



**Chevron** U.S.A. Inc.

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Marketing Department

1992  
January 21, 1991

92 JAN 23 11:12:33

Mr. Scott Seery  
Alameda County Environmental Health  
80 Swan Way, Room 200  
Oakland, CA 94621

Re : Former Chevron Service Station #9-2960  
2416 Grove Way, Castro Valley, CA 94546

Mr. Seery :

Enclosed is the soil vapor extraction pilot test report dated January 15, 1992. Test results indicate that a soil vapor extraction system will work favorably at this site. By extracting vapors from well, C-1, vacuum influence was recorded in all monitoring points on-site. However, there was little or no influence in the monitoring points off-site. Two other extraction points (C-2 and C-3) were tested and both showed good vacuum influence. A work plan is currently being prepared that will include a soil vapor extraction system.

If you have any questions or comments, please feel free to call me at (510) 842-8752.

Sincerely,

Kenneth Kan  
Engineer

LKAN/MacFile 9-2960R2

Enclosure

cc : Mr. Rich Hiett  
RWQCB-S.F. Bay Region  
2101 Webster Street, Suite 500  
Oakland, CA 94612

Ms. Bette Owen  
Chevron U.S.A., Inc.



revised 2/10/92  
LOS

100 TTH

92 JAN 23 09:19:33

1992

January 15, ~~1991~~

Mr. Kenneth L. Kan  
Chevron U.S.A., Inc.  
P.O. Box 5004  
San Ramon, CA 94583

Re: Soil Vapor Extraction Test Report  
Former Chevron Service Station #9-2960  
2416 Grove Way  
Castro Valley, California  
WA Job #4-552-13

Dear Mr. Kan:

This letter presents the results of Weiss Associates' (WA) soil vapor extraction (SVE) test performed at the above referenced site (Figure 1). The test was conducted on December 18 and 19, 1991. The purpose of the test was to evaluate SVE feasibility and determine system design requirements, and to provide information to select cost-effective vapor treatment methods. The test provided data to assess vapor extraction flow rates, vacuum requirements, extent of vacuum influence, hydrocarbon concentrations in extracted vapor and hydrocarbon removal rates. **Test results indicate that SVE from existing wells will effectively remove hydrocarbons from subsurface soil.**

**SITE CONDITIONS**

The site is currently an abandoned, unpaved lot (Figure 2). Ground surface dips towards the northwest at a grade of about 5 %. Previous subsurface investigations indicate a sandy clay layer from about two to seven ft below ground surface which is overlain by fill material. Beneath this clay, sediments consists primarily of interbedded moderate to high permeability sands to the explored depth of about 30 ft. Lower permeability sediments appear in the northwest corner of the site at well C-2 from about 18 to 29 ft. The former underground tank site near the center of the property was backfilled with native soil. The upper nine ft of well C-1 penetrates the edge of this backfilled area. Ground water is about 16 ft below ground surface at well C-2 and about 20 ft below ground surface at well C-4. Ground water flows generally southwest at a gradient of about 0.005 ft/ft.

## SOIL VAPOR EXTRACTION TEST PROCEDURES

The rationale for selecting the wells used in this test, vacuum influence probe installation, the test equipment, and data collection and interpretation methodologies are described below.

### Extraction Well Selection

WA extracted soil vapor from the three monitoring wells with the highest hydrocarbon concentrations (Figure 2). Monitoring well C-1, located at the southwestern edge of the backfilled underground tank excavation, has about one ft of separate-phase hydrocarbon and consequently the highest hydrocarbon concentrations in ground water. September 1991 analytic results for ground water show 3.6 parts per million (ppm) Total Petroleum Hydrocarbons as Gasoline (TPH-G) in well C-2 and 0.26 ppm TPH-G in well C-3. Hydrocarbons were not detected in the other wells except for trace concentrations in well C-4. All monitoring wells are screened from about 5 to their total depth of 30 ft below ground surface.

### Vacuum Influence Probe Installation

As shown in Figure 2, we installed five vacuum influence probes onsite. Points VP-1, -2, -4 and -5 were installed to evaluate the radius of influence in the direction of highest hydrocarbon concentrations detected in ground water. VP-3 was installed to determine if vapor preferentially flows through the tank excavation backfill. This was especially a concern when extracting from well C-1 because the well log indicates that the upper nine ft of casing, including the top two ft of screen intersects this backfill.

Each vacuum influence probe consisted of a 1-inch diameter pipe with a 3-ft perforated section at the bottom. All five points were set at a total depth of about 15 ft. An initial 2-inch diameter pilot hole was drilled to a depth of about 10 ft and the point was then driven to its total depth using an electric jackhammer. The annulus of the pilot hole was backfilled with bentonite with the point in place to prevent air-flow short circuiting from the ground surface. During initial installation of probe VP-3, a coupling sheared. The lower five ft of pipe was left in place and the hole was backfilled with neat cement. VP-3 was successfully installed a

couple ft away. Each point was vacuum-response tested for possible clogging of perforations. All five points responded satisfactorily. VP-2 did not show as much vacuum influence during testing as expected. This was probably due to localized lower permeability sediments.

#### Equipment

To evaluate SVE effectiveness from each test well, we applied a vacuum with our portable SVE test equipment to assess the vacuum required to achieve a preset vapor extraction flow rate. The equipment includes a positive displacement vacuum pump powered by a 3 horsepower explosion-proof motor rated to produce a vacuum of 160 inches of water at different flow rates. We routed extracted vapor through the test system's moisture collection drum and two 200 lb carbon adsorption vessels connected in series.

#### Data Collection and Interpretation

A vacuum gauge connected to the influent side of the system indicated the vacuum applied to the test well. We estimated vapor extraction flow rates based on vacuum and differential pressure gauge readings and performance curves supplied by the equipment manufacturer. We recorded extraction performance parameters about every 2-4 minutes until they stabilized. We then reduced monitoring frequency to about every 5-10 minutes.

To record vacuum influence, we sealed all monitoring points (wells and probes) and measured the induced vacuum in each well with a differential pressure gauge which indicates the difference between well pressure and atmospheric pressure. We first measured vacuum in the closest monitoring points where influence was expected, and then measured vacuum in the other wells. For the remainder of the test, we measured vacuum in all monitoring points at intervals no greater than 30 minutes. Before each extraction event, we measured background vacuum in all monitoring points to distinguish between pressure differences induced by atmospheric change versus pressure differences induced by vapor extraction. To normalize vacuum influence data from each well, we subtracted the measured background vacuum from the stabilized vacuum influence measurement.



We measured hydrocarbon concentrations in extracted vapor and after each carbon adsorption vessel with a portable organic vapor analyzer/flame ionization detector (OVA/FID). To determine concentration trends, we measured hydrocarbon concentrations about every 5 to 10 minutes. We also submitted one-liter vapor samples to a State-certified analytical laboratory for analysis by modified EPA Methods 8015 and 8020 for total petroleum hydrocarbons as gasoline (TPH-G), benzene, toluene, ethyl benzene, and total xylenes (BTEX). We collected samples for laboratory analysis near the beginning and end of each extraction event.

Hydrocarbon removal rates were calculated using analytic results of hydrocarbon concentrations in extracted vapor and vapor flow rates for each extraction event. Actual hydrocarbon removal rates for a dedicated SVE system may vary depending on the applied vacuum, extraction flow rates and hydrocarbon concentration fluctuation during SVE project duration.

#### SVE TEST RESULTS

Vacuum influence was observed in all site monitoring wells under a relatively high applied vacuum ranging from 59 to 131 inches of water. Hydrocarbon concentrations detected in extracted vapor ranged from 17,000 to 110,000 parts per million per volume (ppmv) and hydrocarbon removal rates ranged from 70 to 945 lbs TPH-G/day. Analytic results and hydrocarbon removal rates are presented in Table 1. The analytical report and chain of custody form is also attached.

In all three tests, the initially applied vacuum caused the localized water-table mounding to the point of obscuring the extraction well screen. We reduced the applied vacuum by opening a dilution air valve on the vacuum equipment which resulted in decreasing this mounding effect. Applied vacuums with dilution air are reported in Table 1. Dilution air flow was considered when calculating the reported extraction flow rates.

#### C-1 Test

Extraction from vapor well C-1 provided the greatest onsite vacuum influence (Figure 3). Vacuum influence was only marginally detected at offsite well C-6 and not seen at offsite well C-7. Changes in atmospheric pressure throughout the day may have interfered with the precision of the differential pressure gauges by about  $\pm 0.02$  inches of water, therefore

measurements in these outlying wells are uncertain. A vacuum of about 59 inches of water induced a vapor flow rate of about 25 standard cubic feet per minute (scfm). Analytic results indicated that hydrocarbon concentrations in extracted soil vapor decreased from 110,000 ppmv TPH-G after 11 minutes of extraction to 80,000 ppmv after 68 minutes of extraction. Benzene concentrations remained constant at 24 ppmv while toluene, ethylbenzene and total xylenes concentrations increased from 390, 11 and 41 ppmv to 790, 41 and 140 ppmv, respectively. These high concentrations reflect the presence of separate-phase hydrocarbons in C-1. The hydrocarbon removal rates from well C-1 at the end of the extraction period were about 687 lbs TPH-G/day and about 0.19 lbs. benzene/day (Table 1).

#### C-2 Test

Extraction from vapor well C-2 also provided vacuum influence in all onsite points (Figure 4). Marginal influence was measured in both offsite wells C-6 and C-7. A vacuum of about 131 inches of water induced a vapor flow rate of about 12 scfm. Analytic results indicate that hydrocarbon concentrations in extracted soil vapor decreased from 26,000 ppmv TPH-G after 10 minutes of extraction to 17,000 ppmv after 40 minutes of extraction. Benzene concentrations decreased from 9.2 to 7.2 ppmv. Toluene, ethylbenzene and total xylenes concentrations decreased about three-fold. The hydrocarbon removal rates from well C-2 at the end of the extraction period were about 70 lbs TPH-G/day and about 0.03 lbs benzene/day.

#### C-3 Test

Extraction from monitoring well C-3 also provided vacuum influence in all points (Figure 5). Influence in offsite wells C-6 and C-7 appeared to be greatest during this test but was still marginal. A vacuum of 125 inches of water induced a vapor flow rate of about 15 scfm. Analytic results indicate that hydrocarbon concentrations in extracted soil vapor decreased from 39,000 ppmv TPH-G after 19 minutes of extraction to 29,000 ppmv after 39 minutes of extraction. BETX concentrations decreased between 60 and 80%. The hydrocarbon removal rates from well C-3 at the end of the extraction period were about 149 lbs TPH-G/day and about 0.07 lbs benzene/day.

## CONCLUSIONS AND RECOMMENDATIONS

**SVE should effectively remove volatile hydrocarbons from the site soil.** Test results indicate that a SVE system should produce considerable vapor flow rates, hydrocarbon removal rates and vacuum influence in known areas of concern. Very effective mass removal could be achieved by extracting from existing well C-1. Significant mass removal could also be achieved by extracting from wells C-2 and C-3 although higher applied vacuums are necessary to induce appreciable vapor flow.

The capture zone or effective radius of influence for extraction from well C-1 is about 115 ft to the northeast and about 65 ft to the southwest, based on the distance from the extraction well location to where 1% of the applied vacuum was measured<sup>1</sup>. This apparent greater influence towards the northeast is probably due to preferential flow through the tank excavation backfill. Using this effective radius criteria, extraction from well C-1 would effectively remediate soils under the site. It is important to recognize that subsurface heterogeneities may minimize the effectiveness of vapor extraction in localized areas such as lower permeability sediments.

Extraction from wells C-2 or C-3 resulted in much less significant radii of influence although still produced moderate mass removal rates. Additional extraction from these wells may expedite site remediation but may not be as cost effective.

Data from previous investigations suggest that the highest hydrocarbon concentrations are within a few ft above the water-table interface. **Because high applied vacuum causes the water table to mound in the immediate vicinity of the extraction well, the amount of well screen exposure is reduced. This may reduce the effectiveness of hydrocarbon extraction by limiting vapor flow, and minimizing or restricting separate-phase hydrocarbon flow into the well. Local dewatering in conjunction with vapor extraction would negate some of this water level rise thereby enhancing hydrocarbon removal rates.**

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<sup>1</sup> Chevron Research and Technology Company. Chevron USA Marketing Department Vapor Extraction System Performance Study, Appendix E: General Procedures and Data Interpretation for Vapor Extraction System Pilot Tests. 1991, October 10. Pages E-7, E-8.



To reduce this water-table mounding effect while maintaining similar vapor extraction flow rates, we recommend installing a six-inch diameter well within a few ft of well C-1 for ground water extraction. The larger diameter of this well will accommodate a larger pump with greater pumping capacity. Pumping total fluids (ground water and separate-phase hydrocarbons) would enhance vapor extraction, expedite separate-phase hydrocarbon removal, and partially mitigate migration of hydrocarbons in ground water. Additional ground water remediation and migration mitigation could be accomplished by pumping well C-2 and/or C-3.

Vapor extraction could be conducted from either well C-1 or the new ground water extraction well. Because water-table drawdown is obviously greatest in the ground water extraction well, vapor extraction from the same well would be most effective. It is important to recognize that ground water extraction may not completely negate the water-table mounding seen in this test. Therefore, the applied vacuum may need to be reduced to allow separate-phase hydrocarbon accumulation in the well.

Selection of the most cost-effective vapor treatment method is based on the estimated vapor flow rates and hydrocarbon concentrations in extracted soil vapor over the anticipated project duration. However, it is difficult to predict the long term hydrocarbon concentrations in extracted vapor based on this one day extraction test. When conducting SVE without an extensive hydrocarbon source, hydrocarbon concentrations in extracted vapor are typically highest initially, then decrease after the first few soil pore volumes are purged. High hydrocarbon concentrations are not likely to decrease significantly until separate phase hydrocarbons have been extracted, volatilized or degraded. Previous investigations suggest that separate phase hydrocarbons are limited to the immediate vicinity of well C-1 and therefore should not take an extended period of time to remove by a combination of total fluids and vapor extraction.

The recommended remedial action for the site consists of a two-phase approach. First, total fluids extraction from C-1 in conjunction with vapor extraction from a newly installed large diameter well near well C-1. Extracted vapor should be treated with an advanced oxidation device such as an internal combustion engine or a thermal and/or catalytic oxidizer capable of destroying several hundred pounds of hydrocarbons per day. Ground water would



Mr. Kenneth L. Kan  
January 15, 1991

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Weiss Associates



also be pumped from well C-2. If ground water concentrations rise in well C-3, ground water pumping could be initiated at this location as well, but because concentrations are relatively low we do not recommend pumping C-3 initially. Ground water would be treated by use of an oil/water separator followed by aqueous-phase granular activated carbon (GAC).

Second, after separate-phase hydrocarbons are removed and hydrocarbon concentrations in extracted vapor decrease, the advanced oxidation treatment equipment may be replaced with a vapor-phase GAC system. Because of the uncertain rate of separate-phase hydrocarbon removal, it is difficult to estimate the length of time that advanced oxidation treatment equipment would need to be on site. However, this methodology in combination with ground water/separate-phase hydrocarbon pumping is likely to be the most expedient and cost-effective method of site remediation.

WA is pleased to provide environmental remediation services to Chevron USA and we trust this submittal meets your needs. Upon your request, WA will prepare a work plan for design and installation of a SVE and ground water extraction system for this site. Please call if you have any questions regarding this test or our results.



Sincerely,  
Weiss Associates

Thomas R. Berry  
Project Geologist

Fatima Lelic, P.E., D.E.E.  
Principal Engineer

TRB:trb

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Attachments: Figures  
Table  
Analytical Report and Chain of Custody Form

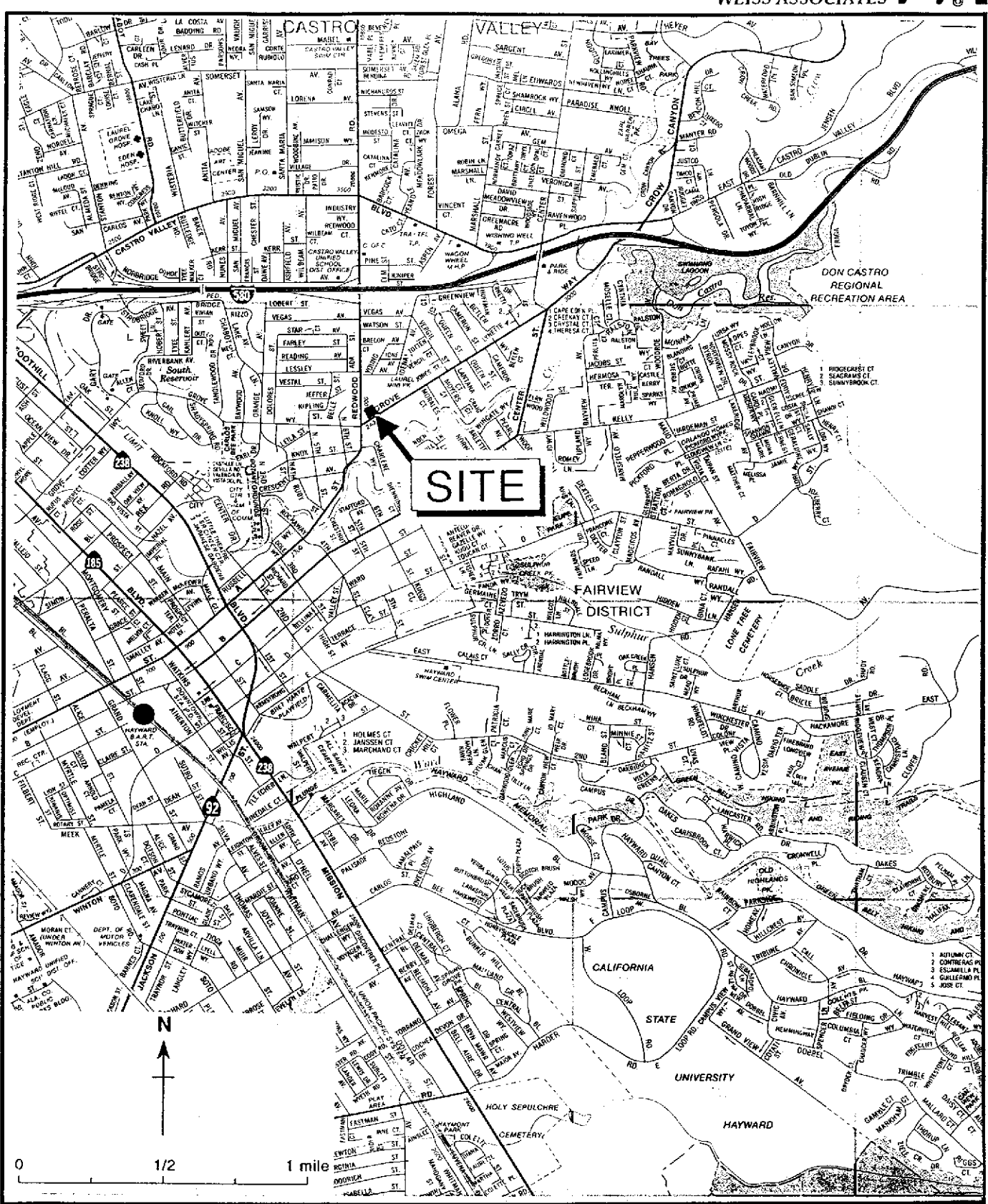


Figure 1. Site Location Map, Former Chevron Service Station #9-2960, 2416 Grove Way, Castro Valley, California

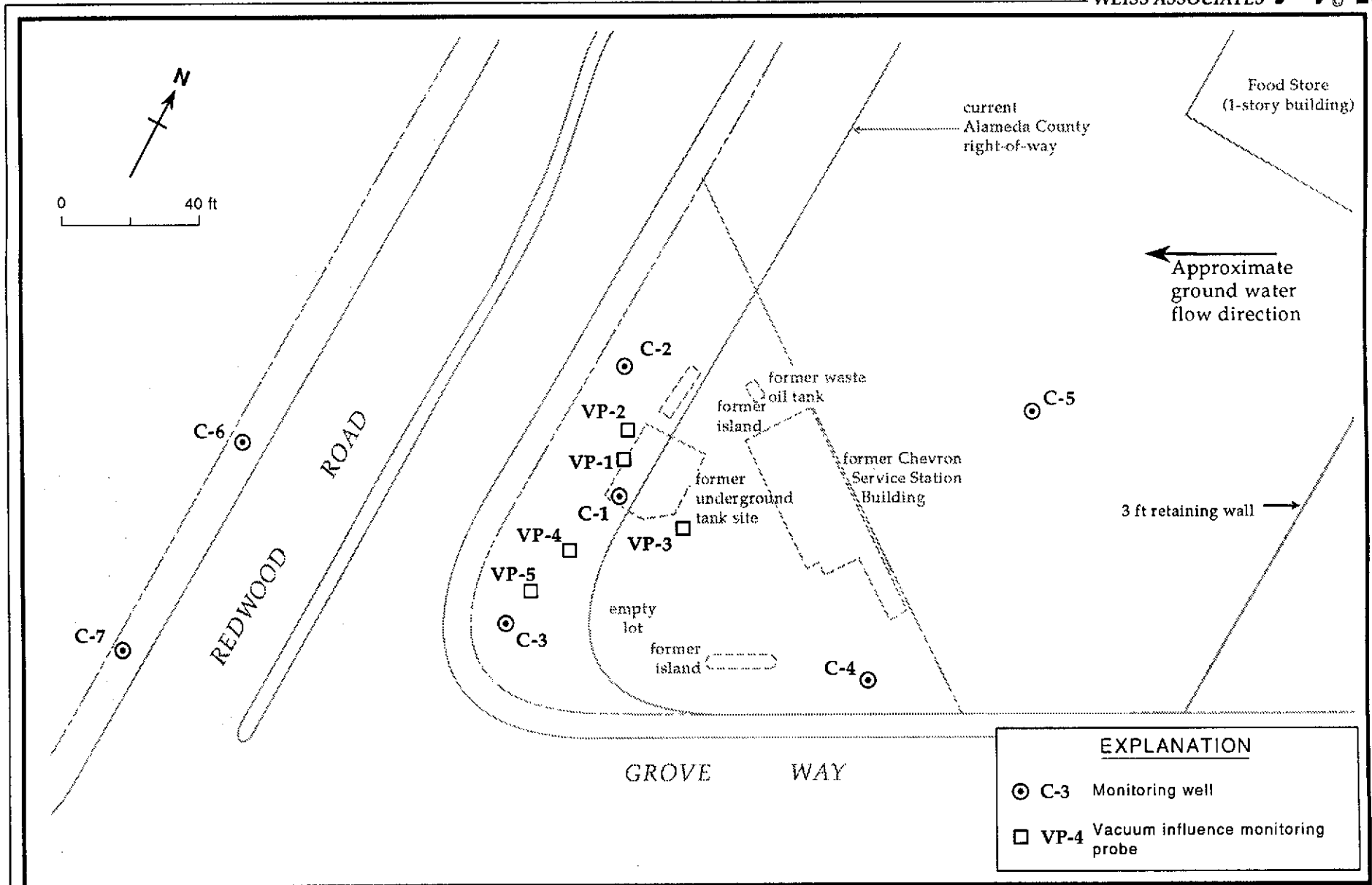


Figure 2. Monitoring Well and Vacuum Influence Probe Locations - Former Chevron Service Station #9-2960, 2416 Grove Way, Castro Valley, California

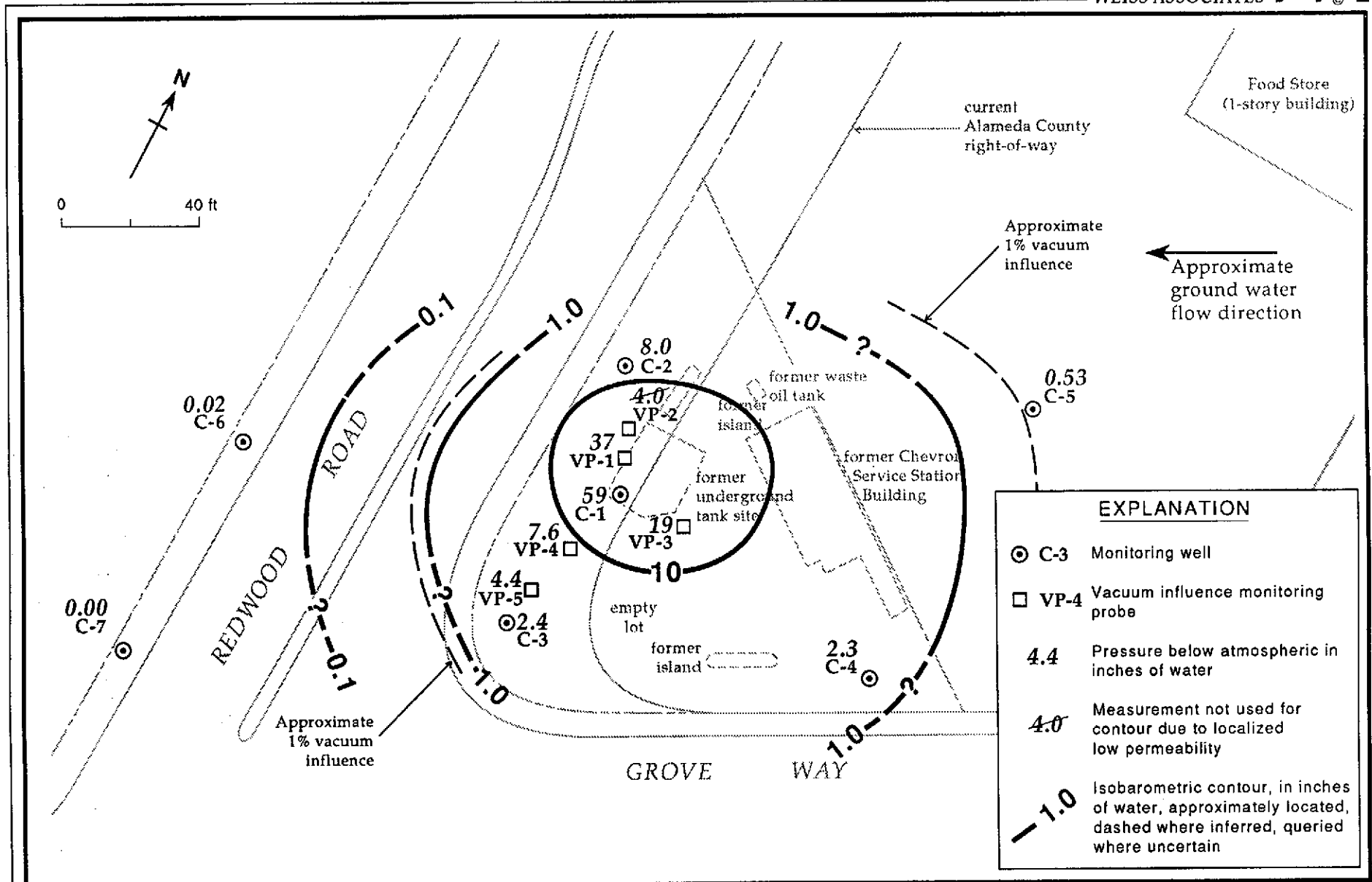


Figure 3. Isobarometric Contours for Vapor Extraction from Monitoring Well C-1 - Former Chevron Service Station #9-2960, 2416 Grove Way, Castro Valley, California

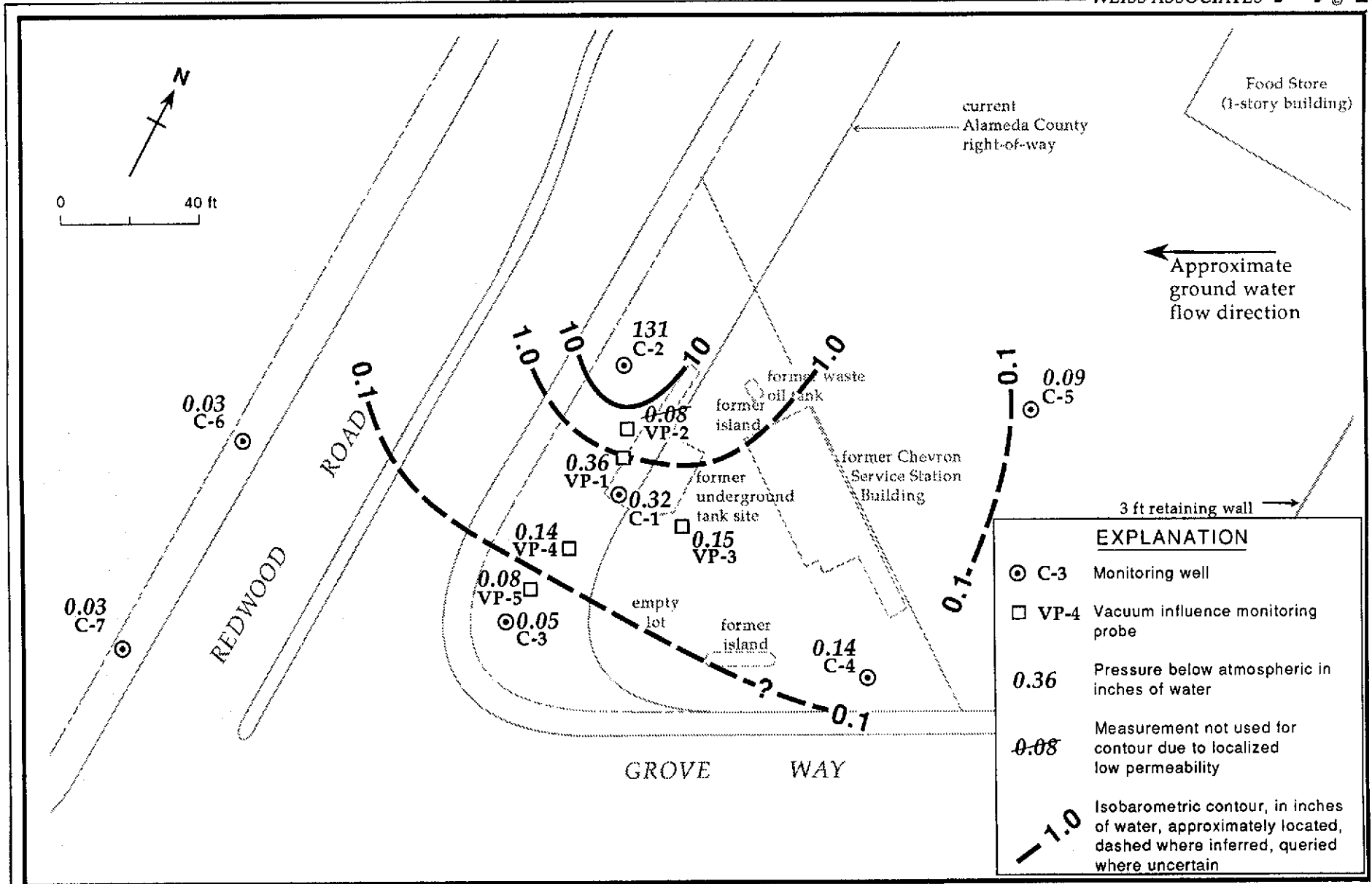
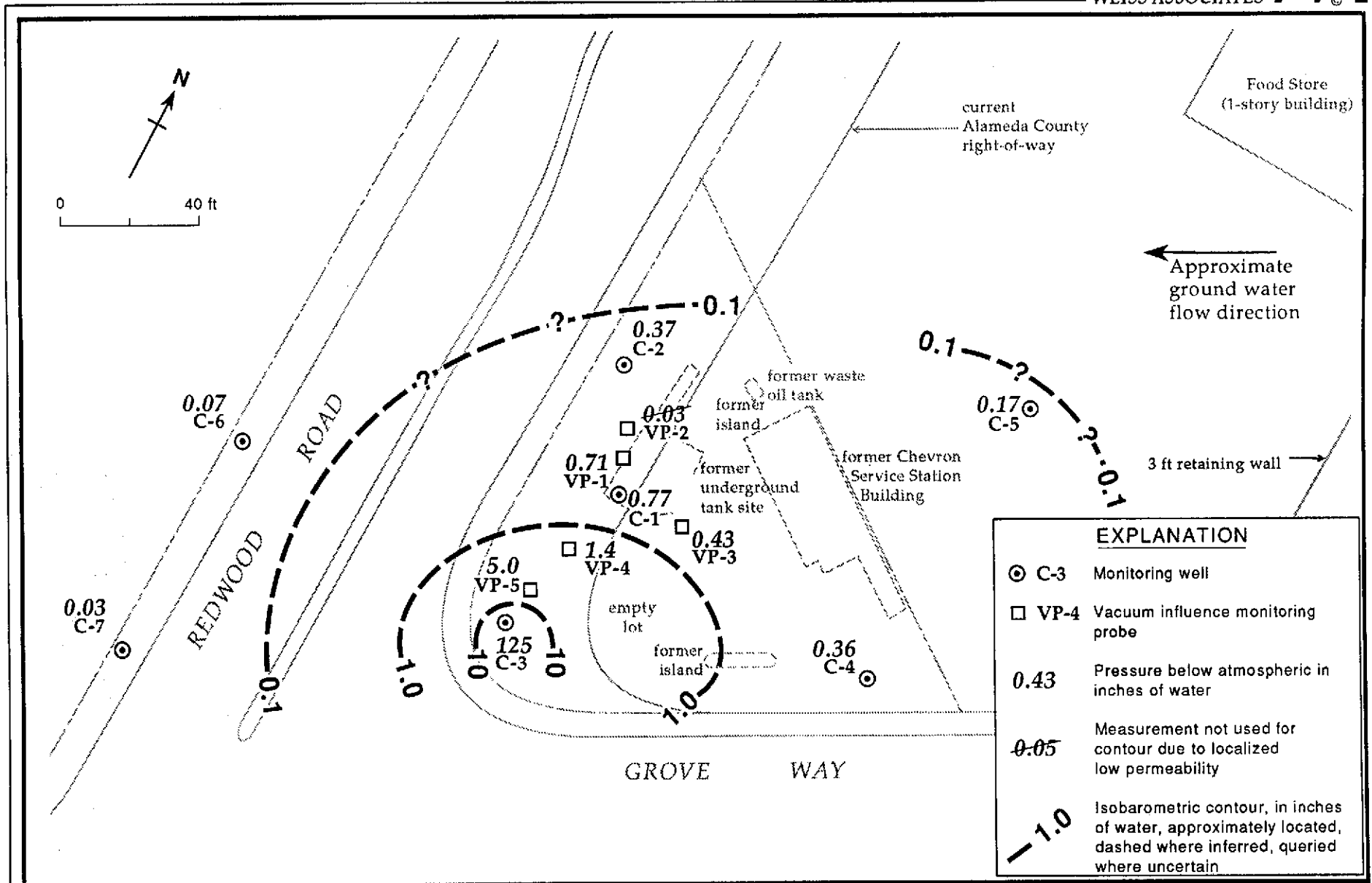


Figure 4. Isobarometric Contours for Vapor Extraction from Monitoring Well C-2 - Former Chevron Service Station #9-2960, 2416 Grove Way, Castro Valley, California



EXPLANATION	
⊙ C-3	Monitoring well
□ VP-4	Vacuum influence monitoring probe
0.43	Pressure below atmospheric in inches of water
0.05	Measurement not used for contour due to localized low permeability
- 1.0	Isobarometric contour, in inches of water, approximately located, dashed where inferred, queried where uncertain

Figure 5. Isobarometric Contours for Vapor Extraction from Monitoring Well C-3 - Former Chevron Service Station #9-2960, 2416 Grove Way, Castro Valley, California

Table 1. Soil Vapor Extraction Test Data, Former Chevron Service Station #9-2960, 2416 Grove Way, Castro Valley, California

WELL ID	APPLIED VACUUM (inches water)	FLOW (scfm)	ELAPSED TIME (min)	INLET HYDROCARBON CONCENTRATIONS (ppmv)		MASS REMOVAL RATE (lbs./day)	
				TPH-G	BENZENE	TPH-G	BENZENE
C-1	60	25	11	110,000(a)	24	945	0.19
	59	25	68	80,000(a)	24	687	0.19
C-2	131(b)	12	10	26,000	9.2	107	0.03
	131(b)	12	40	17,000	7.2	70	0.03
C-3	118	15	19	39,000	18	201	0.08
	125	15	39	29,000	14	149	0.07

Notes:

scfm = Standard cubic feet per minute.

ppmv = Parts per million on volume to volume basis.

TPH-G = Total purgeable hydrocarbons as gasoline.

13.6" water = 1.0" Mercury = 0.033 atm

(a) = 0.95 ft of separate-phase hydrocarbons present in well at test start.

(b) = Applied vacuum greater than height of well screen.

Valve is estimated length of exposed well screen.



# Superior Precision Analytical, Inc.

1555 Burke, Unit I • San Francisco, California 94124 • (415) 647-2081 / fax (415) 821-7123

## C E R T I F I C A T E   O F   A N A L Y S I S

LABORATORY NO.: 12642  
CLIENT: Weiss Associates  
CLIENT JOB NO.: 4-552-13

DATE RECEIVED: 12/19/91  
DATE REPORTED: 12/23/91  
DATE REVISED : 12/24/91

ANALYSIS FOR BENZENE, TOLUENE, ETHYL BENZENE & XYLENES  
by EPA SW-846 Methods 5030 and 8020

LAB #	Sample Identification	Concentration(ppb)			
		Benzene	Toluene	Ethyl Benzene	Xylenes
1	C-1#1	24000	390000	11000	41000
2	C-1#2	24000	790000	41000	140000
3	C-2#1	9200	350000	79000	330000
4	C-2#2	7200	130000	28000	120000
5	C-3#1	18000	35000	12000	23000
6	C-3#2	14000	27000	7700	13000

ppb - parts per billion in air

Minimum Detection Limit for Benzene in air = 85 ppb  
Minimum Detection Limit for Toluene and Xylenes in air = 250 ppb  
Minimum Detection Limit for Ethyl Benzene in air = 65 ppb  
Concentration of BTXE in air is calculated based on 20 C and 1 ATM.  
Reported as volume to volume.

### QAQC Summary:

Daily Standard run at 20ug/L: %DIFF 8020 = <15%  
MS/MSD Average Recovery = 81% : Duplicate RPD = 3.8%

Richard Srna, Ph.D.

*Cecilia G. Joaguen (for)*  
Laboratory Director





# Superior Precision Analytical, Inc.

1555 Burke, Unit I • San Francisco, California 94124 • (415) 647-2081 / fax (415) 821-7123

## C E R T I F I C A T E   O F   A N A L Y S I S

LABORATORY NO.: 12642  
CLIENT: Weiss Associates  
CLIENT JOB NO.: 4-552-13

DATE RECEIVED: 12/19/91  
DATE REPORTED: 12/23/91  
DATE REVISED : 12/24/91

ANALYSIS FOR TOTAL PETROLEUM HYDROCARBONS  
by Modified EPA SW-846 Method 5030 and 8015

LAB #	Sample Identification	Concentration (ppm) Gasoline Range
1	C-1#1	110000
2	C-1#2	80000
3	C-2#1	26000
4	C-2#2	17000
5	C-3#1	39000
6	C-3#2	29000

ppm - parts per million in air

Minimum Detection Limit for Gasoline in Air: 30 ppm

Concentration of gasoline in air is calculated based on 20 C and 1 ATM and an assumed molecular weight of hexane. Reported as volume to volume.

### QAQC Summary:

Daily Standard run at 2mg/L: %DIFF Gasoline = <15%  
MS/MSD Average Recovery = 85%: Duplicate RPD = 0.8%

Richard Srna, Ph.D.

*Cecilia J. Gorgues (for)*  
Laboratory Director

Fax copy of Lab Report and COC to Chevron Contact:  Yes  No

12692

Chain-of-Custody-Record

Chevron U.S.A. Inc.  
P.O. BOX 5004  
San Ramon, CA 94583  
FAX (415)842-9591

Chevron Facility Number 9-2960 (CASTRO VALLEY)  
Facility Address 2416 GROVE WAY. CASTRO VALLEY  
Consultant Project Number 4-552-13  
Consultant Name WEISS ASSOCIATES  
Address 5500 SHELLMOUND ST. EMERYVILLE, CA  
Project Contact (Name) TOM BERRY  
(Phone) 510 547 5420 (Fax Number) 510-547 5043

Chevron Contact (Name) KEN KAN  
(Phone) 510-842-8752  
Laboratory Name SUPERIOR ANALYTICAL LAB  
Laboratory Release Number 660430  
Samples Collected by (Name) DAVE CHARLES  
Collection Date 12/19/91  
Signature David Charles

Sample Number	Lab Sample Number	Number of Containers	Matrix S = Soil W = Water A = Air C = Charcoal	Type G = Grab C = Composite D = Discrete	Time	Sample Preservation	Iced (Yes or No)	Analyses To Be Performed											Remarks			
								BTEX + TPH GAS (8020 + 8015)	TPH Diesel (8015)	Oil and Grease (5520)	Purgeable Halocarbons (8010)	Purgeable Aromatics (8020)	Purgeable Organics (8240)	Extractable Organics (8270)	Metals Cd, Cr, Pb, Zn, Ni (ICAP or AA)	AFET/HAPE						
C-1 #1		1	A	G	1038	NONE	N	X														
C-1 #2		1	A	G	1158																	
C-2 #1		1	A	G	1501																	
C-2 #2		1	A	G	1531																	
C-3 #1		1	A	G	1402																	
C-3 #2		1	A	G	1435																	

**RUSH**

Please initial: Red  
 Samples Stored in ice. No  
 Appropriate containers. Yes  
 Samples preserved. No  
 VOA's without headspace. N/A  
 Comments:

**RUSH**

Relinquished By (Signature) <u>David Charles</u>	Organization <u>Weiss Assoc.</u>	Date/Time <u>12/19/91</u>	Received By (Signature) <u>Ken Kan</u>	Organization <u>express</u>	Date/Time <u>12/19/91</u>	Turn Around Time (Circle, Choice) 11 <input checked="" type="radio"/> 24 Hrs. <b>RUSH</b> <input type="radio"/> 48 Hrs. <input type="radio"/> 5 Days <input type="radio"/> 10 Days <input type="radio"/> As Contracted
Relinquished By (Signature) <u>Ken Kan</u>	Organization <u>express</u>	Date/Time <u>12/19/91</u>	Received By (Signature)	Organization	Date/Time	
Relinquished By (Signature)	Organization	Date/Time	Received For Laboratory By (Signature) <u>Lita B. Aaron</u>		Date/Time <u>12-20-91 0815</u>	

COC-3LW/03 91/HCH