical results of water from wells MW-5 and MW-6 suggest delineation of gasoline hydrocarbons to the northeast and southwest of the former tank excavation. Soil and groundwater results are summarized in Tables 1 and 2.

1.4 Groundwater Monitoring and Sampling

A periodic monitoring program was initiated by ACC in January 1993. Depth to water was measured in each well on a monthly basis, and groundwater samples from these wells were collected quarterly. Free-phase hydrocarbons or sheen has not been observed in the site wells. Groundwater is interpreted to flow toward the west-southwest, toward Encinal Avenue with an average gradient of approximately 0.01 foot/foot.

The most recent groundwater sampling results from onsite wells indicated detectable concentrations of petroleum hydrocarbons in wells MW-1 through MW-4; the highest concentrations were noted in MW-1 at 18,000 ppb TPH-g and 570 ppb benzene, located directly downgradient of the former UST pit (Table 2). Since January 1993, varying concentrations of hydrocarbons in wells MW-1 through MW-4 appear to be a result of residual hydrocarbons from former excavations that continue to be "washed out" of the soil by fluctuating groundwater levels.

TABLE 1
SOIL ANALYTICAL RESULTS
Alameda Cellars
2425 Encinal Avenue, Alameda, California
(page 1 of 1)

Sample Number	Date Sampled	TPHg	Benzene	Toluene	Ethyl-benzene	Total Xylenes
MW1/B1-10.5'	12/23/92	314	4.3	3.8	6.8	11.6
MW1/B1-16'	12/23/92	<0.05	<0.0005	<0.0005	<0.0005	<0.0005
B2-10'	12/23/92	1,365	18.9	37.0	28.4	56.0
B2-14'	12/23/92	26	0.7	0.5	1.2	2.3
MW2/B3-5.5'	12/23/92	121	0.8	0.7	4.6	10.2
MW2/B3-10.5'	12/23/92	<0.05	<0.0005	<0.0005	<0.0005	<0.0005
MW3/B4-5.5'	12/23/92	10.1	0.4	0.4	0.5	0.8
MW3/B4-15.5'	12/23/92	<0.05	<0.0005	<0.0005	<0.0005	<0.0005
B5-5'	12/23/92	<0.05	<0.0005	<0.0005	<0.0005	<0.0005
MW2a-7'	01/06/93	24	0.8	0.6	0.6	1.1
MW2a-15'	01/06/93	7.9	0.5	0.4	0.2	0.5
S1-7'	05/12/93	<1.0	<0.005	<0.005	<0.005	<0.005
S2-10'	05/12/93	<1.0	<0.005	<0.005	<0.005	<0.005
S3-10'	05/12/93	<1.0	<0.005	<0.005	<0.005	<0.005
S4-10'	05/12/93	<1.0	<0.005	<0.005	<0.005	<0.005
S5-10'	05/12/93	<1.0	0.130	<0.005	<0.005	<0.005
S6-10'	05/12/93	8.7	0.130	<0.005	0.020	0.024
S7-10'	05/12/93	<1.0	<0.005	<0.005	<0.005	<0.005
S8-10'	05/12/93	<1.0	<0.005	<0.005	<0.005	<0.005
S9-10'	05/12/93	<1.0	<0.005	<0.005	<0.005	<0.005
MW4-5.5'	12/10/93	<0.05	<0.0005	<0.0005	<0.0005	<0.0005
MW4-11'	12/10/93	<0.05	<0.0005	<0.0005	<0.0005	<0.0005
MW5-6'	12/10/93	<0.05	<0.0005	<0.0005	<0.0005	<0.0005
MW5-11'	12/10/93	<0.05	<0.0005	<0.0005	<0.0005	<0.0005
MW6-6'	12/14/93	<0.05	<0.0005	<0.0005	<0.0005	<0.0005
MW6-10.5'	12/14/93	<0.05	<0.0005	<0.0005	<0.0005	<0.0005

All results in mg/kg ≈ parts per million (ppm)

TPHg	Total petroleum hydrocarbons as gasoline
<	Less than listed detection limit established by the laboratory
MW1/B1-10.5'	Monitoring well/soil boring identification and sample depth (10.5 feet below ground surface)

TABLE 2
GROUNDWATER MONITORING DATA
AND ANALYTICAL RESULTS
Alameda Cellars
2425 Encinal Avenue, Alameda, California
(page 1 of 2)

Well Number	Date	Depth to Water	Groundwater Elevation	TPHg	Benzene	Toluene	Ethyl-benzene	Total Xylenes
MW-1 (Elevation of Top of Casing-27.61 MSL)								
	01/09/93	6.75	20.86	5,360	1,560.0	1,026.0	641.0	2,706.2
	04/12/93	6.52	21.09	12,000	750.0	100.0	500.0	1,400.0
	07/13/93	8.68	18.93	720	119.6	32.7	70.8	262.0
	10/12/93	9.04	18.57	8,400	420.0	39.0	280.0	880.0
	12/20/93	7.87	19.74	5,200	270.0	58.0	170.0	590.0
	03/18/94	6.96	20.65	18,000	570.0	180.0	270.0	1,500.0
	04/08/94	7.69	19.92	NT	NT	NT	NT	NT
	03/20/95	5.54	22.07	230	15	4.5	9.4	38
MW-2a (Elevation of Top of Casing-27.98 MSL). Replaced well MW-2.								
	01/09/93	7.06	20.92	5,680	801.6	598.6	840.2	2,196.1
	04/12/93	6.77	21.21	12,000	460.0	110.0	240.0	1,600.0
	07/13/93	8.94	19.04	550	145.2	47.5	126.8	127.4
	10/12/93	9.04	18.57	2,000	280.0	17.0	100.0	120.0
	12/20/93	8.24	19.74	3,300	450.0	40.0	200.0	350.0
	03/18/94	7.80	20.18	7,900	370.0	53.0	190.0	530.0
	04/08/94	7.67	20.31	NT	NT	NT	NT	NT
	03/20/95	5.62	22.36	6,500	590	96	360	1000
MW-3 (Elevation of Top of Casing-27.89 MSL)								
	01/09/93	6.68	21.21	<50	<0.5	<0.5	<0.5	<0.5
	04/12/93	6.41	21.48	1,500	95.0	30.0	46.0	85.0
	07/13/93	8.74	19.15	540	18.3	106.2	75.7	128.0
	10/12/93	9.20	18.69	3,500	290.0	230.0	210.0	460.0
	12/20/93	7.95	19.94	690	31.0	10.0	31.0	25.0
	03/18/94	6.60	21.29	450	9.6	11.0	5.5	23.0
	04/08/94	7.70	20.19	NT	NT	NT	NT	NT
	03/20/95	5.25	22.64	490	19	2.7	24	46
S1	05/12/93	—	—	1,000	200	25	93	56
S4	05/12/93	—	—	710	230	2.7	7.8	3.4
S5	05/12/93	—	—	74	1.2	0.9	<0.5	1.4
S6	05/12/93	—	—	18,000	<5.0	58	120	150
MW-4 (Elevation of Top of Casing-26.97 MSL)								
	12/20/93	7.25	19.72	580	2.3	<0.5	1.4	1.1
	03/18/94	6.64	20.33	2,100	11.0	1.5	2.3	6.0
	04/08/94	7.12	19.85	NT	NT	NT	NT	NT
	03/20/95	5.08	21.89	3,400	140	12	45	29
MW-5 (Elevation of Top of Casing-27.34 MSL)								
	12/20/93	8.01	19.33	<50	<0.5	<0.5	<0.5	<0.5
	03/18/94	7.80	19.54	<50	<0.5	<0.5	<0.5	<0.5
	04/08/94	7.82	19.52	NT	NT	NT	NT	NT
	03/20/95	5.72	21.62	<50	<0.5	<0.5	<0.5	<0.5

See page 2 of 2.

TABLE 2
GROUNDWATER MONITORING DATA
AND ANALYTICAL RESULTS
Alameda Cellars
2425 Encinal Avenue, Alameda, California

Well Number	Date	Depth to Water	Groundwater Elevation	TPHg	Benzene	Toluene	Ethyl-benzene	Total Xylenes
MW-6 (Elevation of Top of Casing-28.03 MSL)								
	12/20/93	8.00	20.03	<50	<0.5	<0.5	<0.5	<0.5
	03/18/94	—	—	NT	NT	NT	NT	NT
	04/08/94	7.72	20.31	<50	<0.5	<0.5	<0.5	<0.5
	03/20/95	5.04	22.99	<50	<0.5	<0.5	<0.5	<0.5

Depth to water measured in feet below top of casing.
All results in μg/L ≈ parts per billion (ppb)

TPHg	Total petroleum hydrocarbons as gasoline
<	Less than listed detection limit established by laboratory
MSL	Mean Sea Level
NT	Not Tested

1.5 Regional Geology and Hydrogeology

The site is located within the Bay Plain. The Bay Plain is a geomorphic terrain which is the gently bayward sloping alluvial plain of Alameda County adjacent to the east shore of San Francisco Bay. The Bay Plain is situated on the eastern side of the San Francisco Bay depression. This depression is an irregular warpage of the earth's crust resulting principally from downward movement along northwest-trending faults at its edge (California Department of Water Resources, 1963). The regional topography slopes toward the west southwest, which is the interpreted direction of regional groundwater movement. The nearest marine water is approximately 2/3 mile southwest of the site.

1.6 Groundwater Well Inventory

An inventory of wells located within a one-mile radius of the subject property identified 61 operating wells (Appendix B, Corrective Action Plan). Of the wells, one is listed as used for domestic purposes. The domestic well is located on Alameda Historical High School campus. According to Alameda Unified School District personnel the well is not in use. There are 15 wells in the area that are listed as irrigation wells. Many of the irrigation wells were drilled during the 1976-77 drought and are believed to be relatively shallow. It is unknown how many wells are still in use today. No wells with one mile of the study area are used for municipal purposes. There are 32 listed wells within one mile of the site which are reportedly used for monitoring. Total depths of the wells in the area range from 15 to 325 feet below ground surface.

2.0 SUBSURFACE CHARACTERISTICS

2.1 Site Geology and Hydrogeology

During drilling activities, the site was observed to be covered with a baserock/asphalt cap. Beneath the cap, subsurface soils consisted of fine grained sand to an explored depth of 18 feet. The sand is part of the Merritt Sand Formation. A report by the Alameda County Flood Control and Water Conservation District (ACFCWCD), dated June 1988, describes the Merritt Sand as consisting of loose, well-sorted, fine to medium grained sand and silt, with lenses of sandy clay and clay. The sand was a wind and water deposited beach and near-shore deposit and is exposed only in the Alameda and Oakland areas.

Discharge from groundwater aquifers consists of natural and artificial discharge. Natural discharge includes evapotranspiration, groundwater discharge to streams, and underflow to San Francisco Bay. Artificial discharge comprises pumping from wells. Water pumped from wells is used for irrigation and industrial use. Domestic water to the site is supplied by the East Bay Municipal Utility District from surface water sources. The sources are from outside of the Alameda area and include the Hetch-Hetchy Reservoir system.

Groundwater beneath the site occurs at approximately 8 feet below grade in Merritt Sand. Groundwater flow direction and gradient is consistently to the west-southwest at gradients ranging from 0.004-0.015 foot/foot and averaging 0.01 foot/foot. Gradient and flow direction from March 20, 1995 are illustrated on Figure 3. The shallow aquifer in the area is the Merritt Sand (ACFCWCD report, dated June 1988). Wells drilled within the Merritt Sand have the lowest groundwater specific capacity of all wells installed throughout Alameda County. The report states that salt-water intrusion has occurred on a limited basis within the Merritt Sand in Alameda.

2.2 Aquifer Test Results

Due to the close proximity, approximately 100 feet to the west of the site, and similar geologic and hydrogeologic characteristics, ACC used the constant-rate pumping test data from an aquifer test performed at the ARCO Station No. 2112, located at 1260 Park Street, Alameda, California.

Between December 18 and 19, 1991, GeoStrategies Inc., (GSI) conducted a 4-hour step-drawdown test and a "24-hour" constant-rate pumping test to attempt to obtain information concerning the hydrogeologic properties of the uppermost aquifer beneath the site and evaluate the feasibility of groundwater extraction as a groundwater remediation method. The step-drawdown test was conducted to select the optimum discharge rate for the constant-rate pumping test. The constant-rate pumping test results were used to evaluate the area of influence from pumping and to calculate the hydraulic properties of the shallow aquifer underlying the site, including: transmissivity (T), storativity (S) and well yield.

2.2.1 Step-Discharge Test

A step-discharge pumping test was attempted in ARCO well AR-1 on December 18, 1991, to determine a sustainable pumping rate from the constant discharge test. During the step test, water was pumped from well AR-1 at a rate of 1.0 gallons per minute (gpm) over a time period of 62 minutes. The pumping rate was thereafter increased to 2.0 gpm over a time period of 162 minutes, and step 3 was a 46 minute recovery step. Evaluation of the step-drawdown data from a time versus drawdown plot indicated a pumping rate of 1.0 gpm should be used for the constant-rate aquifer test.

2.2.2 Constant Discharge Test

A constant discharge pumping test was performed on December 18 and 19, 1991. Extraction well AR-1 was utilized as the pumping well. The test was conducted at an average discharge rate of 1.0 gpm for 24 hours (1440 minutes). Maximum observed drawdown in the pumping well was 6.66 feet. Maximum observed drawdown in the pumping well and observation wells are summarized in Table 1 in Appendix A. Water-level data were collected and recorded as the pumping well recovered to greater than 90% of the initial recorded static water level.

2.2.3 Recovery Test

Upon termination of the constant discharge test, water-level recovery was monitored in the pumping well and the observation wells (A-2 and A-3). The water level in well EW-1 recovered to within 90 percent of the original static water level. Due to the effects of a partially penetrating well efficiency, aquifer parameters were not calculated using the recovery well data.

2.2.4 Analysis of Aquifer Pumping Test Data

Time versus drawdown data were plotted for observation wells A-3 and A-2. Transmissivity (T) and storativity (S) values were calculated from field data plots using the Jacob Straight-line Method (1946). Calculated T values were 1483 gallons per day per feet (gpd/ft) and 3342 gpd/ft respectively, and S values were 2.0 X 10^{-2} to 7.3 X 10^{-3} respectively.

Calculated T and S values were evaluated for effects of delayed drainage in an unconfined aquifer by using the Graphical Well Analysis Package (GWAP). Calculated T values were 1510 gpd/ft and 3882 gpd/ft respectively, and S values were 2.14 X 10^{-2} to 3.5 X 10^{-3} respectively. These results were consistent with the Jacob Method results. These data results are summarized in Table 3.

TABLE 3
RESULTS OF AQUIFER TESTING

Well Number	Gallons per Minute (gpm)	Transmissivity (gal/day/foot)	Storage Coefficient
A-2 (Jacob)	0.0	3342	0.0073
A-2	0.0	3882	0.0036
A-3 (Jacob)	0.0	1483	0.0200
A-3	0.0	1510	0.0215
AR-1	1.0	-	-

2.2.5 Analysis of Recovery Test Data

During the recovery phase of the pump test, water levels were recorded in well AR-1. Recovery test data were not evaluated.

2.2.6 Groundwater Flow Velocity

The estimated average groundwater flow velocity in the shallow aquifer underlying the site can be calculated using the following formula:

Estimated Velocity = (Hydraulic Conductivity)(gradient) / (effective porosity)

or V = Ki / ne (assume 30%)

Based on a representative hydraulic conductivity (K) value of 2,500 gallons per day per foot (gpd/ft), a conversion factor of 1 gpd/ft equals 0.134 feet per day, a groundwater gradient of 0.01 (i), and an estimated effective porosity of 0.3, the average theoretical groundwater flow velocity (V) is calculated to be 11.1 feet/day.

2.2.7 Well Influence

Data collected from the observation wells during the 24-hour constant-rate aquifer test at ARCO Station No. 2112 was used to construct a well influence map. Radius of influence appeared to vary from 60 to 80 feet from the pumping well (GSI). The cone of depression created by pumping well AR-1 did not equilibrate during the constant-rate test, indicating that pumping for a longer time duration may produce greater influence.

True "capture" implies a steady state cone of depression which does not truly exist in an unconfined aquifer. Therefore, a zone of stagnation exists between the radius of capture and radius of influence on the downgradient side of the drawdown cone.

The analysis of capture radii assumes that the aquifer is homogeneous, isotropic, uniform in thickness, and infinite in areal extent. This analysis also assumes that the pumping well fully penetrates the aquifer, recharge boundaries are not present, water is released instantaneously, and the groundwater flow direction and gradient are uniform. The actual capture zone may be smaller than those predicted by the above equations if recharge boundary effects are present or if the aquifer transmissivity is underestimated because of partial penetration effects.

2.3 Soil Vapor Test Results

Due to the close proximity, and similar geologic and hydrogeologic characteristics, ACC used the vapor extraction test data from a test performed at the ARCO Station No. 2112, located at 1260 Park Street, Alameda, California.

GSI performed a 6-hour vapor extraction test on October 2, 1991 to evaluate the feasibility of vapor extraction as a soil remediation method. Results of the vapor extraction test were presented in the GSI Continuing Site Assessment / Quarterly Monitoring Report, dated 1/27/92.

Data collected during the vapor extraction test indicated a radius of influence extending approximately 40 feet from the respective vapor extraction well (GSI). The flow rate during the test varied from 45 to 60 cubic feet per minute (cfm).

2.4 Potential Sources of Hydrocarbons

Previous investigations indicate that the vadose zone and the groundwater beneath the site are impacted by petroleum hydrocarbons. Analysis of soil samples collected from beneath the former gasoline USTs indicated up to 1,500 ppm of TPH as gasoline. Water encountered in the UST pit was not sampled; however, groundwater samples collected during the initial site investigation indicated a maximum TPH-gasoline concentration of 5,680 ppb (MW-2a) and a maximum benzene concentration of 1,560 ppb (MW-1). The distribution of hydrocarbons in soil and in groundwater appears to be consistent with possible releases from former USTs, dispensers, and product lines.

2.5 Hydrocarbons Occurrence in the Soil

The extent of hydrocarbon-impacted soil, while not delineated, appears to be primarily limited to the vicinity of the former UST pit. The estimated extent of TPH as gasoline greater than 10 ppm in the soil occurs between 5.5 and 10 feet bgs and includes an area extending from the former UST pit to the former dispensers. This estimate is based on results of analyses of soil samples, known releases, and field observations. Migration of hydrocarbons in soil from known source areas are assumed to have impacted soil to approximately 5 feet beyond the sidewalls of the UST pit, dispenser, and product-line trenches. The total volume of soil containing hydrocarbons greater than 100 ppm in this interval is estimated to be approximately 25 cubic yards. The volume of soil containing hydrocarbons greater than 10 ppm is estimated to be 50 cubic yards directly associated with the source areas. Hydrocarbon concentrations observed in soil are illustrated on Figure 4 and summarized in Table 1.

The horizontal extent of hydrocarbon-impacted soil does not appear to extend beyond the property boundaries along the northern, western, and eastern sides (beyond borings S1, S2, S3, S4, S7, S8 and S9). However, along the southern side, hydrocarbon-impacted soil appears to extend toward Park and Encinal Avenues; the offsite occurrence of impacted soil is most likely a result of source migration in groundwater. Indications of impacted soil were observed primarily at the soil/groundwater (capillary fringe) interface (about 10 feet bgs), with the exception of borings B2 and MW-2a where groundwater was encountered during drilling at approximately 15 bgs (Table 1).

2.6 Hydrocarbon Occurrence in the Groundwater

Free-phase product has not been observed, but dissolved hydrocarbons have been detected in groundwater beneath the site. Results of analyses of groundwater indicate the northwestern and northeastern extent of dissolved hydrocarbons is delineated by wells MW-5 and MW-6, respectively. The distribution of dissolved hydrocarbons in groundwater indicates that the hydrocarbon plume appears to be concentrated in the vicinity of the former UST pit and dispenser island, but extends offsite toward Park and Encinal Avenues.

However, relatively low levels of hydrocarbons (74 ppb TPHg and 1.2 ppb benzene) were detected in the "grab" sample from boring S5 located south of the site near Encinal Avenue, suggests that the dissolved plume has not migrated appreciably south of the site.

Residual hydrocarbons from the former tank excavation and dispenser island appear to be migrating offsite in a west-southwesterly direction via the groundwater. The lighter and more mobile fractions of gasoline (benzene) tend to migrate more quickly than ethylbenzene, toluene, or xylene; therefore, the higher levels of benzene noted in samples S1-H20 and S4-H20 compared to xylenes may indicate a preferred path of plume migration within the groundwater. Hydrocarbon concentrations observed in groundwater are illustrated on Figure 5 and summarized in Table 2.

2.7 Physicochemical Properties

Gasoline is a volatile, flammable liquid which as various constituents that include up to 200 petroleum-derived chemicals. Analysis of gasoline components is usually limited to detection of benzene, toluene, ethylbenzene, and xylene (BTEX). The BTEX components pose the most potential threat the human health and they have the potential to move through soil and contaminate groundwater. Diesel is less volatile and flammable than gasoline.

2.7.1 Toxicity

Benzene is highly toxic and exposure to acute levels can irritate mucous membranes, cause restlessness, convulsions, excitement, depression and even death from respiratory failure. Chronic levels of benzene can cause bone marrow depression or leukemia. The Department of Health Services Action Levels for benzene is 0.7 ppb and the Maximum Contaminant Level (MCL) for drinking water is 1 ppb. Toluene, ethylbenzene and xylene are slightly less toxic than benzene with MCLs at 100 ppb, 680 ppb and 1,750 ppb respectively.

2.7.2 Persistence

The solubility of benzene in water at 23.1 °C is 0.188% (w/w) with a boiling point of 80°C. Toluene, ethylbenzene and xylene are slightly more soluble in water. These elements volatilize quickly in air. Research has indicated petroleum hydrocarbons are subject to degradation by the action of bacteria. Biodegradation can be enhanced by the presence of aerobic conditions and subsurface materials which provide a greater surface area for attachment of hydrocarbons.

2.7.3 Potential for Migration

The lighter fractions of gasoline (BTEX constituents) are more mobile than other fractions. BTEX can therefore migrate or dissipate away from the main hydrocarbon plume. Mobility can be reduced due to lower permeability layers in the dune sand. The majority of aquifer recharge from precipitation is minimal due to capping of the area by pavement and stormdrain runoff.

This reduced recharge decreases hydraulic affects and reduces migration.

2.7.4 Exposure Assessment

Exposure routes for workers and public could be via dermal contact and inhalation of volatilized contaminants and windblown dust. Because asphalt and concrete covers the site, the potential risk of exposure to subsurface hydrocarbons is low.

3.0 EVALUATION OF CORRECTIVE ACTION

This section presents discussions on selection criteria and cleanup levels, available alternatives to treat gasoline hydrocarbons in soil and groundwater, and an initial screening to identify treatment alternatives that can be successfully applied to the site. Interim remedial measures and source control actions are not addressed. This rational assumes that a threat to public health and safety appears not to be imminent and we are aware of no continuous release of hydrocarbons at the site.

3.1 Protocol For Selection Of Corrective Action

Regulations CCR Title 23, Chapter 16, Articles 5, 7, and 11 of the UST regulations require that a soil and groundwater investigation phase be implemented to assess the nature of the release and to determine a method of cleanup. The regulations also specify that the Remedial Action Plan (RAP) or Workplan, shall consist of those activities determined to be cost effective. "Cost-effective" is defined in the regulations as "actions that achieve similar or greater water quality benefits at an equal or lessor cost than other corrective actions."

The primary remedial objective is to minimize the impact of hydrocarbons to groundwater that is considered of potential beneficial use. Criteria used to evaluate treatment alternatives are effectiveness, treatment time, future liability, and cost. Corrective actions for the site were assessed in a Corrective Action Plan date September 8, 1994 by ACC.

3.2 Remedial Alternative for Soil

The alternative recommended for treatment of hydrocarbons in soil is vapor extraction.

3.3 Remedial Alternative for Groundwater

The remedial alternative for groundwater is active groundwater extraction and recovery can be implemented by installation of one extraction well.

The alternative for removal of dissolved hydrocarbons in groundwater is carbon adsorption. Carbon adsorption is used to remove the dissolved phase of petroleum products by adsorption to activated carbon. At least two carbon filtration units are placed in series. The efficiency of removal for aqueous phase carbon is 98 percent. Activated carbon is used as a primary or secondary treatment technology.

4.0 CONCLUSIONS

At this time, to remediate the relatively thin layer of hydrocarbon-impacted soil beneath the site and control migration of the dissolved hydrocarbon plume, a combination (dual) vapor extraction and groundwater extraction system should be installed at the site. Dual extraction would effectively remediate hydrocarbons from the capillary fringe and control offsite plume migration. Vapor and water extracted from the wells would be separated and treated; water and soil vapor would be cost-effectively treated by carbon adsorption. Well placement and expected radius of influence for groundwater and vapor extraction is illustrated in Figure 6.

4.1 Scope of Work

Develop workplan, site safety plan, permits and system design to incorporate the following work: (1) installation of one 6-inch diameter groundwater extraction well and one 4-inch diameter vapor extraction well in locations illustrated on Figure 5; (2) piping necessary to treat extracted vapors and groundwater on the surface using activated carbon; (3) sample ports placed to sample influent and effluent vapors and groundwater; and, (5) develop a written plan to monitor, operate and maintain system at regular intervals for a period of one year, and incorporate any concerns of the Alameda County Health Agency, Division of Environmental Protection, Department of Environmental Health.

Item 1: Six-inch diameter PVC well to 25 feet below ground surface (bgs), 2-foot silt trap, 0.020 continuous wrap screen from 5-23 feet bgs, No. 2/12 sand from 4-25 feet, bentonite seal from 3-4 feet bgs, and neat cement to grade.

Four-inch diameter PVC well to 14 feet bgs, 0.020 continuous wrap screen from 5-14 feet bgs, No. 2/12 sand from 4.5-14 feet, bentonite seal from 3.5-4.5 feet bgs, and neat cement to grade. Appropriate steps should be taken to avoid "short-circuiting" of subsurface vapors through the planter area, such as paving or placing 20-mil polyethylene sheeting.

Item 2: Standard groundwater extraction system including: submersible total fluids pump; totalizer; surge tank; feed pump; filter; flowmeter; influent, effluent and midpoint sampling ports, twin carbon adsorption vessels; and discharge piping.

Standard soil vapor extraction system including: water separator; filter; vacuum blower; silencer; influent, effluent and midpoint sampling ports; twin carbon adsorption vessels; and discharge piping.

Item 4: System to be monitored weekly for one month, monthly for six months, evaluated at six months and quarterly thereafter. The monitoring plan shall cover expected contingencies and include customary safeguards for normal operation. Information supplied in Appendices A and B may be used to aid in system design.

5.0 REFERENCES

ACC Environmental Consultants, Inc. August 1994. *Corrective Action Plan, 2425 Encinal, Alameda, California.*

GeoStrategies Inc. August 27, 1992. *Aquifer Test/Vapor Well Installation Report, ARCO Service Station No. 2112, 1260 Park Street, Alameda, California.*

California Department of Water Resources. 1960. *Intrusion of salt water into groundwater basins of southern Alameda County.* California Department Water Resources, Davis. Resources Plan. 81, 64 p.

Alameda County Health Care Services Letter. October 7, 1992. *Site at 2425 Encinal Avenue, Alameda, California, and the Extension of the Field Work Due Date.*

Alameda County Investigation. *California Water Resources Board Bull. 13.* 1963, 196 p.

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

Fetter, C.W. 1994. *Applied Hydrogeology*. New York: Macmillan College Publishing Company

Driscoll, F.G. 1986. *Groundwater and Wells, Second Edition*. St. Paul, Minnesota: Johnson Filtration Systems Inc.

6.0 LIMITATIONS

The discussion and recommendations presented in this report are based on the following:

1. The exploratory test borings drilled at the site.

2. The observations by field personnel.

3. The results of laboratory analyses performed by a state-certified analytical laboratory.

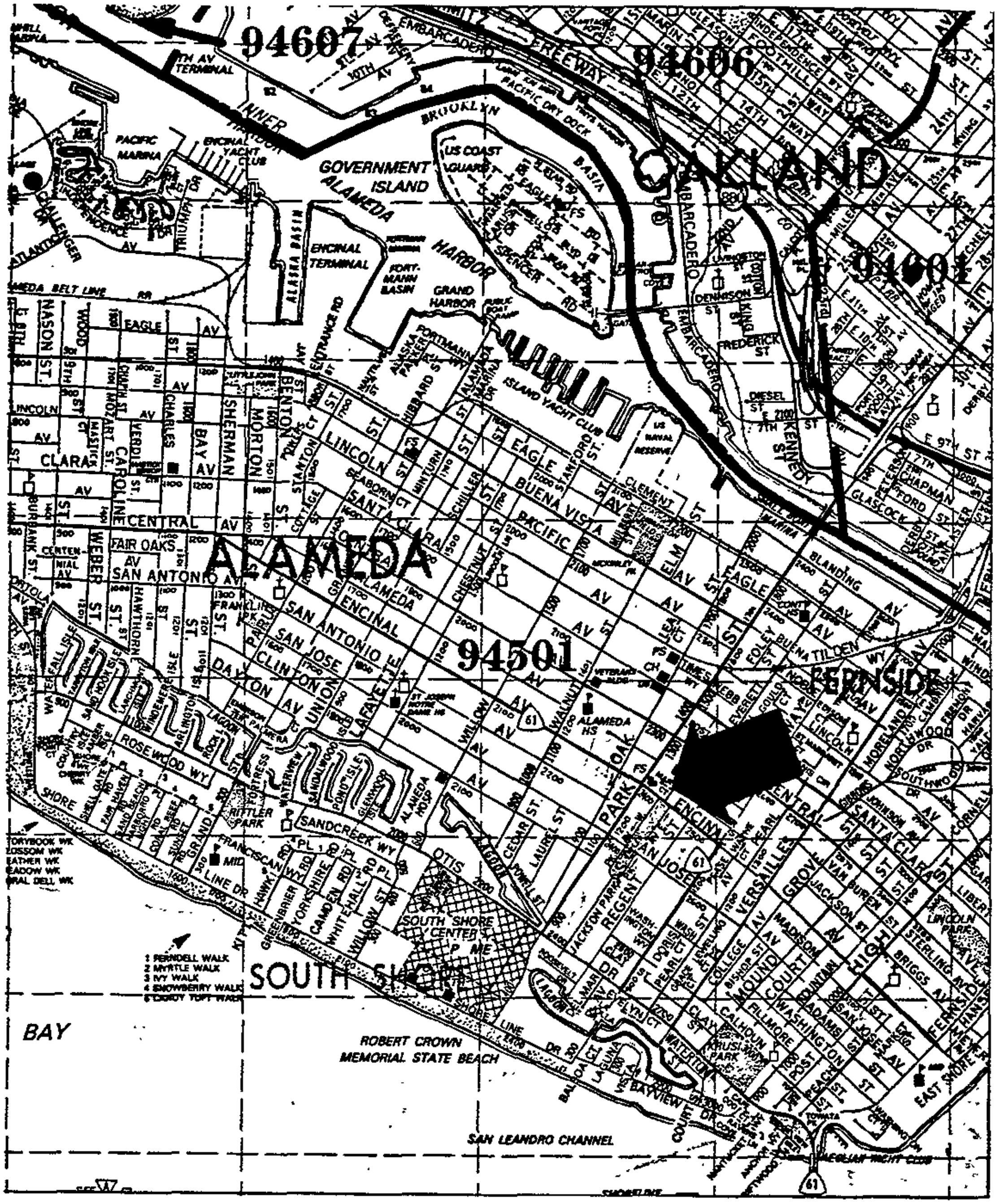
4. Documents referenced in this report.

5. Our understanding of the regulations of the State of California and the County of Alameda.

It is possible that variations in the soil or groundwater conditions could exist beyond the points explored in this investigation. In addition, changes in the groundwater conditions could occur at some future time due to variations in rainfall, temperature, regional water usage, or other unknown factors.

The service performed by ACC Environmental Consultants has been conducted in a manner consistent with the level of care and skill ordinarily exercised by members of our profession currently practicing under similar conditions in the area. Please note that contamination of soil and groundwater must be reported to the appropriate agencies in a timely manner. No other warranty, expressed or implied, is made.

ACC Environmental Consultants includes in this report chemical analytical data from a state-certified laboratory. The analytical results are performed according to procedures suggested by the United States Environmental Protection Agency and the State of California. ACC is not responsible for laboratory errors in procedure or result reporting.



Scale: 1" = 0.25 miles

Source: Thomas Brothers

Project No. 6093-3	**Location Map** Alameda Cellars 2425 Encinal Avenue Alameda, California	**Figure:** **1**
Date: 03/20/1995		

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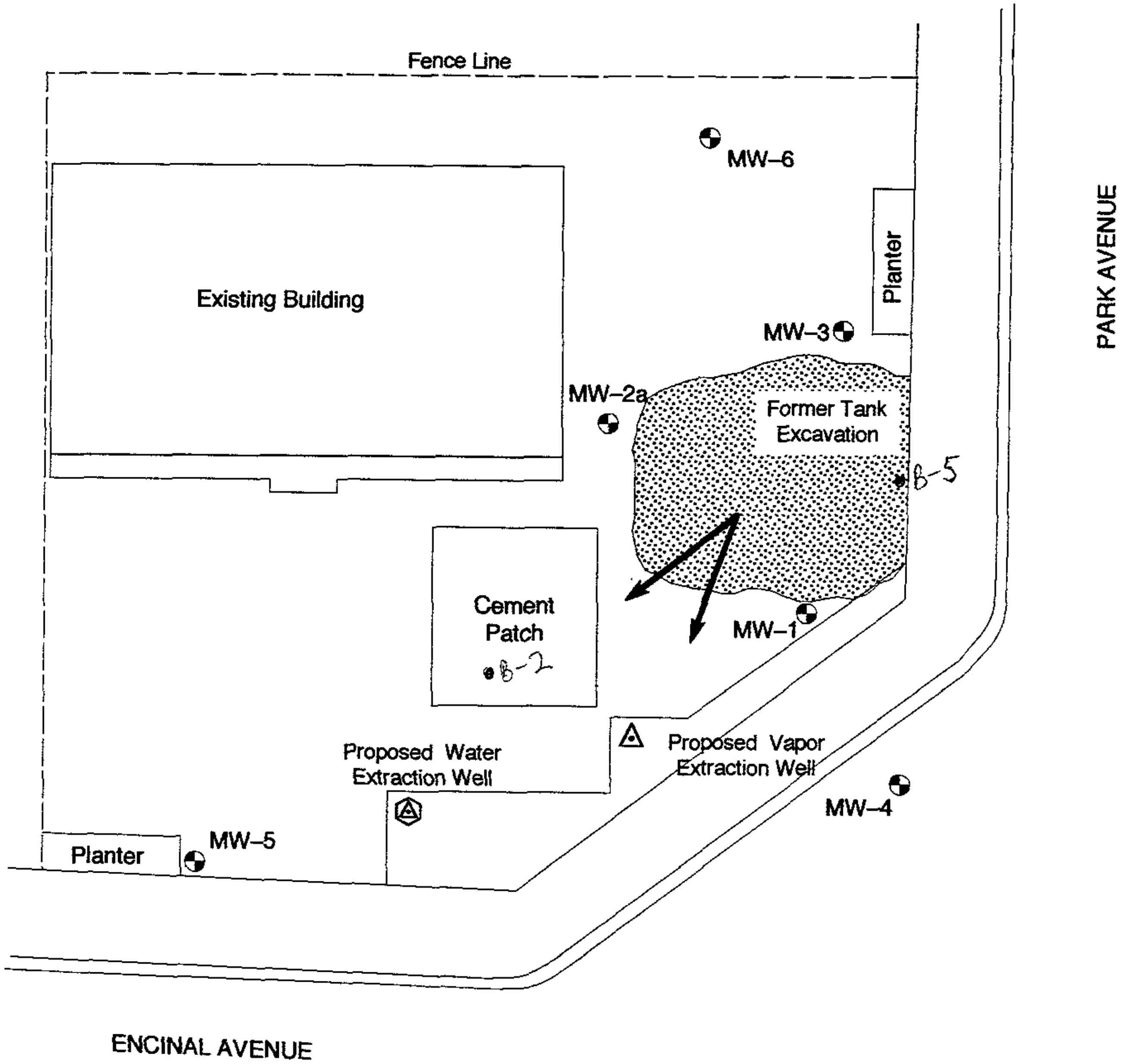

Legend

- Monitoring Well
- Approximate Groundwater Flow

Title: **Site Plan** **2425 Encinal Ave** **Alameda, California**	
Figure Number: 2	Scale: 1" = 20"
Drawn By: TRF	Date: 3/29/95
Project Number: 6039-5	

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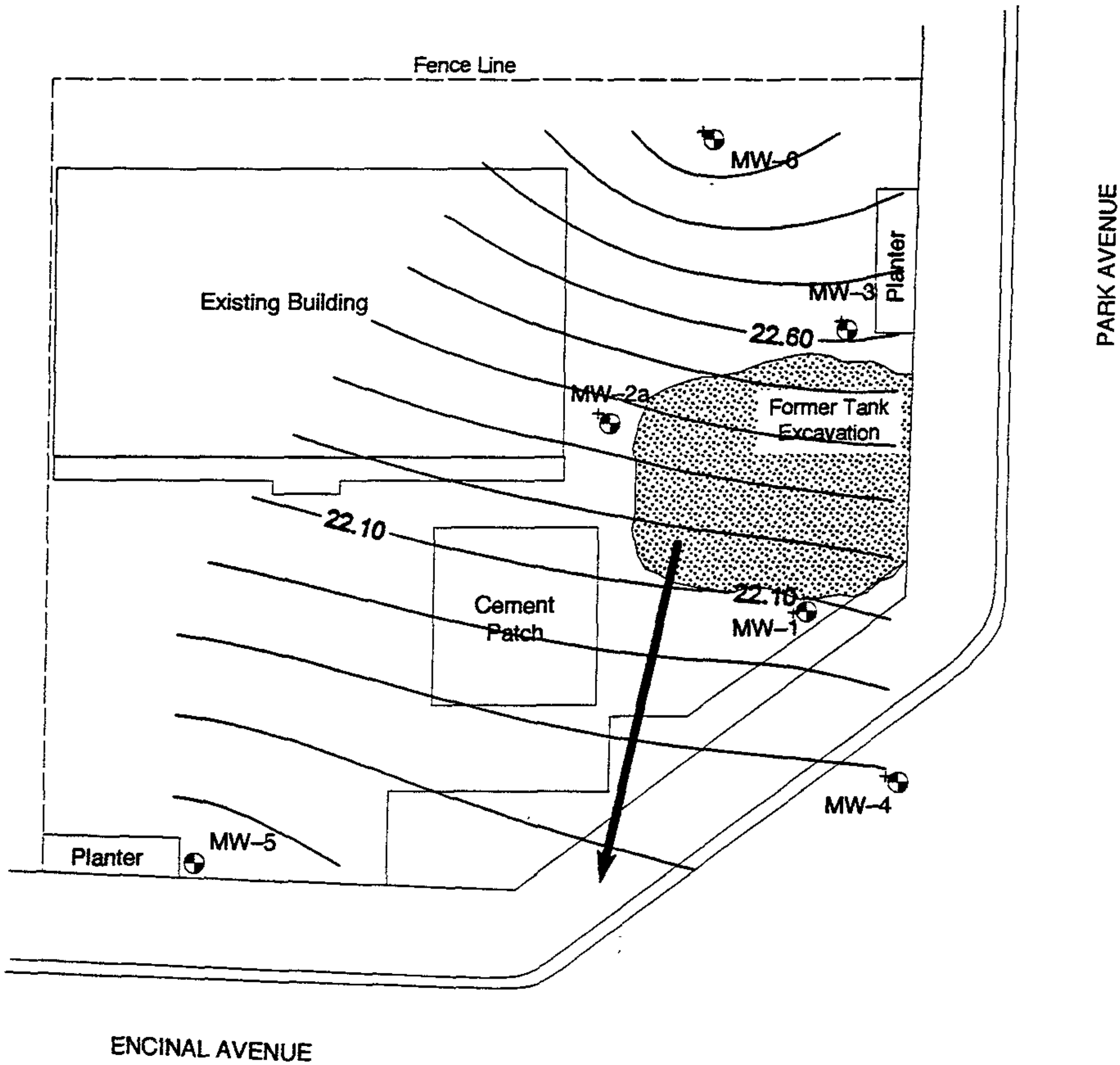

Legend

Monitoring Well

Groundwater Elevation Contour
(Contour interval = 0.1 feet)

Approximate Groundwater Flow Direction 3/20/95

Title:	Gradient Map 2425 Encinal Ave Alameda, California		
Figure Number:	3	Scale:	1" = 20"
Drawn By:	TRF	Date:	3/29/95
Project Number:	6039-5		

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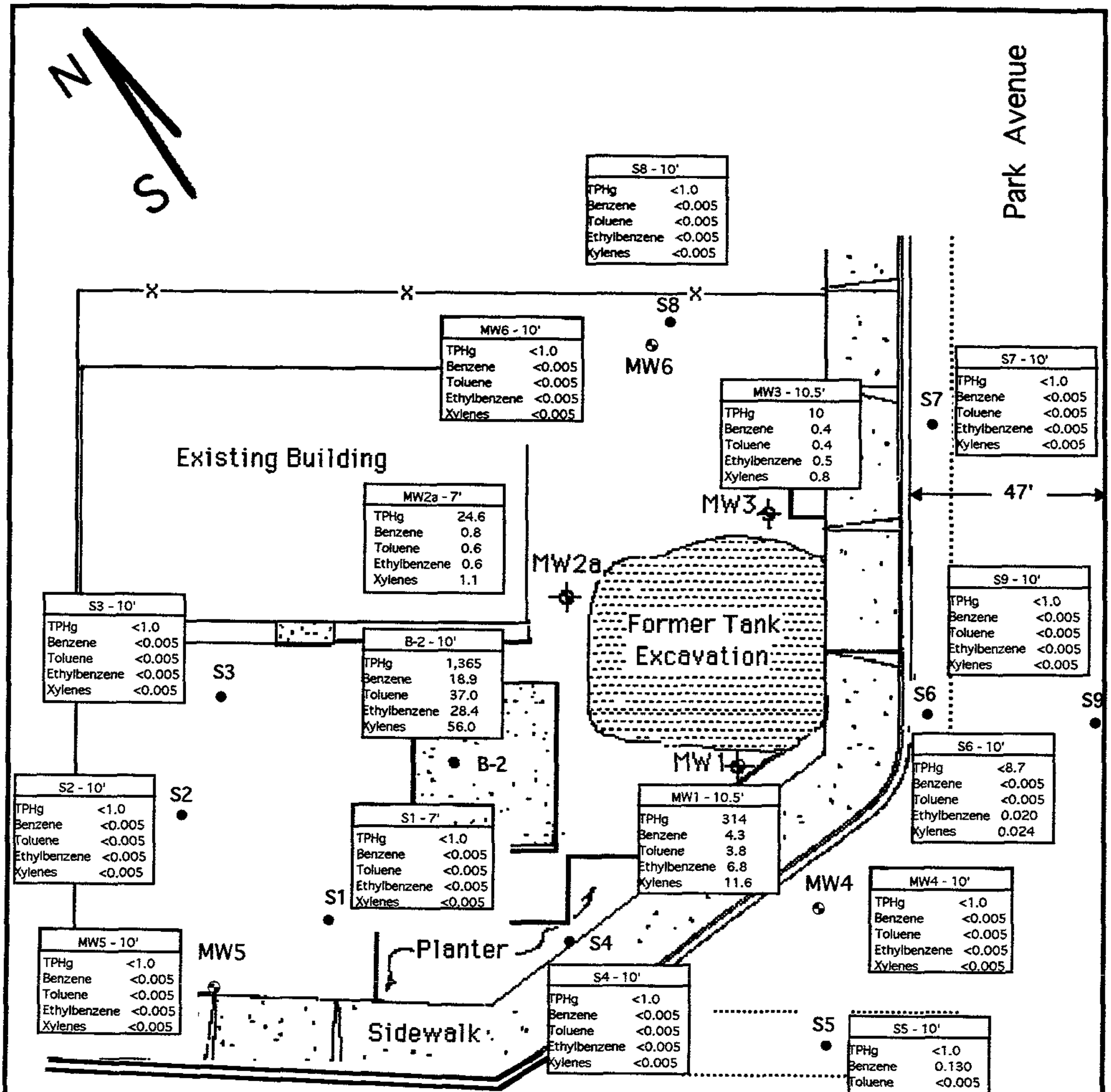
N E S W



LEGEND

- TPHg — Total Petroleum Hydrocarbons as gasoline
- ⊕ Monitoring Well
- ● Soil boring

Scale: 1" = 20'

Source: Wells Surveyed by Ron Archer

All results in Parts Per Million (ppm)

Project # 94-6039-5	09/01/94	Drawn By: MCK

Figure 4
Concentrations of TPHg/BTEX in Soil
2425 Encinal Avenue
Alameda, California

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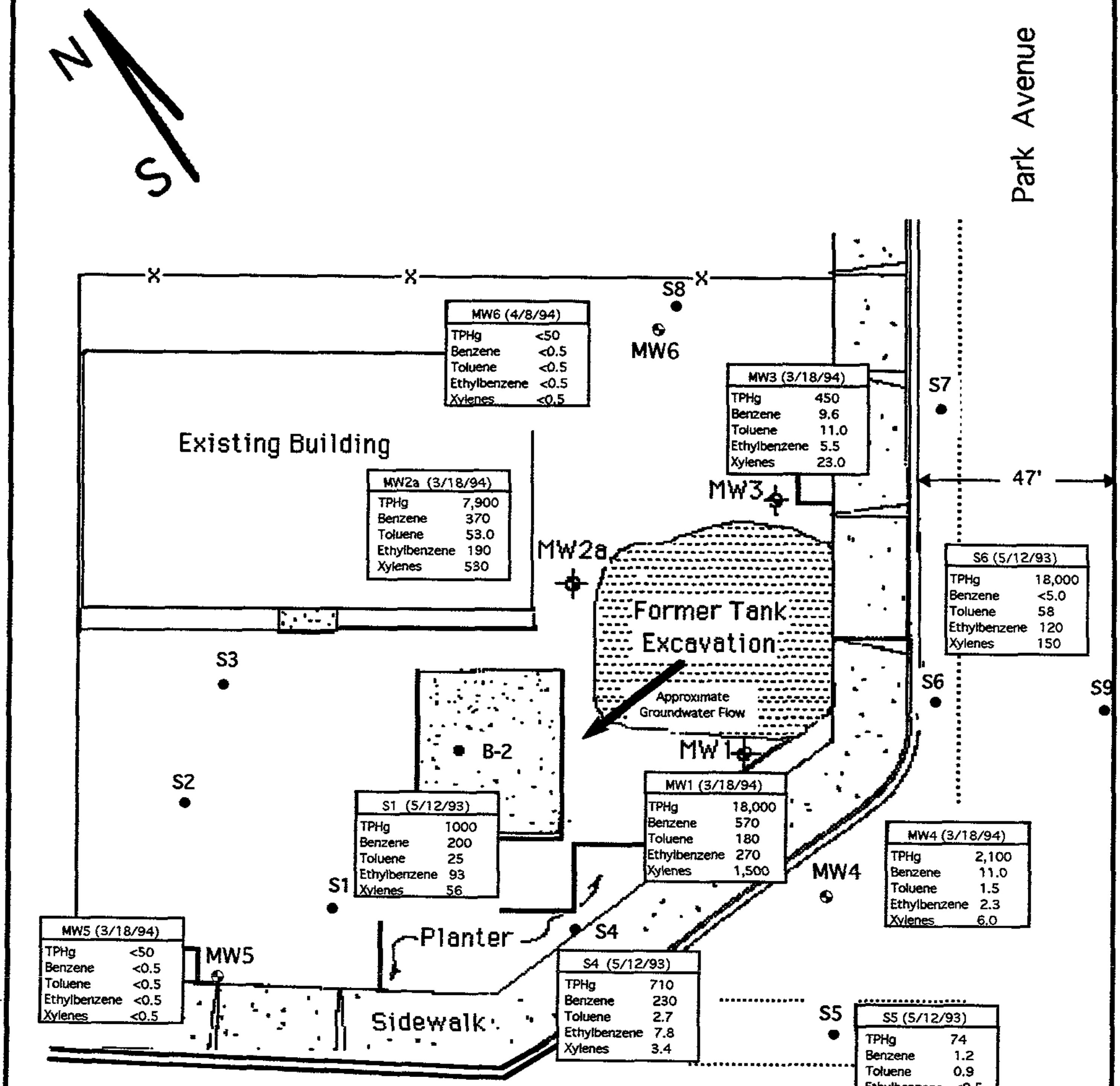

LEGEND

TPHg — Total Petroleum Hydrocarbons as gasoline

⊕ — Monitoring Well

● — Soil boring

All results in Parts Per Billion (ppb)

Scale: 1" = 20'

Source: Wells Surveyed by Ron Archer

Figure 5
Concentrations of TPHg/BTEX in Groundwater
2425 Encinal Avenue
Alameda, California

Project # 94-6039-5	09/01/94	Drawn By: MCK

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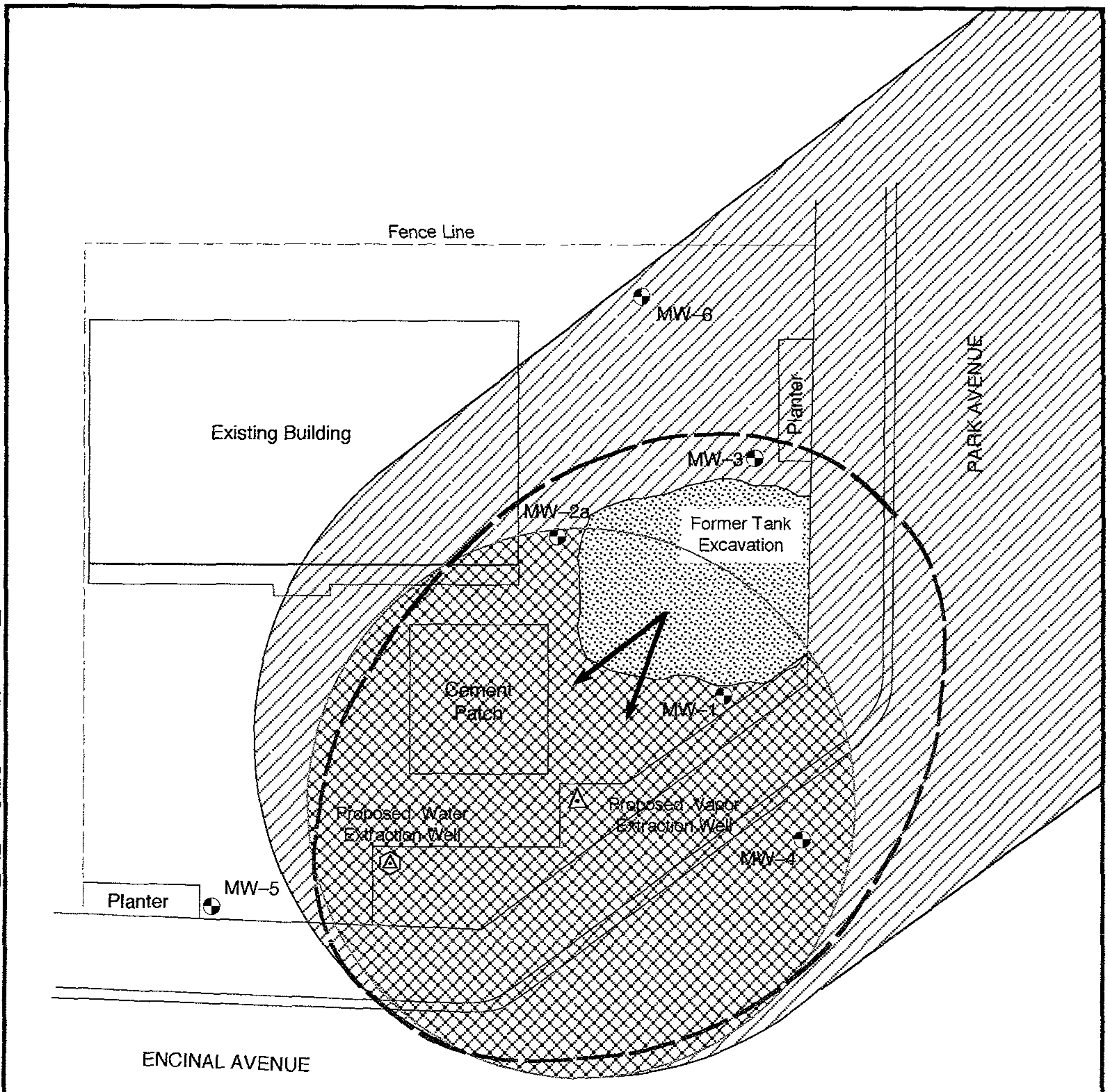

Legend

- Approximate Area of Groundwater Contaminant Plume
- Radius of Influence for Groundwater
- Radius of Influence for Soil Vapor
- Monitoring Well
- Approximate Groundwater Flow

Title:	*Proposed Well Location & Radius of Influence Map 2425 Encinal Ave Alameda, California*
Figure Number: 6	Scale: 1" = 20"
Drawn By: TRF	Date: 3/29/95
Project Number: 6039-5	

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N E S W

APPENDIX A

GSI GeoStrategies Inc.

August 27, 1992

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

Attn: Mr. Michael Whelan

Re: Aquifer Test/Vapor Well Installation Report
ARCO Service Station No. 2112
1260 Park Street
Alameda, California

Gentlemen:

This Aquifer Test/Vapor Well Installation Report by GeoStrategies Inc. (GSI) presents the field activities and results associated with an aquifer test performed on groundwater Recovery well AR-1. In addition, this report describes the field activities and results associated with the installation of four additional vapor extraction wells (AV-4 through AV-8). The aquifer test consisted of a step-drawdown and constant-rate discharge tests performed on December 18 through 19, 1991. These tests were performed to evaluate the feasibility of groundwater extraction as a remedial option. The vapor extraction wells were installed on January 2, 1992 to enhance the existing vapor extraction well network.

The scope of activities presented in this document were performed at the request of ARCO Products Company. Field work and laboratory analysis methods were performed to comply with current State of California Water Resources Control Board (SWRCB) guidelines. Field methods and procedures are presented in the GSI Work Plan dated January 2, 1991.

SITE BACKGROUND

In January, 1990 Applied GeoSystems (AGS) drilled six exploratory soil borings (B-1 through B-6) to assess soil conditions in the area of the present and former underground storage tank (UST) complexes. Total Petroleum Hydrocarbons calculated as Gasoline (TPH-Gasoline) was detected in soil samples collected from borings (B-1 through B-5) located adjacent to the former UST complex at concentrations ranging from 3.7 to 21,000 parts per million (ppm). TPH-Gasoline was not detected in soil samples collected from boring B-6 which is located in the present UST location.

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In July and September 1990 Gettler-Ryan, Inc. (G-R) excavated and removed five UST's containing gasoline products from the former UST complex. Approximately 1950 cubic yards of soil were excavated and hauled off-site from the former and present UST complexes. Overexcavation of the former UST complex to remove hydrocarbon contaminated soil was limited due to property boundaries and the close proximity of the station building.

In September, 1990, GSI installed four groundwater monitoring wells (A-1 through A-4), one groundwater recovery well (AR-1) and three vapor extraction wells (AV-1 through AV-3). These wells were installed to evaluate the horizontal and vertical extent of petroleum hydrocarbons in soil and groundwater beneath the site.

On October 2, 1991, GSI performed a soil vapor extraction pilot test to assess the potential for using vapor extraction as a remedial method. The results of the well installations and the vapor extraction pilot test are presented in the GSI Continuing Site Assessment/Quarterly Monitoring Report dated January 27, 1992.

HYDROGEOLOGIC CONDITIONS

The project site is located within the East Bay Plain on Alameda Island. Alameda is bordered by the San Francisco Bay to the southwest, San Leandro Bay to the southeast, and the Oakland Inner Harbor to the east. The closest marine water is approximately 2/3 mile south of the site. the site is situated on the Merritt formation comprised of fine sand, both silty and clayey with lenses of sandy clay and clay (Radbruch, 1969). AGS and GSI boring logs indicated the site is underlain by poorly-graded sands with minor disseminated clay and silt to a total explored depth of 30 feet below grade. First encountered groundwater is approximately 12 feet below ground surface with groundwater flow to the west at an approximate hydraulic gradient of 0.005. The base of the aquifer has not been observed beneath the site.

AQUIFER TEST FIELD ACTIVITIES

The 4-hour step-drawdown and 24-hour constant-rate tests were performed utilizing Recovery well AR-1 on December 18 through 19, 1991. The tests were performed to assess the feasibility of utilizing Recovery Well AR-1 to achieve hydrodynamic control of groundwater for extraction of petroleum hydrocarbons from the first encountered water-bearing zone. Ground-water recovery well AR-1 was installed to extract groundwater from the shallow aquifer zone beneath the site and to assess aquifer parameters for potential recovery system design.

Water-level measurements were obtained from pumping Recovery well AR-1 and selected monitoring wells prior to conducting the test to establish baseline data (Plate 3). Pressure transducers connected to a Hermit SE2000 data logger were installed in Recovery Well AR-1 and three selected observation wells (A-2 through A-4) to monitor water-level changes during the tests. Water-level changes in Well A-1 was measured with an electronic interface probe at various time intervals throughout the duration of the tests.

AQUIFER TEST RESULTS

Data collected during the 4-hour step-drawdown and 24-hour constant-rate test were evaluated and used to calculate specific aquifer parameters; Transmissivity (T) and Storativity (S). Additional aquifer characteristics evaluated include radius of influence and well yield.

Step-Drawdown Test

Well AR-1 was pumped a various discharge rates to establish an optimum long-term discharge rate for the 24 hour constant-rate test. The step-drawdown test consisted of three steps; Step 1 ran for 62 minutes at 1.0 gallons per minute (gpm); Step 2 ran to 162 minutes at 2.0 gpm; Step 3 was a 46 minute recovery step. An evaluation of the step-drawdown test data from a time versus drawdown plot (Appendix A) indicated that a pumping rate of 1 gpm should be used for the constant-rate test.

Constant-Rate Test

Recovery well AR-1 was pumped for a total of 1440 minutes at a constant discharge rate of 1.0 gpm. Maximum observed drawdown in the pumping well was 6.66 feet. Maximum observed drawdowns in the pumping well and observation wells are summarized in Table 1. Water-level data were collected and recorded as the pumping well recovered to greater than 90% of the initial recorded static water level.

Recovery well AR-1 partially penetrates the aquifer. It is difficult to evaluate the effect of the water level in the recovery well since the aquifer thickness is unknown. However, a greater drawdown is anticipated in the recovery well. The effect of a partially penetrating recovery well on the monitoring well drawdown is expected to be insignificant. Due to the effects of a partially penetrating well efficiency aquifer parameters were not calculated using the recovery well data.

Time versus drawdown data were plotted for observation Wells A-2 and A-3. Transmissivity (T) and Storativity (S) values were calculated from these field data plots using the Jacob Straight - line Method (1946). Calculated transmissivities values from the field plots using Jacob's Method for Wells A-2 and A-3 are 3342 gallons per day per feet (gpd/ft. and 1483 gpd/ft., respectively. Storativity values for Wells A-2 and A-3 were calculated to be 7.3 x 10^{-3} and 2.0 x 10^{-2}, respectively. Storativity values appear to be consistent with an aquifer that is unconfined to semi-confined. These data results are summarized in Table 1. Field Data Plots are presented in Appendix B.

To evaluate the potential effects of delayed drainage in an unconfined aquifer, GSI used Graphical Well Analysis Package (GWAP) software to analyze test data using the Neuman Method (1975). Data plots generated utilizing GWAP are presented in Appendix C. Transmissivity values calculated using the Neuman Method for Wells A-2 and A-3 are 3882 gpd/ft. and 1510 gpd/ft., respectively. Storativity values for wells A-2 and A-3 are 3.50 x 10^{-3} and 2.14 x 10^{-2}, respectively. These results are consistent with Jacob Method results. These data results are summarized in Table 1.

Approximately 3,750 gallons of groundwater were pumped during the aquifer test. Groundwater was disposed of by H&H Ship Service Company. The Uniform Hazardous Waste manifest is presented in Appendix D.

Well Influence

Data collected from the observation wells during the 24-hour constant-rate aquifer test were used to construct a well influence map for Recovery Well AR-1 after 1440 minutes of pumping at 1.0 gpm (Plate 4). Radius of influence appeared to vary from 60 to 80 feet from the pumping well for the constant-rate test. The cone of depression created by pumping Recovery Well AR-1 did not equilibrate during the constant-rate test, indicating that pumping for a longer time duration may produce greater influence.

Well Efficiency

The well efficiency was calculated using the step drawdown as described by Todd (1980). A plate of the Specific Capacity vs. Well Discharge is included in Appendix E. Well efficiency was calculated to be approximately 28% at a flow rate of 1 gpm. The calculations are shown in Appendix E.

VAPOR EXTRACTION WELL FIELD ACTIVITIES

Soil Borings

Four exploratory borings (AV-4 through AV-7) were drilled to a depth of 13.0 feet below ground surface and completed as vapor extraction wells AV-4 through AV-7. The exploratory soil borings were drilled with a truck-mounted rig using 8- and 10-inch-diameter continuous flight hollow-stem augers. A GSI geologist observed the drilling, described the soils encountered, and prepared a lithologic log for each boring using the Unified Soil Classification System (ASTM D 2488-84) and Munshell Soil Color Chart. The exploratory soil borings logs are presented in Appendix F.

Soil Sampling

Soil samples were collected at five-foot depth intervals using a modified California split-spoon sampler fitted with precleaned stainless steel liners. Soil from each sample interval was selected to perform head-space analysis in the field for volatile organic vapor. Field testing procedures involved removing the soil from the stainless steel liner into a clean glass jar and immediately covering the jar with aluminum foil secured under a ring-type threaded lid. After approximately twenty minutes, the foil was pierced and the head-space within the jar was tested for total organic vapor, measured in parts per million (ppm), using an Organic Vapor Monitor (OVM) photoionization detector. Head space analyses are a standard GSI field screening procedure and are performed as a reconnaissance procedure only. They are not used to evaluate the actual levels of organic compounds in the samples or the extent of hydrocarbons contamination. Head-space analysis results are presented on the boring logs in Appendix F. Drill cutting composite samples were also collected to evaluate the appropriate method of disposal. Chemical results of drill cutting samples were sent to Dillard Trucking located in Byron, California for a soil profile and disposal.

Soil samples retained for chemical analysis were covered on both ends with aluminum foil and sealed with plastic end caps. The samples were labeled, entered on a Chain-of-Custody form, placed in a cooler with blue ice and transported to Sequoia Analytical (Sequoia), a State-certified environmental laboratory located in Redwood City, California.

Vapor Extraction Well Installation

Vapor extraction wells AV-4 through AV-7 were constructed inside 10-inch augers using 4 - inch diameter Schedule 40 PVC casing and 0.020 - inch continuously-wrapped PVC well screen. Well screens (6 to 9 feet in length) were installed from the bottom of the boreholes to between 4 and 7 feet below ground surface. Lonestar #2/12 graded sand was placed in the annular space across the entire screened interval to two feet above the top of the screen. A one to two-foot bentonite seal followed by a cement-grout seal was placed above the sand to within one foot of surface grade. the wells were completed at ground surface using a water-proof locking cap, lock, and traffic-rated vault set in concrete. Well construction details are presented in Appendix F.

Soil Chemical Analytical Results

Soil samples were submitted from the 10.5 foot interval from each of the borings. Soil samples submitted for analysis were analyzed for TPH-Gasoline according to EPA Method 8015 (Modified); and BTEX according to EPA Method 8020.

Soil analysis identified TPH-Gasoline and Benzene in the 10.5 foot sample (AV-4-10.5) from boring AV-4 at concentrations of 21,000 and 190 parts per million (ppm), respectively. TPH-Gasoline and Benzene were reported as none detected (ND) in the samples from the other borings. Table 2 presents a summary of the soil analytical results. the Soil Chemical Analytical Report and Chain-of-Custody Form are presented in Appendix G.

WELL SURVEY RESULTS

A well survey was conducted to identify water supply wells and their uses within a 1/2-mile-radius of the site. This information was obtained from records at the Alameda County Flood Control and Water Conservation District. As indicated on Plate 1, thirteen wells are located within a 1/2 mile radius of the site. One well (No. 10) is approximately 1,000 feet down-gradient, two wells (No. 11 and No. 12) are approximately 1,500 feet down-gradient, eight wells (No. 1, No. 4 through 7, and No. 13) are cross-gradient, and two wells (No. 2 and No. 3) are up-gradient. Table 3 summarizes well survey data including: the state well number, well location, total depth, year installed, and usage (status) of the thirteen wells.

TABLE 1

WELL AR-1 PUMP TEST RESULTS

WELL NO	PUMP RATE (gpm)	PUMPING DURATION (min.)	MAXIMUM DRAWDOWN (ft.)	JACOB METHOD T	JACOB METHOD S	NEUMAN METHOD T	NEUMAN METHOD S
A-1	0	----	0.00	(3)	(3)	(3)	(3)
A-2	0	----	0.10	3342	.0073	3882	.00358
A-3	0	----	0.11	1483	.0200	1510	.02147
A-4	0	----	0.06	(3)	(3)	(3)	(3)
AR-1	1	1440	6.66	----	----	----	----

1. T = Transmissivity (gpd/ft)
2. S = Storativity (dimensionless)
3. Insufficient drawdown to calculate T and S.

TABLE 3

SUMMARY OF ONE-HALF MILE RADIUS WELL SURVEY
ARCO Service Station No. 2112
1260 Park Street, Alameda, California

MAP ID	STATE NUMBER	WELL LOCATION	TOTAL DEPTH (FT)	YEAR DRILLED	USAGE (STATUS)
1	2S3W7N1	2235 Lincoln Ave.	206	1916	IRR
2	2S3W18D1	2518 Chester St.	20	1977	IRR
3	2S3W18F1	2806 Van Buren St.	20	1977	IRR
4	2S3W18M2	1101 College Ave.	40	1988	IRR
5	2S3W12Q1	1215 Willow St.	20	1977	IRR
6	2S3W12Q4	2059 San Antonio Ave.	21	1940	IRR
7	2S3W12R1	Central Ave. & Oak St.	325	?	DOM+
8	2S3W12R2	2121 Alameda Ave.	19	1977	IRR
9	2S3W12R3	2121 Alameda Ave.	19	1977	IRR

SOURCE: Alameda County Flood Control and Water Conservation District

IIR = Irrigation
DOM = Domestic
ABN = Abandoned

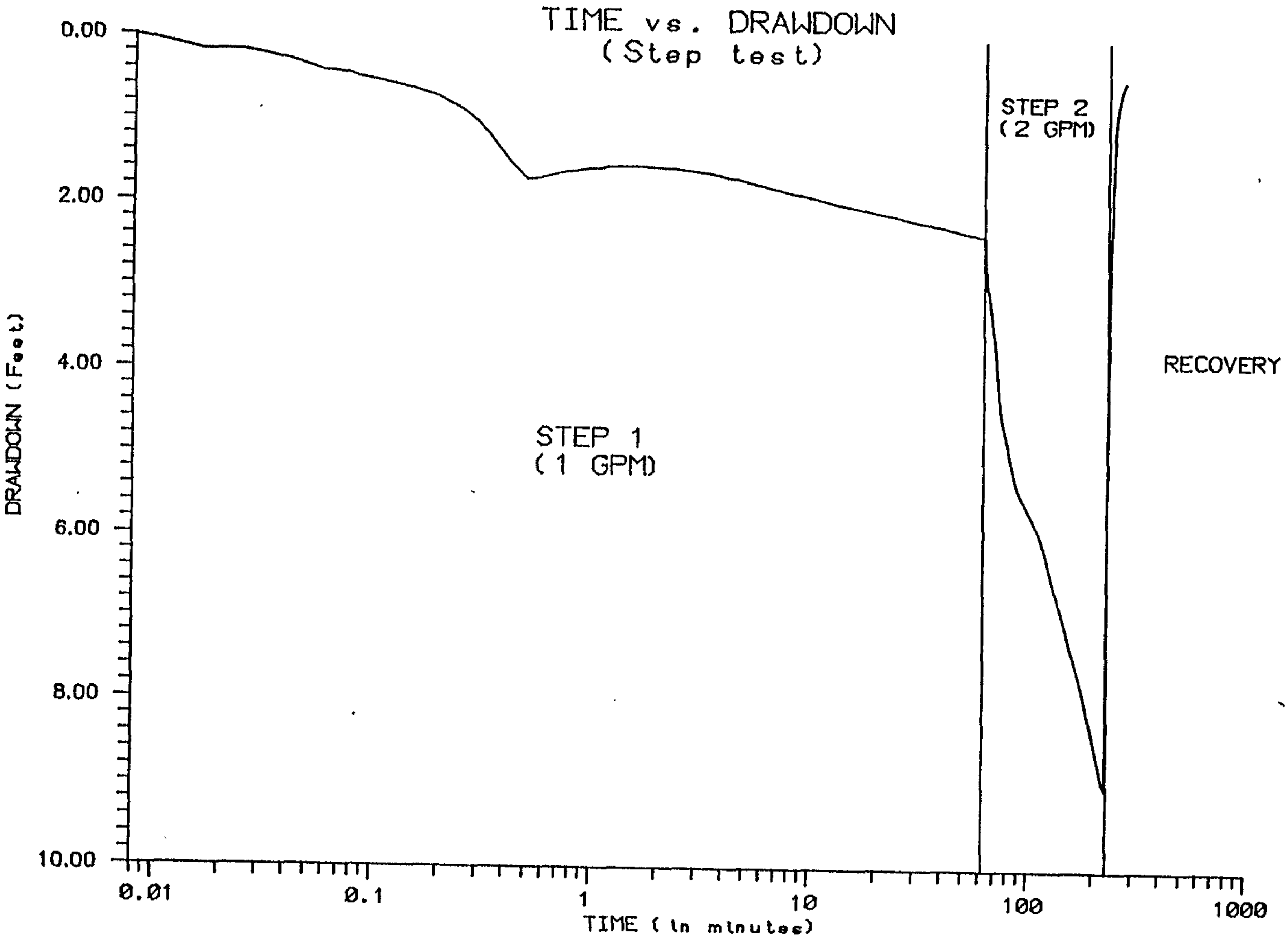
Notes: 1. This survey does not include monitoring wells or piezometers located nearby sites where subsurface investigations are on-going as these not considered water producing wells.
2. Information regarding type of and method used for sealing wells is not available.
3. Locations are approximated on the vicinity map (Plate 1).

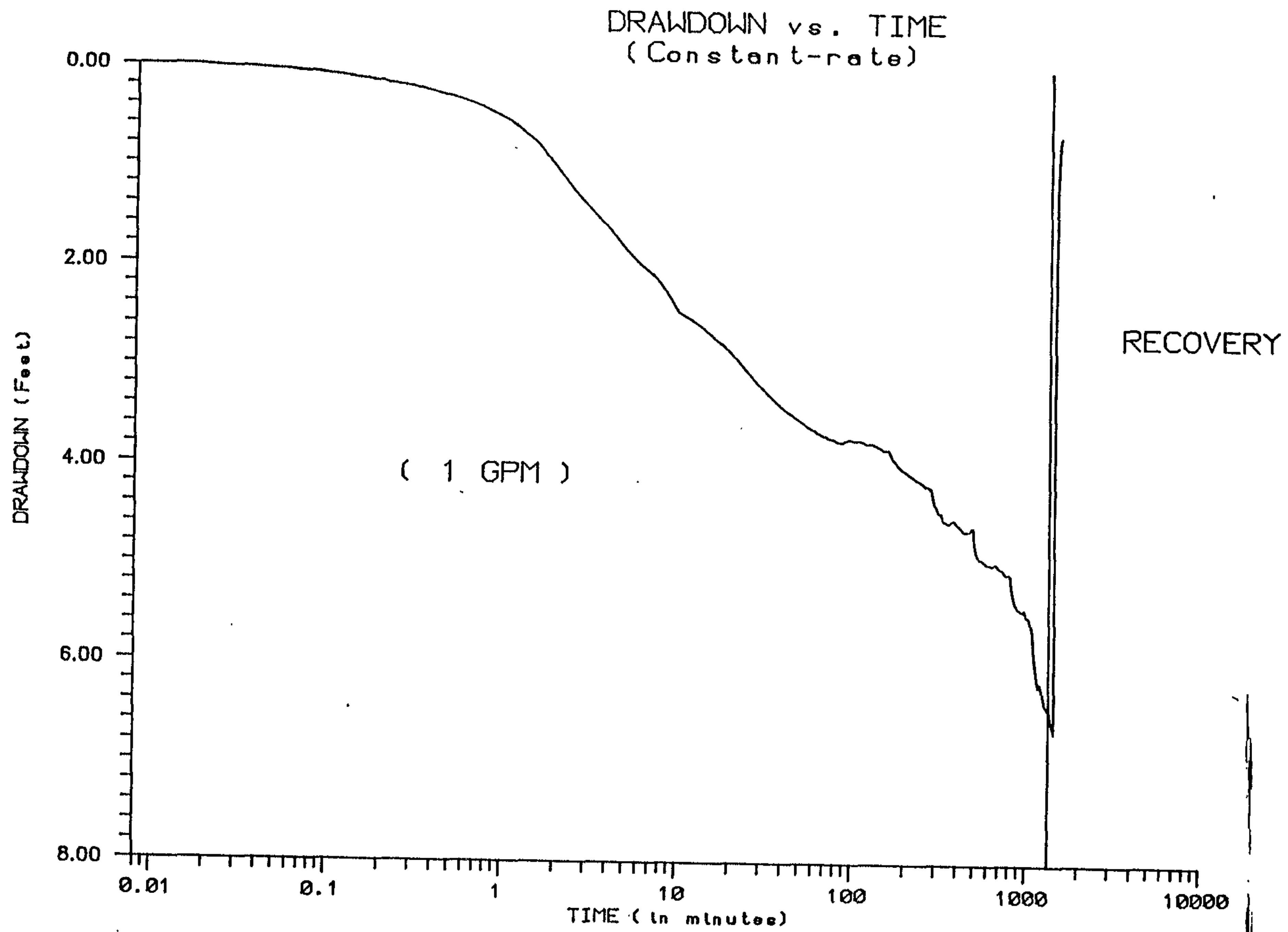
792005-5

TABLE 3

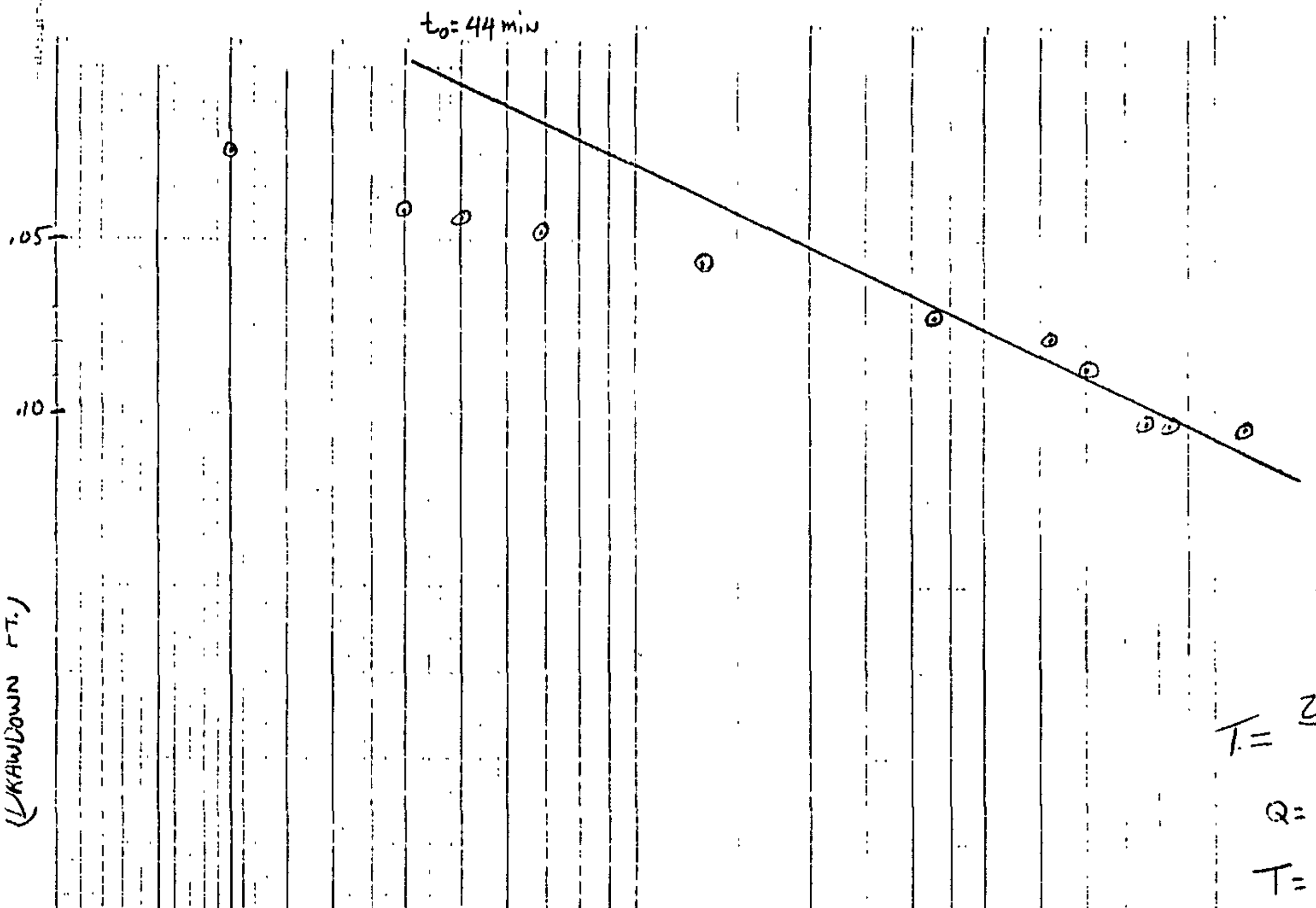
SUMMARY OF ONE-HALF MILE RADIUS WELL SURVEY
ARCO Service Station No. 2112
1260 Park Street, Alameda, California

MAP ID	STATE NUMBER	WELL LOCATION	TOTAL DEPTH (FT)	YEAR DRILLED	USAGE (STATUS)
10	2S3W13A1	2242 San Antonio Ave.	20	1977	IRR
11	2S3W13B1	2163 San Jose Ave.	127	1921	ABN
12	2S3W13B2	871 Walnut St.	25	1977	IRR
13	2S3W13J3	1032 Regent St.	20	1977	IRR


TIME vs. DRAWDOWN
(Step test)
STEP 1
(1 GPM)
STEP 2
(2 GPM)
RECOVERY
DRAWDOWN (Feet)
0.00
2.00
4.00
6.00
8.00
10.00
0.01
0.1
1
10
100
1000
TIME (in minutes)


DRAWDOWN vs. TIME
(Constant-rate)
0.00
2.00
4.00
6.00
8.00
DRAWDOWN (Feet)
(1 GPM)
RECOVERY
0.01
0.1
1
10
100
1000
10000
TIME (in minutes)

WELL A-2



CLIENT	ARCO
JOB NO.	792005
DATE	DEC. 19, 1991
TEST NO.	1
ANALYSIS	JACOB
PUMP. WELL	AR-1
OBS. WELL	A-2
Q =	1 G.P.M.
R =	64 ft.

$$T = \frac{264\ Q}{\Delta s}$$

Q = 1 gpm Δs = .079

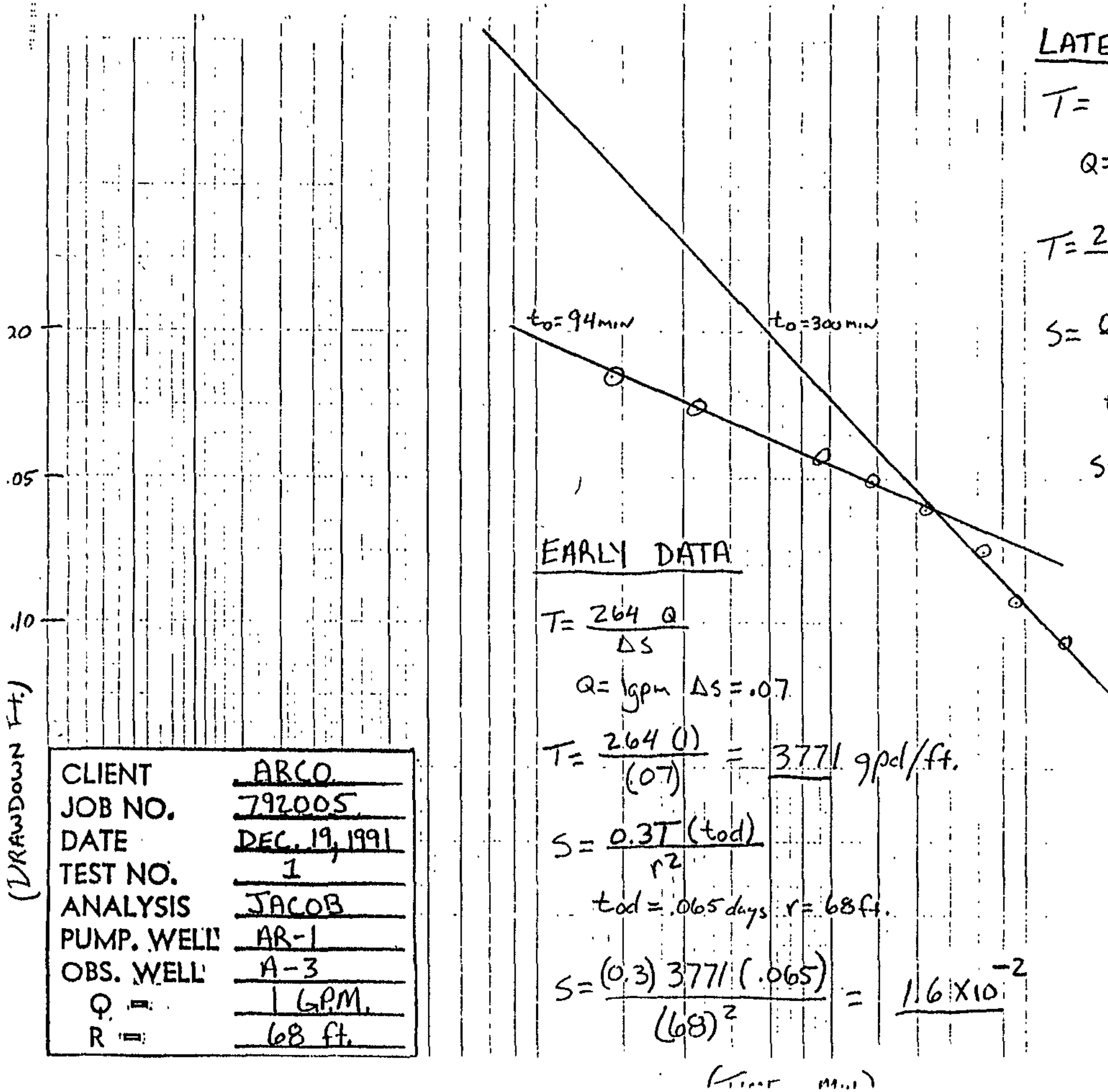
$$T = \frac{264\ (1)}{.079} = 3342 \text{ gpd/ft.}$$

$$S = \frac{0.3T\ (t_{od})}{r^2}$$

t_{od} = .03 r = 64 ft.

$$S = \frac{(0.3)\ 3342\ (.03)}{(64)^2} = 7.3 \times 10^{-3}$$

WELL A-3



LATE DATA

$$T = \frac{264\,Q}{\Delta s}$$

$Q = 1$ gpm $\Delta s = .178$

$$T = \frac{264\,(1)}{.178} = \underline{1483} \text{ gpd/ft.}$$

$$S = \frac{0.3T\,(t_{od})}{r^2}$$

$t_{od} = .21$ days, $r = 68$ ft.

$$S = \frac{(0.3)\,1483\,(.21)}{(68)^2} = \underline{2.0 \times 10^{-2}}$$

EARLY DATA

$$T = \frac{264\;Q}{\Delta s}$$

$Q = 1$ gpm $\Delta s = .07$

$$T = \frac{264\,(1)}{(.07)} = \underline{3771} \text{ gpd/ft.}$$

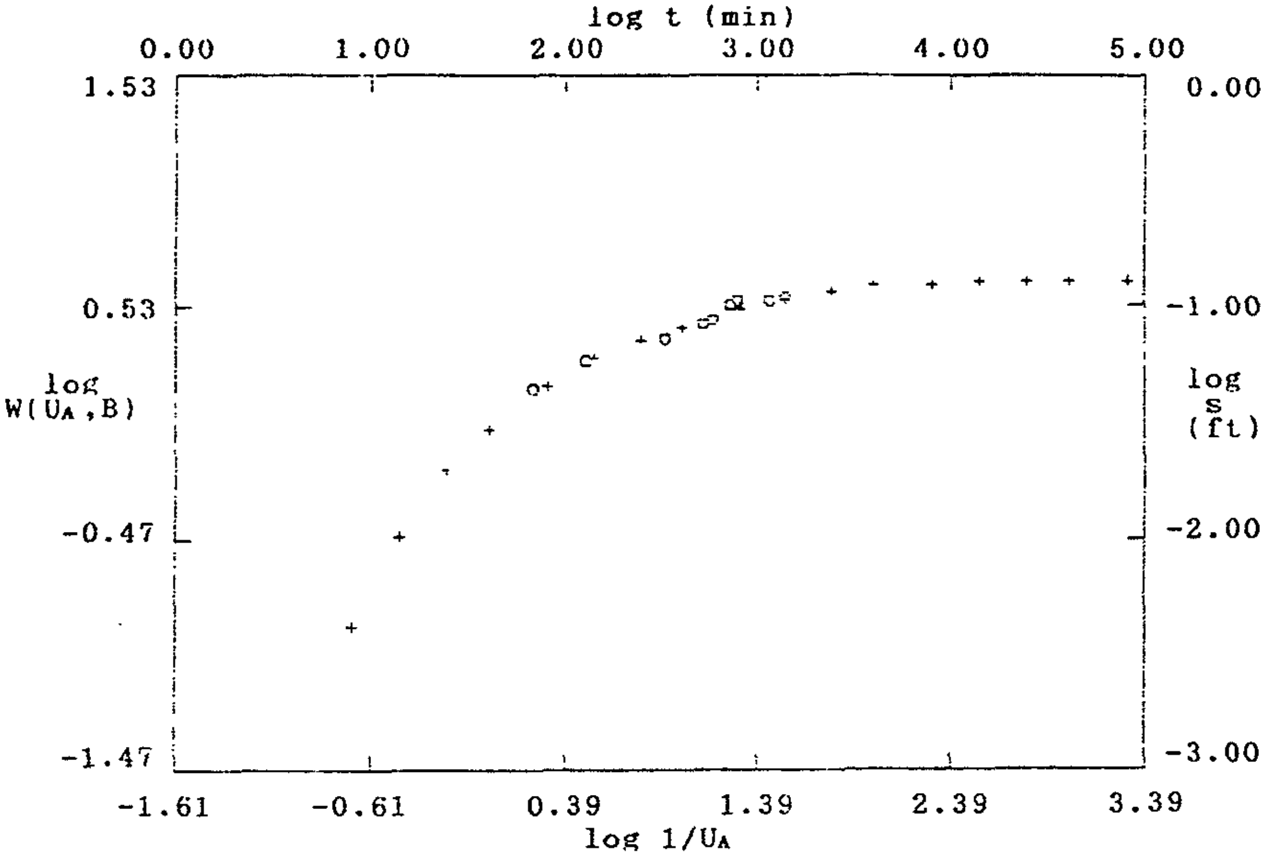
$$S = \frac{0.3T\,(t_{od})}{r^2}$$

$t_{od} = .065$ days $r = 68$ ft.

$$S = \frac{(0.3)\,3771\,(.065)}{(68)^2} = \underline{1.6 \times 10^{-2}}$$

CLIENT	ARCO
JOB NO.	792005
DATE	DEC. 19, 1991
TEST NO.	1
ANALYSIS	JACOB
PUMP. WELL	AR-1
OBS. WELL	A-3
Q =	1 GPM.
R =	68 ft.

WELL A-2



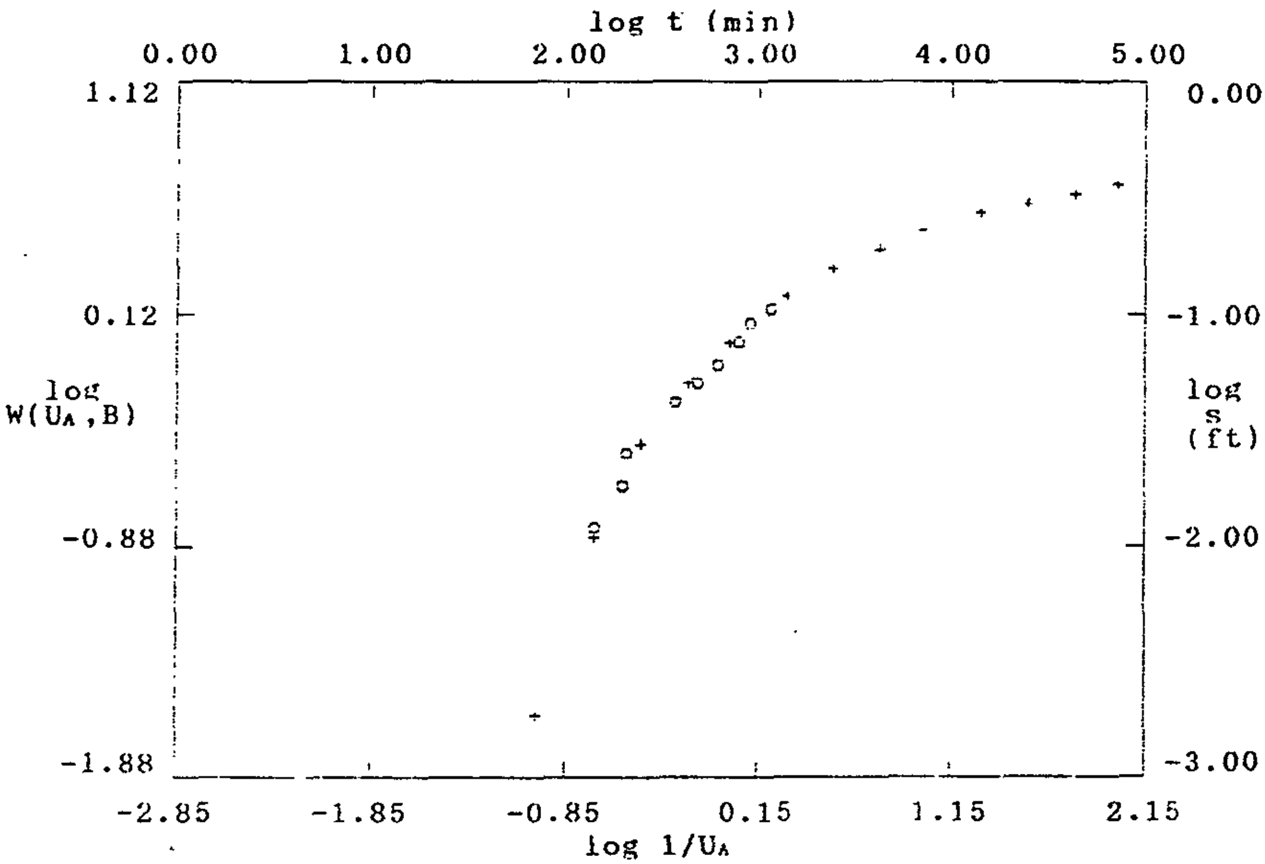
o - Data

+ - Type Curve
Unconfined Elastic: beta = 0.004

<u>SOLUTION</u>

Transmissivity = 3.882E+0003 gpd/ft
Aquifer Thick. = 1.700E+0001 ft
Hydraulic Cond.= 2.284E+0002 gpd/sq ft
Storativity = 3.585E-0003

WELL A-3

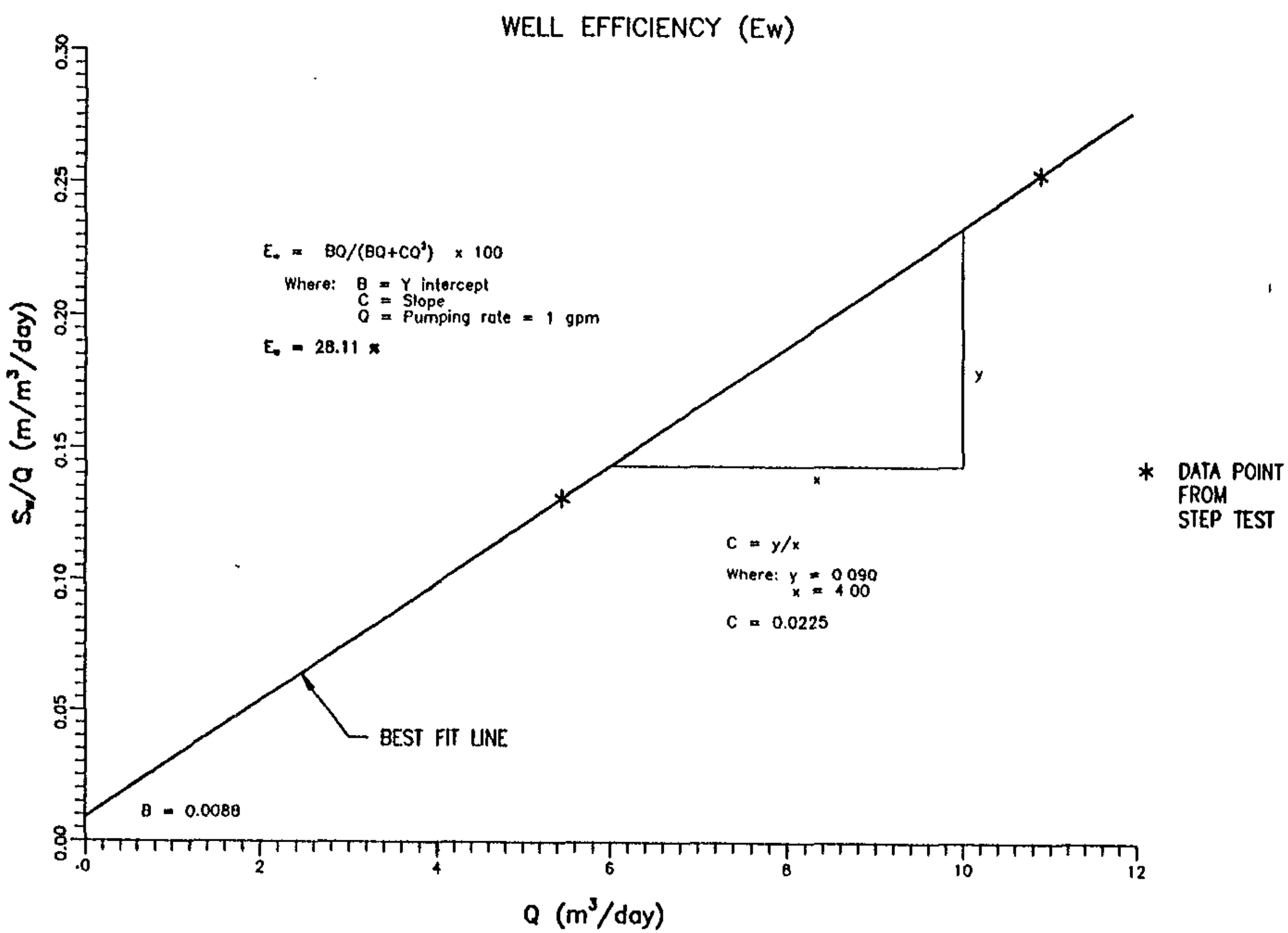


o - Data

+ - Type Curve
Unconfined Elastic: beta = 0.001

SOLUTION

Transmissivity = 1.510E+0003 gpd/ft
Aquifer Thick. = 1.700E+0001 ft
Hydraulic Cond.= 8.884E+0001 gpd/sq ft
Storativity = 2.147E-0002



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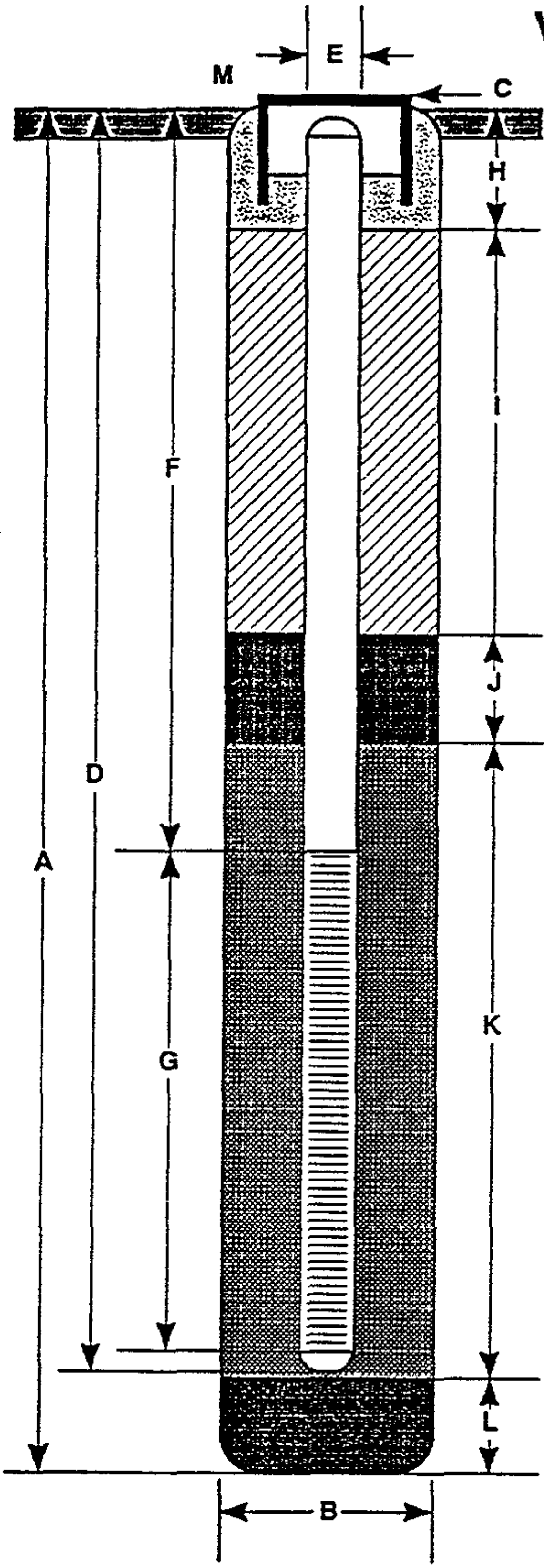
WELL EFFICIENCY
ARCO Service Station #2112
1260 Park Street
Alameda, California

PLATE 1

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
792005		8/92	

WELL CONSTRUCTION DETAIL



A	Total Depth of Boring	13	ft.
B	Diameter of Boring	10	in.
	Drilling Method	Hollow Stem Auger	
C	Top of Box Elevation	N/A	ft.
	☐ Referenced to Mean Sea Level		
	☐ Referenced to Project Datum		
D	Casing Length	13	ft.
	Material	Schedule 40 PVC	
E	Casing Diameter	4	in.
F	Depth to Top Perforations	7	ft.
G	Perforated Length	6	ft.
	Perforated Interval from	7 to 13	ft.
	Perforation Type	Continuous wrap	
	Perforation Size	0.020	in.
H	Surface Seal from	0.0 to 1.5	ft.
	Seal Material	Concrete grout	
I	Backfill from	1.5 to 5	ft.
	Backfill Material	Cement grout	
J	Seal from	5 to 7	ft.
	Seal Material	Bentonite pellets	
K	Gravel Pack from	7 to 13	ft.
	Pack Material	Lonestar #2/12 sand	
L	Bottom Seal		ft.
	Seal Material		
M	Traffic-rated box with locking well cap and lock.		

Note: Depths measured from initial ground surface.

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Well Construction Detail

WELL NO. **AV-4**

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
792006		1/92		

Field location of boring:	Project No.: 792006	Date: 1/2/92	Boring No:
(See Plate 2)	Client: ARCO Service Station No. 2112		AV-4
	Location: 1260 Park Street		
	City: Alameda, California		Sheet 1
	Logged by: R.S.Y.	Driller: ~~Bayland~~	of ~~1~~
Drilling method: Hollow Stem Auger	Casing installation data:		
Hole diameter: 10-inches	Top of Box Elevation:	Datum:	

Water Level	12'
Time	10:05
Date	1/2/92

PID (ppm)	Blows/ft.* or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
								PAVEMENT SECTION - 1 ft.
				1				
				2				
								SAND (SP) - dark brown (10YR 3/3), medium dense,
				3				moist; 90% fine sand; 5% fines.
	150	S&H		4				
	250		AV-4-					
0	250		5	5				
	psi							
				6				
				7				COLOR CHANGE to dark yellow brown (10YR 4/6), at 6 ft.
				8				
				9				
		S&H						
			AV-4-	10				strong chemical odor, slightly coarser sand.
200	14		10.5					
				11				
		S&H		12		∇		
								saturated at 12 ft.
290	10			13				COLOR CHANGE to dark gray (7.5YR 4/0).
				14				Bottom of Boring at 13 ft.
								1/2/92
				15				
				16				
				17				
				18				
				19				
				20				

Remarks:

* Converted to equivalent Standard Penetration blows/ft.

GSI GeoStrategies Inc.

Log of Boring

BORING NO. **AV-4**

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
792006	JEV	1/92		

Field location of boring:	Project No.: 792006	Date: 1/2/92	Boring No:
(See Plate 2)	Client: ARCO Service Station No. 2112		AV-5
	Location: 1260 Park Street		
	City: Alameda, California		Sheet 1
	Logged by: R.S.Y.	~~Driller: Bayland~~	~~of 1~~
	Casing installation data:		
Drilling method: Hollow Stem Auger			
Hole diameter: 10-inches	Top of Box Elevation:	Datum:	

Water Level	12'			
Time	11:45			
Date	1/2/92			

PID (ppm)	Blows/ft.* or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
								PAVEMENT SECTION - 1 ft.
				1				
								brick fragments from 1 to 3 ft.
				2				
								SAND (SP) - very dark grayish brown (10YR 3/2),
				3				medium dense, moist; 95% fine sand; 5% fines.
			AV-5-					
0	500	S&H	4	4				
	psi							
				5				
				6				
				7				
				8				
				9				
		S&H						CLAYEY SAND (SC) - olive gray (5Y 4/2), very stiff,
			AV-5-	10				moist; 80% fine sand; 20% clay.
23	20		10.5					
				11				
		S&H		12		▽		
								saturated at 12 ft.
10	22			13				
								Bottom of Boring at 13 ft.
				14				1/2/92
				15				
				16				
				17				
				18				
				19				
				20				

Remarks:

* Converted to equivalent Standard Penetration blows/ft.

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Log of Boring

BORING NO. **AV-5**

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
792006	JW	1/92		

Field location of boring:	Project No.: 792006	Date. 1/2/92	Boring No:
(See Plate 2)	Client: ARCO Service Station No. 2112		AV-6
	Location: 1260 Park Street		
	City: Alameda, California		Sheet 1
	Logged by: R.S.Y.	Driller: ~~Bayland~~	of ~~1~~
	Casing installation data:		
Drilling method: Hollow Stem Auger			
Hole diameter: 10-inches	Top of Box Elevation:	Datum:	

Water Level	12'			
Time	13:15			
Date	1/2/92			

PID (ppm)	Blows/ft.* or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
								PAVEMENT SECTION - 1 ft.
				1				
				2				SAND (SP) - dark yellow brown (10YR 4/4), medium dense, moist; 95% fine sand; 5% fines.
				3				
	250	S&H		4				
	250		AV-6-					
0	250 psi		5	5				
				6				
				7				
				8				
				9				COLOR CHANGE to yellowish brown (10YR 5/6) at 8 ft.
		S&H						
			AV-6-	10				
0	30		10.5					
				11				
								saturated at 12 ft.
		S&H		12		▽		COLOR CHANGE to olive gray (5Y 4/2) at 12 ft.
0	19			13				
								Bottom of Boring at 13 ft.
				14				1/2/92
				15				
				16				
				17				
				18				
				19				
				20				

Remarks:

* Converted to equivalent Standard Penetration blows/ft.

GSI GeoStrategies Inc.

Log of Boring

BORING NO. **AV-6**

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
792006	[signature]	1/92		

Field location of boring:	Project No.: 792006	Date: 1/2/92	Boring No: AV-7
(See Plate 2)	Client: ARCO Service Station No. 2112		
	Location: 1260 Park Street		
	City: Alameda, California		Sheet 1 of 1
	Logged by: R.S.Y.	Driller: Bayland	
	Casing installation data:		

Drilling method: Hollow Stem Auger

Hole diameter: 10-inches

Top of Box Elevation: | Datum:

Water Level	12'			
Time	15:00			
Date	1/2/92			

PID (ppm)	Blows/ft.* or Pressure (psi)	Type of Sample	Sample Number	Depth (ft.)	Sample	Well Detail	Soil Group Symbol (USCS)	Description
								PAVEMENT SECTION - 1 ft.
				1				
				2				
				3				SAND (SP) - dark yellow brown (10YR 4/6), medium dense, moist; 95% fine sand; 5% fines.
	250	S&H		4				
	250		AV-7-					
4.1	250		5	5				
	psi							
				6				
				7				
				8				
				9				
		S&H						COLOR CHANGE to dark gray (5Y 4/1) at 9 ft.
			AV-7-	10				
2.5	15		10.5					
				11				
		S&H		12		∇		saturated at 12 ft.
			AV-7-					
0	15		13	13				
								Bottom of Boring at 13 ft.
				14				1/2/92
				15				
				16				
				17				
				18				
				19				
				20				

Remarks:

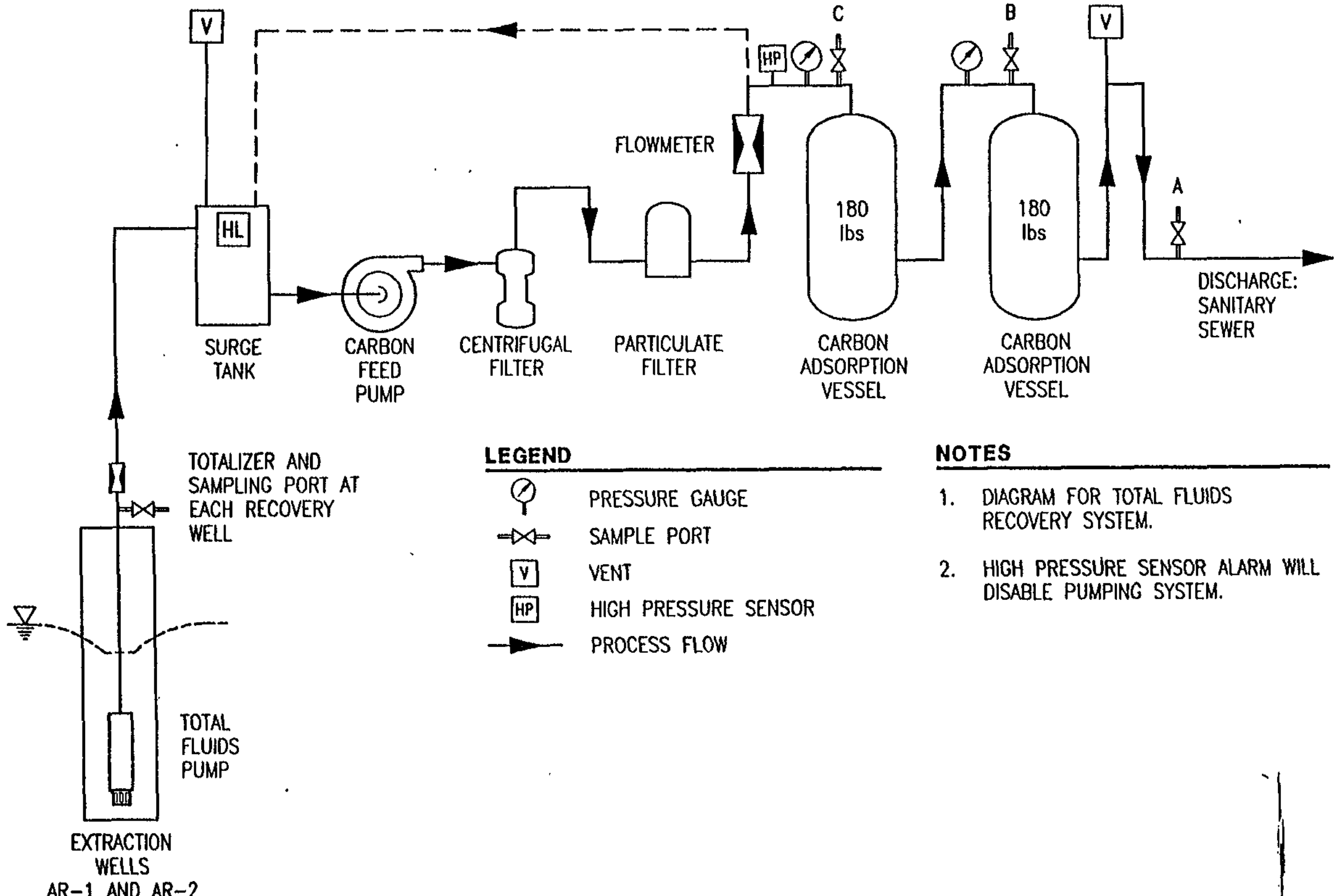
* Converted to equivalent Standard Penetration blows/ft.

GSI GeoStrategies Inc.

Log of Boring

BORING NO. **AV-7**

JOB NUMBER	REVIEWED BY RG/CEG	DATE	REVISED DATE	REVISED DATE
792006	[signature]	1/92		



NOTES

1. DIAGRAM FOR TOTAL FLUIDS RECOVERY SYSTEM.
2. HIGH PRESSURE SENSOR ALARM WILL DISABLE PUMPING SYSTEM.

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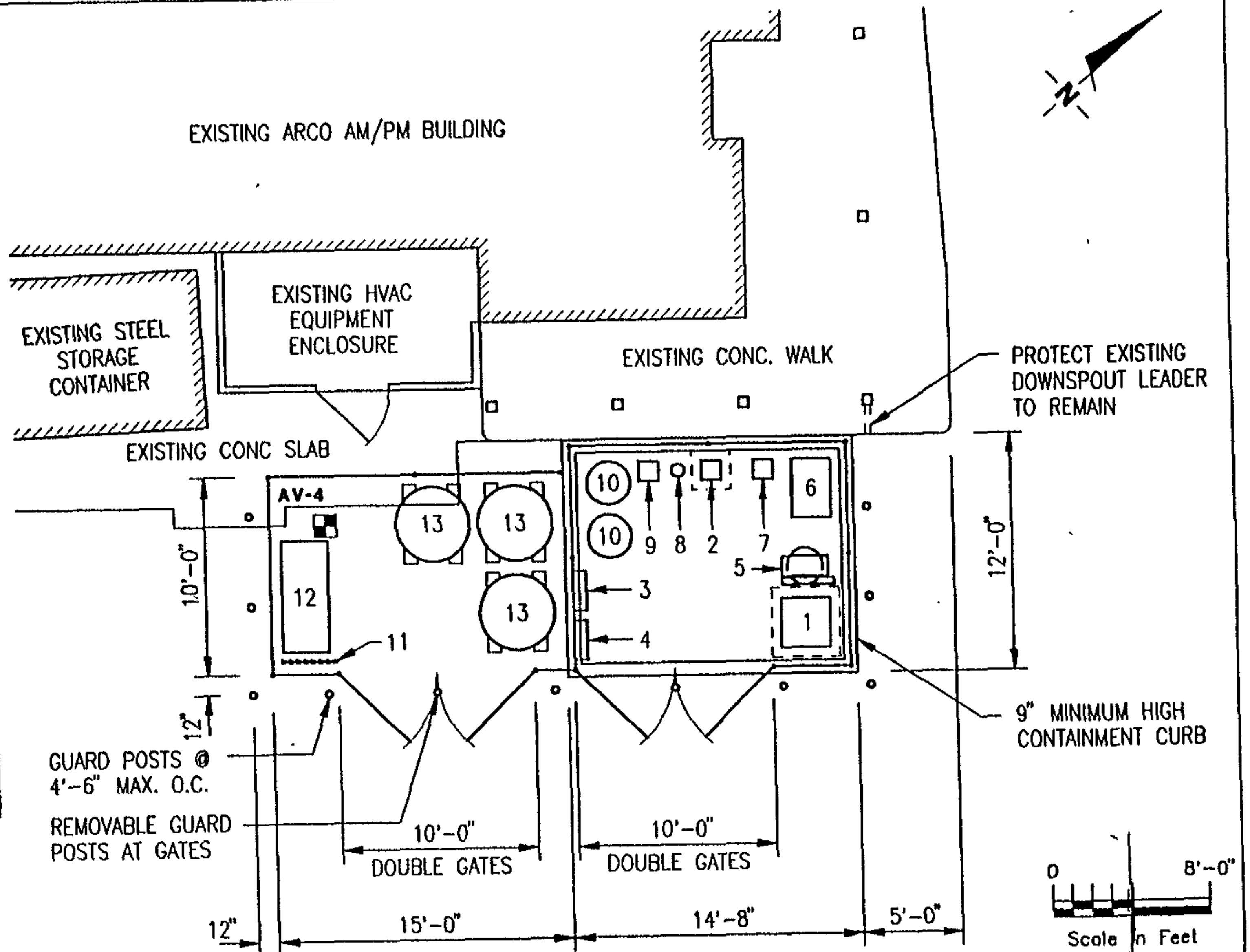
GROUNDWATER SYSTEM PROCESS FLOW DIAGRAM
ARCO Service Station #2112
1260 Park Street
Alameda, California

PLATE 5

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
792012-7	gcm	9/92	

EQUIPMENT SCHEDULE	
ITEM	DESCRIPTION
1	PIPING JUNCTION BOX
2	TREATMENT PAD SUMP
3	100 AMP SUB PANEL
4	CONTROL PANEL
5	AIR COMPRESSOR
6	SURGE TANK
7	CARBON FEED PUMP
8	CENTRIFUGAL FILTER
9	PARTICULATE FILTER
10	CARBON VESSEL (GW)
11	VAPOR MANIFOLD
12	VAPOR EXTRACTION SKID
13	CARBON VESSEL (VAP)



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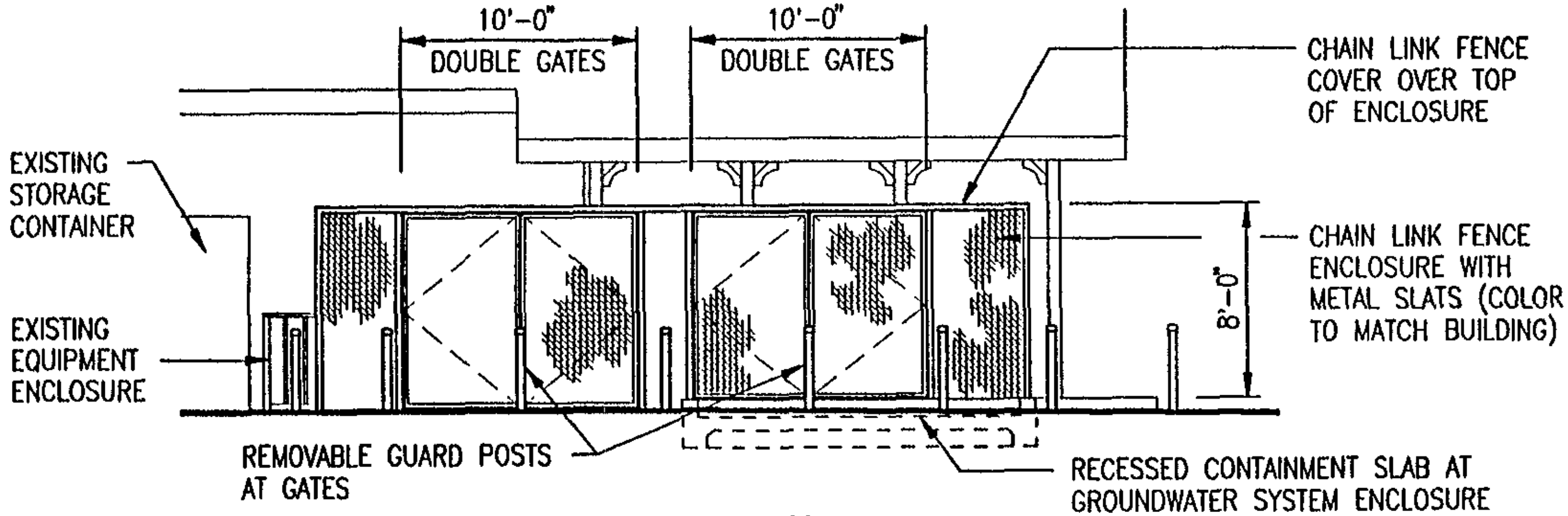
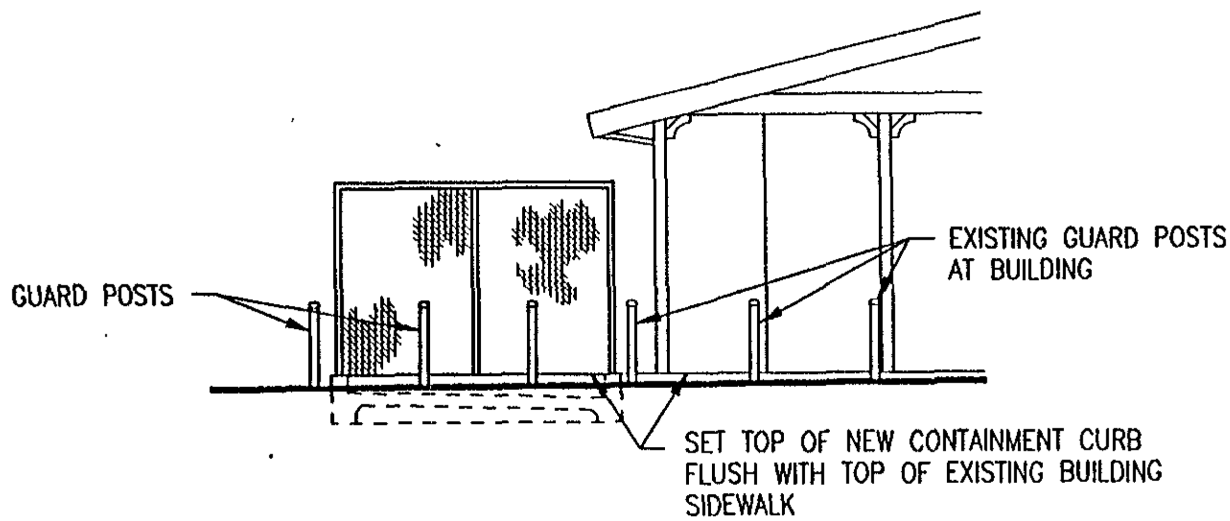
TREATMENT SYSTEM ENCLOSURE PLAN
ARCO Service Station #2112
1260 Park Street
Alameda, California

PLATE 7

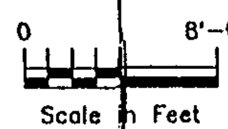
JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
792012-7	gcm	9/92	



SOUTHEAST ELEVATION



NORTHEAST ELEVATION



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TREATMENT SYSTEM ENCLOSURE ELEVATIONS
ARCO Service Station #2112
1260 Park Street
Alameda, California

PLATE 8

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
792012-7	JCM	9/92	

GROUNDWATER TREATMENT SYSTEM
OPERATION AND MAINTENANCE

System Start-up

Prior to start-up of the system, the carbon vessels will be filled with domestic water and allowed to sit for 24 hours. The system will then be operated until the vessels have been emptied and refilled with groundwater. At this time, a water sample will be collected from the effluent to the sewer. The sample will be analyzed by EPA Methods 8015 (Modified) and 8020 to identify concentrations of TPH-Gasoline and Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX). During these and all subsequent samplings, the effluent flow rate, temperature, pH and specific conductance will be measured and recorded. Effluent samples will be collected and analyzed for TPH-Gasoline and BTEX three times in the first week. A 24-hour turnaround will be requested for analytical results. If TPH-Gasoline or BTEX are detected above the EBMUD allowable limits, the system will be shut down and inspected. The EBMUD will be notified at this time. Modifications will be performed to bring the system into compliance with the EBMUD permit requirements and the system restarted.

Water Sampling

Following the first week start-up period, the three sample ports on the treatment system will be sampled on a weekly basis for eight weeks and analyzed for TPH-Gasoline and BTEX by EPA Method 8015 (Modified) and 8020. Sampling following the first eight weeks of operation will be on a monthly basis.

Routine System Operation

System inspection and maintenance will be performed every two weeks. If the results of chemical analysis of the effluent water sample exceed established discharge criteria, the system will immediately be shut down. Subsequently, the system will be inspected, repaired or modified, and reactivated.

When chemical analytical results indicate that breakthrough has occurred on the leading carbon vessel, it will be temporarily removed from service while the carbon is replaced with virgin carbon. The second vessel will then become the lead vessel.

PROJECT NUMBER - 7920
ARCO SERVICE STATION NO. 2112
1260 Park Street
Alameda, California

Vapor Treatment
Carbon Use Estimate

Formula:

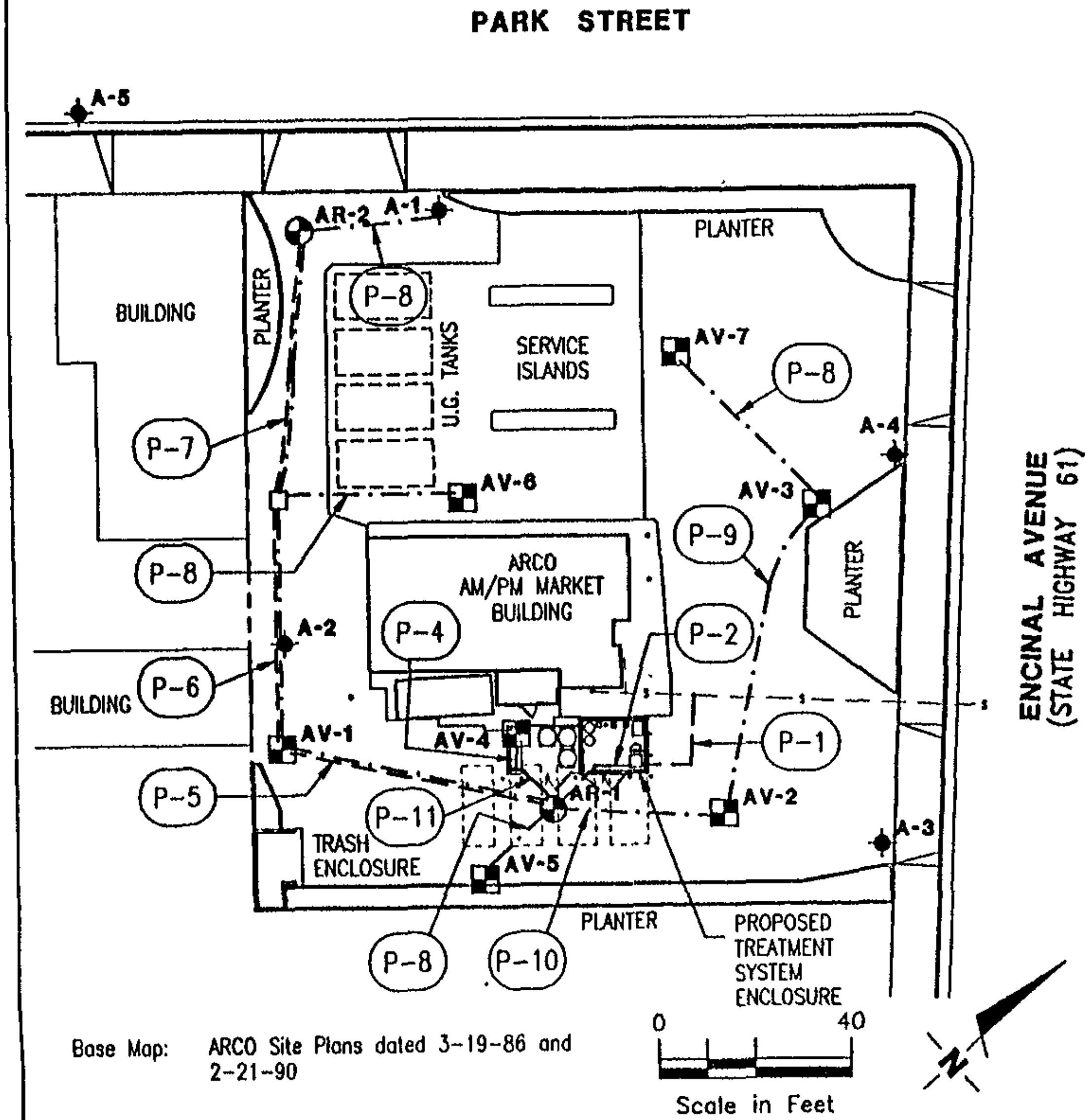
$$\text{Concentration, ppmv} \times \frac{1 \text{ lb*mol AIR}}{386 \text{ cubic feet}} \times \text{flowrate, } \frac{\text{cubic feet}}{\text{minute}} \times 1440 \frac{\text{minutes}}{\text{day}} \times 65 \frac{\text{lb TPH-G}}{\text{lb*mol TPH-G}} \times \frac{1 \text{ lb Carbon}}{0.2 \text{ lb TPH-G}} = \frac{\text{lb Carbon}}{\text{day}}$$

Note: A carbon loading rate of $\frac{0.2 \text{ lb TPH-G}}{1.0 \text{ lb Carbon}}$ is the industry standard supplied by Westates Carbon.

Assume a maximum of 160 cfm and 200 ppmv TPH-G:

$$200 \times 10^{-6} \frac{\text{lb*mol TPH-G}}{\text{lb*mol AIR}} \times \frac{1 \text{ lb*mol AIR}}{386 \text{ cubic feet}} \times 160 \frac{\text{cubic feet}}{\text{minute}} \times 1440 \frac{\text{minutes}}{\text{day}} \times 65 \frac{\text{lb TPH-G}}{\text{lb*mol TPH-G}} \times \frac{1 \text{ lb Carbon}}{0.2 \text{ lb TPH-G}} = 38.8 \frac{\text{lbs Carbon}}{\text{day}}$$

A 2000 pound carbon vessel will last 52 days, use 2 months.



Base Map: ARCO Site Plans dated 3-19-86 and 2-21-90

EXPLANATION

- Ground-water monitoring well
- Ground-water recovery well
- Vapor extraction well
- Proposed ground-water recovery well
- Proposed ground-water recovery piping lines
- Proposed vapor recovery piping lines and/or air sparging lines
- Piping junction box

RECOVERY SYSTEM PIPING SCHEDULE

LINE NO.	GROUNDWATER SYSTEM PIPING	VAPOR RECOVERY SYSTEM PIPING	AIR SPARGING SYSTEM PIPING
P-1	(1) 4" Sch. 40 PVC	N/A	N/A
P-2	(1) 4" Sch. 40 PVC	N/A	N/A
P-3	N/A	N/A	(DELETED)
P-4	N/A	(1) 3" Sch. 40 PVC	N/A
P-5	(1) 4" Sch. 40 PVC	(3) 3" Sch. 40 PVC	(1) 1 1/2" Sch. 80 PVC
P-6	(1) 4" Sch. 40 PVC	(2) 3" Sch. 40 PVC	(1) 1 1/2" Sch. 80 PVC
P-7	(1) 4" Sch. 40 PVC	(1) 3" Sch. 40 PVC	(1) 1 1/2" Sch. 80 PVC
P-8	N/A	(1) 3" Sch. 40 PVC	(1) 1 1/2" Sch. 80 PVC
P-9	N/A	(2) 3" Sch. 40 PVC	(1) 1 1/2" Sch. 80 PVC
P-10	N/A	(3) 3" Sch. 40 PVC	(1) 1 1/2" Sch. 80 PVC
P-11	N/A	(7) 3" Sch. 40 PVC	(1) 1 1/2" Sch. 80 PVC

GSI GeoStrategies Inc.

SITE PLAN
ARCO Service Station #2112
1260 Park Street
Alameda, California

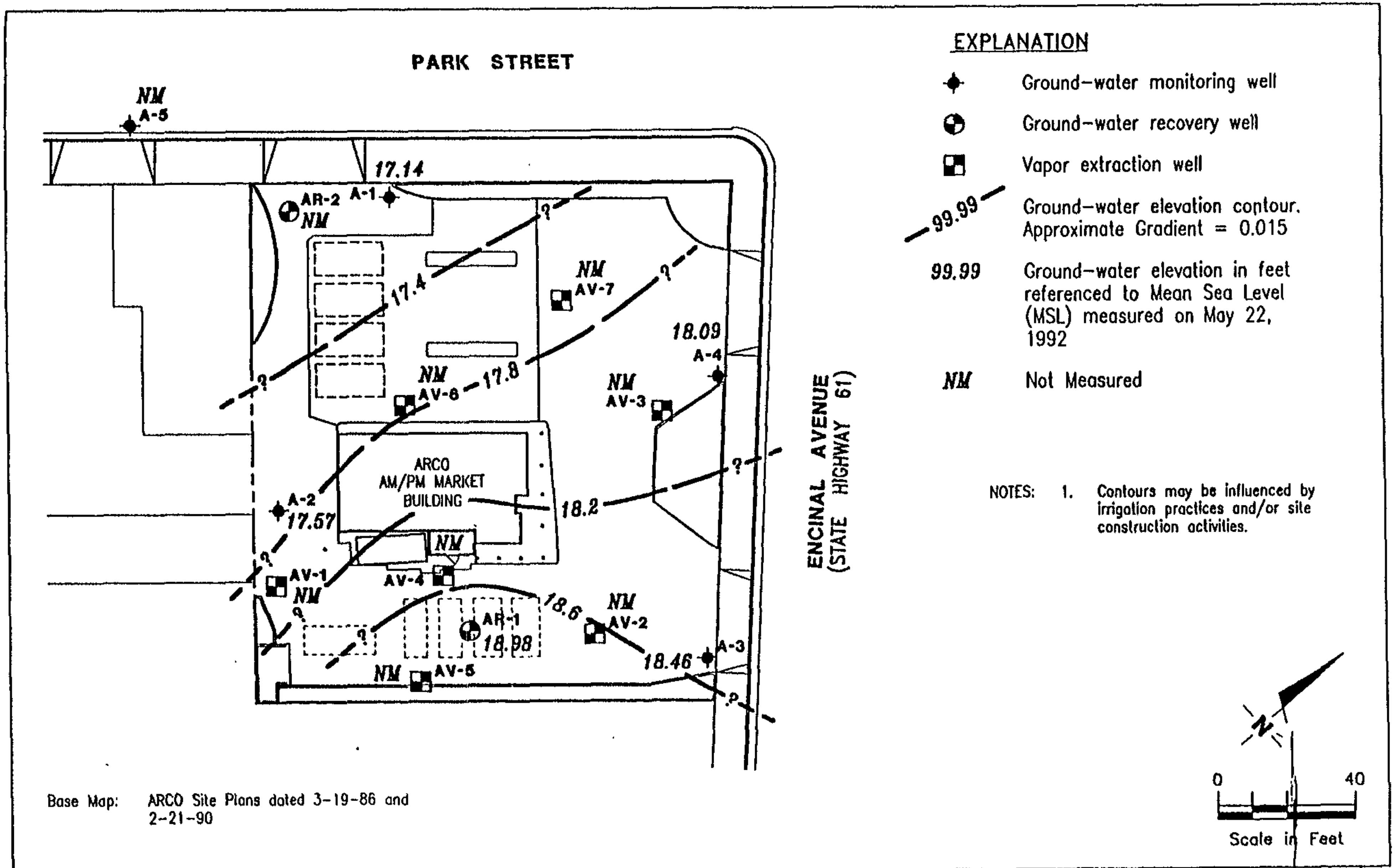
PLATE 1

JOB NUMBER 792012-7

REVIEWED BY JCM

DATE 9/92

REVISED DATE



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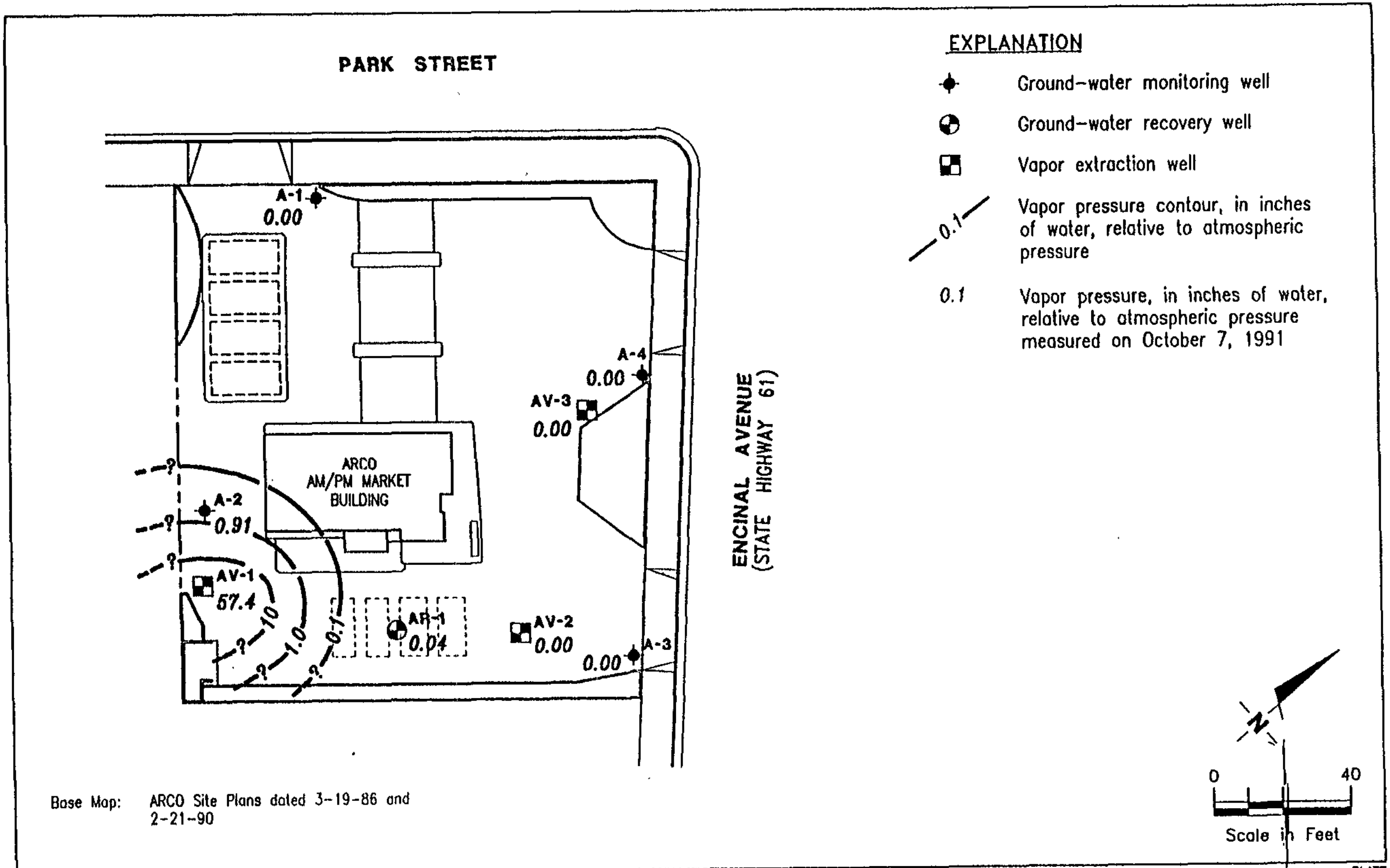
POTENTIOMETRIC MAP
ARCO Service Station #2112
1260 Park Street
Alameda, California

PLATE 2

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
792012-7	CMG	9/92	



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VACUUM PRESSURE INFLUENCE MAP
ARCO Service Station #2112
1260 Park Street
Alameda, California

PLATE 4

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
792012-7	CMG	9/92	

APPENDIX B

Ground-water Analytical Data

Ground-water samples were collected from the monitoring network upon completion of the well installation and development. Sampling results from the February 18, 1992 sampling event were used to construct a Benzene Concentration Map (Plate 3). The historical groundwater analytical database is presented in Table 1.

VAPOR EXTRACTION TEST RESULTS

On October 2, 1991, GSI performed a 6-hour vapor extraction test to evaluate the feasibility of vapor extraction as a soil remediation method. Results of the vapor extraction test are presented in the GSI Continuing Site assessment/Quarterly Monitoring report, dated January 27, 1992.

Evaluation of Data

Data collected during the vapor extraction test indicate a radius of influence extending approximately 40 feet from the vapor extraction well AV-1 (see Plate 4). Laboratory analysis detected TPH-Gasoline and benzene in the extracted vapors at concentrations of 530 and 16 ppm, respectively. The flow rate varied during the test from 45 to 60 cubic feet per minute (cfm) (Table 3).

Assuming an average flow rate of 50 cfm and the above concentrations, 4.2 pounds of TPH-Gasoline and 0.18 pounds of Benzene are estimated to have been recovered during the test. Over a 24-hour period, this would result in the maximum recovery of 16.8 lbs of TPH-Gasoline and 0.74 lbs of Benzene. It is anticipated that lower recovery rates will be observed during long term operation of the vapor extraction system.

Based on available data, it appears that the eight vapor extraction wells (Plate 1) are sufficient to address the known soil hydrocarbon contamination at this site.

AQUIFER TEST RESULTS

During December 18 and 19, 1991, GSI performed a 4-hour step draw-down and a 24-hour constant-rate test in order to evaluate the feasibility of ground-water extraction as a ground-water remediation method.

The step-drawdown test was performed in order to select the optimum discharge rate for the constant-rate portion of the test. The constant-rate test results were used to evaluate the area of influence from pumping and calculate the hydraulic properties of the shallow aquifer zone underlying the site. Aquifer test results are presented in the pending GSI Aquifer Test/Vapor Well Installation report.

Evaluation of Data

Drawdown data collected from monitoring wells A-2 and A-3 during the aquifer test indicate that a discharge rate of 1.0 gallon per minute appeared to produce a radius of influence that varied from 60 to 80 feet from Recovery Well AR-1. Calculated storativity values appear to be consistent with an aquifer that is unconfined to semi-confined in nature.

Based on available data it appears that ground-water extraction is a viable method of gaining hydrologic control of the known hydrocarbon plume.

PURPOSE OF REMEDIATION

The purpose of remediation will be to hydrodynamically control and remove identified hydrocarbons in the shallow groundwater and to remove identified hydrocarbons in the soil beneath the site. Remediation will be implemented for the purpose of obtaining eventual site closure from Alameda County Department of Health Services and the State of California Regional Water Quality Control Board.

GROUNDWATER REMEDIATION DESIGN

Recovery Wells AR-1 and AR-2 will be utilized to control and extract dissolved hydrocarbons for treatment. The locations of Wells AR-1 and AR-2 were chosen because of their locations with respect to the dissolved hydrocarbon plume, the hydraulic gradient and the estimated radius of influence observed during the aquifer test.

Flow Calculations

Based on aquifer test data, a combined flow rate from Recovery Wells AR-1 and AR-2 is estimated to be in the range of 2 to 4 gpm.

System Components

The ground-water extraction and treatment system will consist of total-fluids pump systems installed in Recovery Wells AR-1 and AR-2 to attenuate dissolved hydrocarbons in the uppermost water-bearing zone. Groundwater containing dissolved hydrocarbons will be pumped from Recovery Wells AR-1 and AR-2 to the on-site treatment facility. Components of the treatment facility will consist of two particulate filters, and two 180-pound carbon adsorption vessels in series. Groundwater will be treated in the carbon vessels, and discharged to the sanitary sewer. The process flow diagram, treatment system plan and elevation are presented on Plates 5, 7 and 8.

Carbon Usage

Groundwater extracted from Recovery Wells AR-1 and AR-2 will be routed to the particulate filters and then to the carbon adsorption vessels. The carbon vessels have been sized to provide a minimum of 30 days each of treatment at a maximum anticipated flowrate of 4 gpm and a maximum TPH-Gasoline concentration of 2,000 parts per billion (ppb). At the anticipated flow rate of 2 gpm and an anticipated TPH-Gasoline concentration of 200 ppb, a 180 pound carbon vessel should provide more than 5 years of treatment before breakthrough. Water treatment carbon usage calculations are presented in Appendix A.

Additional Extraction Wells

Should additional extraction wells be necessary to mitigate ground - water conditions, the proposed system design is capable of treating the additional expected water flow up to a maximum of 10 gpm.

SOIL REMEDIATION DESIGN

The soil vapor extraction and treatment system will consist of a vacuum blower connected to Vapor Extraction Wells AV-1 through AV-7 and Monitoring Well A-1. The hydrocarbon vapors will be adsorbed onto activated carbon.

Based on the results of the vapor extraction test, vapor extraction from these wells is estimated to provide a sufficient radius of influence to begin remediation of soil contamination.

System Components

The vapor process flow diagram is included on Plate 6. A 5-hp positive displacement blower will be used to draw contaminated vapor from the soil. A water separator will be used to remove excess entrained water in the airstream prior to entry into the blower. The blower will supply contaminated vapor to the carbon treatment system. Carbon treatment will consist of three 2000 lb. carbon vessels in series. The treatment system flow diagram, enclosure plan and elevations are included on Plates 6, 7, and 8.

An influent concentration of 200 ppm and a flowrate of 160 scfm was used to size the vapor treatment system. This estimate is based on an average of 40 scfm from four vapor extraction wells. In order to provide dilution capability and system flexibility, all vapor wells will be manifolded separately (Plate 6). Outside air dilution capability will also be provided to maintain minimum required air flow through the vapor extraction blower.

Carbon Usage

Soil vapors extracted from Vapor Extraction Wells AV-1 through AV-7 and A-1 will be routed to the water separator and then to the carbon adsorption vessels. The carbon vessels have been sized to provide a minimum 30 days each of treatment at a maximum anticipated flowrate of 160 scfm and an initial TPH-Gasoline concentration of 200 ppm. Long-term TPH-Gasoline concentrations are expected to fall below 100 ppm. At this concentration a 2000 pound carbon vessel will provide up to six months of treatment. Vapor treatment carbon usage calculations are presented in Appendix A.

SYSTEM DISCHARGE PERMITS

The interim ground-water extraction and treatment system requires an East Bay Municipal Utility District (EBMUD) Sanitary Sewer System permit for effluent discharge.

A permit from the Bay Area Air Quality Management District (BAAQMD) for discharge of treated effluent has been obtained for operation of the vapor extraction system.

SYSTEM OPERATION AND MAINTENANCE

System operation and maintenance plans for the water and vapor treatment systems have been prepared and are presented in Appendix A.

SYSTEM EVALUATION

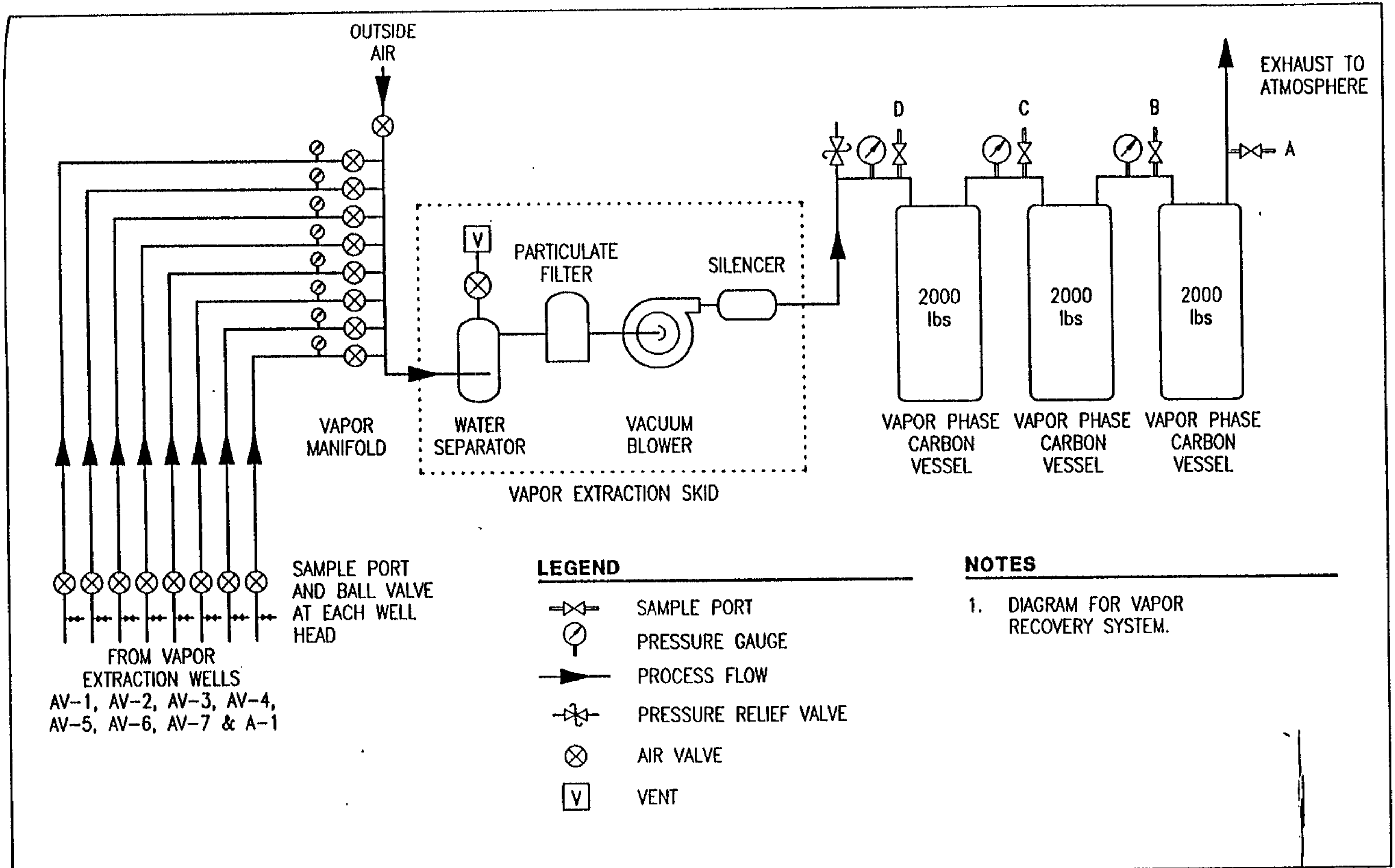
An interim remedial system evaluation report will be prepared after 60 days of continuous system operation. The report will include a brief site history and evaluation of chemical and potentiometric data as they relate to system performance and efficiency.

TABLE 3

VACUUM PRESSURE RESULTS FOR WELL AV-1

TIME (minutes since start-up)	INFLUENT CONCENTRATION (ppm)	VACUUM PRESSURE AT WELL HEAD (inches of water)	FLOWRATE (cubic feet/min.)
11	860	42.3	45.8
78	600	53.7	52.7
139	500	56.4	55.1
195	440	58.0	58.3
259	400	58.9	60.3
311	360	58.3	59.8
336	350	57.4	58.8

PPM = Parts Per Million, measured by field instrument calibrated to hexane.



GSI GeoStrategies Inc.

VAPOR SYSTEM PROCESS FLOW DIAGRAM
ARCO Service Station #2112
1260 Park Street
Alameda, California

PLATE **6**

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
792012-7	*gcm*	9/92	

VAPOR TREATMENT SYSTEM OPERATION AND MAINTENANCE

System Start-up

Upon notification of the BAAQMD, the system will be operated until the carbon vessels have been filled with extracted soil vapors. Samples will be taken from the blower exhaust, between the first and second carbon vessels, and after the third carbon vessel. Samples will be analyzed by EPA Methods 8015 (Modified) and 8020 to identify concentrations of TPH-Gasoline and Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX). During these and all subsequent samplings, the effluent air flow rate will be measured and recorded. Samples will be collected and analyzed for TPH-Gasoline and BTEX daily until a breakthrough estimate has been established. A 24-hour turnaround will be requested for analytical results. If TPH-Gasoline or BTEX are detected above the BAAQMD allowable limits, the system will be shut down and inspected. The BAAQMD will be notified at this time. Modifications will be performed to bring the system into compliance with the BAAQMD permit requirements and the system restarted.

Vapor Sampling

The three sample parts on the vapor treatment system will be sampled on a daily basis for TPH-Gasoline and BTEX. Sampling following the start-up period will be based on the results of the breakthrough estimation. Once a breakthrough period has been established and given BAAQMD approval the sampling frequency will be reduced.

Routine System Operation

System inspection and maintenance will be performed every two weeks. If the results of chemical analysis of the effluent vapor sample exceed established discharge criteria, the system will immediately be shut down. Subsequently, the system will be inspected, repaired or modified, and reactivated.

When chemical analytical results indicate that breakthrough has occurred on the leading carbon vessel, it will be temporarily removed from service while the carbon is replaced with virgin carbon. The second vessel will then become the lead vessel.

PROJECT NUMBER - 7920
ARCO SERVICE STATION NO. 2112
1260 Park Street
Alameda, California

Carbon Use Estimate

Formula:*

$$\text{Concentration, mg/l} \times \frac{3.8\ \text{l}}{\text{gal}} \times \frac{\text{lb carbon}}{0.08\ \text{lb TPH-G}} \times \frac{\text{lb}}{454{,}000\ \text{mg}} \times \frac{1440\ \text{min.}}{\text{day}} \times \frac{\text{gal}}{\text{min}} = \frac{\text{lb of carbon}}{\text{day}}$$

* Treatment Technology for Removal of Dissolved Gasoline from Groundwater, API Publication 4369, May 1983

Assume maximum of 4 gpm and 2 mg/l TPH-G

$$2\ \text{mg/l TPH-G} \times \frac{3.8\ \text{l}}{\text{gal}} \times \frac{\text{lb carbon}}{0.08\ \text{lb TPH-G}} \times \frac{\text{lb}}{454{,}000\ \text{mg}} \times \frac{1440\ \text{min.}}{\text{day}} \times 4\ \text{gpm} = 1.2\ \text{lbs carbon/day}$$

A 180 pound carbon vessel will last approximately 140 days.

Assume a flow rate of 2 gpm and 0.2 mg/l TPH-G

$$0.2\ \text{mg/l TPH-G} \times \frac{3.8\ \text{l}}{\text{gal}} \times \frac{\text{lb carbon}}{0.08\ \text{lb TPH-G}} \times \frac{\text{lb}}{454{,}000\ \text{mg}} \times \frac{1440\ \text{min.}}{\text{day}} \times 2\ \text{gpm} = 0.06\ \text{lbs carbon/day}$$

A 180 pound carbon vessel will last greater than 5 years.