February 23, 1994

Chevron
Chevron U.S.A. Products Company
2410 Camino Ramon
San Ramon, CA 94583
PO Box 5004
San Ramon, CA 94583-0804

Marketing Department
Phone 510 842 9500

Ms. Jennifer Eberle
Alameda County Health Care Services
80 Swan Way, Room 200
Oakland, CA 94621

Re: Hydraulic Test Results
Former Chevron Service Station #9-4816
301 14th Street, Oakland

Dear Ms. Eberle:

Enclosed we are forwarding the results of the aquifer test conducted by our consultant, Weiss Associates at the referenced site. These results are to supplement the November 2, 1993, work plan which proposed to install a ground water extraction and treatment system to operate concurrently with the existing soils vapor extraction system.

As indicated in the report, the originially proposed extraction wells CR-1, VEW-3 and C-5 will be sufficient to achieve plume capture. However, well C-5 will be reconstructed into a 4-inch diameter well more suitable for extraction. Reconstruction of this well will occur in conjunction with the installation of the additional off-site well. The permitting process is currently underway.

We would appreciate your review of these results and formal concurrence to the previously submitted work plan. Implementation of this work will be taken upon receipt of your formal concurrence. If you have any questions or comments, please do not hesitate to contact me at (510) 842-9581. I look forward to your reply. → for GWE.

Sincerely,
CHEVRON U.S.A. PRODUCTS COMPANY

Nancy Vukelich
Site Assessment and Remediation Engineer

Enclosure

cc: Mr. Rich Hiett, RWQCB
Mr. J.N. Robbins, CHVPKV/1156
Ms B.C. Owen
File (9-4816WP Addendum)

Ms. Beth D. Castleberry
Ware & Freidenrich
400 Hamilton Avenue
Palo Alto, CA 94301-1825

Weiss Associates *Environmental and Geologic Services*
5500 Shellmound Street, Emeryville, CA 94608-2411 Fax. 510-547-5043 Phone: **510-450-6000**

February 24, 1994

Nancy Vukelich
Chevron U.S.A., Products Company
P.O. Box 5004
San Ramon, CA 94583-0804

Re: Hydraulic Test Results
Former Chevron Service Station #9-4816
301 14th Street
Oakland, California
WA Job #4-582-81

Dear Ms. Vukelich:

This letter presents the results of the hydraulic tests conducted by Weiss Associates (WA) at the site referenced above. Monitoring wells CR-1 and VEW-3 were tested on January 26 and January 27, 1994, respectively. The hydraulic test objectives were to:

- Confirm that the extraction wells proposed in the ground water extraction system work plan will effectively capture the known extent of hydrocarbons in ground water beneath the site[1];

- Calculate aquifer hydraulic parameters, such as transmissivity, storativity and sustainable flow rates,

- Evaluate hydraulic response in observation wells and determine the extent of influence and long-term hydraulic capture area,

- Evaluate using existing wells as extraction wells, and

- Determine whether additional extraction wells may be necessary.

1 Weiss Associates, 1993, GWE System Installation Workplan, Former Chevron Service Station #9-4816, 301 14th Street, Oakland, California, consultant's letter to Ms. Nancy Vukelich, Chevron USA Products Company, 5 pp.

CR-1 HYDRAULIC TEST

A seven-hour hydraulic test was conducted on CR-1. Prior to pumping, background water levels were recorded for 1.5 hours (Figure 2). Ground water was extracted from monitoring well CR-1 at a constant pumping rate of about 2.5 gallons per minute (gpm). Water levels in the pumping well and wells C-1, C-2, C-3, C-4, C-5, VEW-1, and VEW-3 were monitored throughout the test with down-hole pressure transducers and water level data were recorded using an electronic data logger. Monitoring wells C-6, C-7, C-8, C-9, and MW-10 were not monitored during the test due to the excessive traffic along Harrison and 14th Streets. Barometric pressure was recorded throughout the test to determine the influence of atmospheric pressure changes on water levels.

Well CR-1 was pumped at a steady rate of about 2.5 gpm for the first 4 hours of the test. At that time, the water level in the well appeared to have reached a steady state. However, about 4 to 5 hours into the test, the pump began cycling on and off. The flow rate was then decreased to about 2 gpm for the final 2 hours. Water level recovery was measured in the instrumented wells after pumping was stopped.

During the hydraulic testing of CR-1, significant water level responses of at least 0.05 ft were observed in five of the seven observation wells (Table 1). The water level in well VEW-1, located about 10 ft from the pumping well, dropped below the transducer due to the lack of

Table 1. Observation Well Responses During Pumping of Well CR-1 at 2.5 gpm for 7 hours.

Observation Well	Distance from Pumping Well (ft)	Maximum Drawdown (ft)
C-1	70	0.03
C-2	76	<0.01
C-3	7	1.50
C-4	50	0.15
C-5	58	0.15

Table 1. (Continued)

VEW-1	12	>1.0
VEW-3	56	0.20

available drawdown, so the data were unmeasurable. However, at least 1 ft of drawdown was noted. Observation well C-3 had the greatest measured response with 1.5 ft of drawdown (Figure 3). Observation well C-1 showed the least response to pumping (about 0.03 ft of water level drawdown), and observation well C-2 showed no response (less than 0.01 ft of drawdown). Wells C-1 and C-2 are located the furthest distance from the pumping well; however, they may have responded with a longer pumping duration. Barometric pressure changes did not appear to mask observation well drawdowns.

The data were analyzed using Theis (1935)[2], Cooper and Jacob (1946)[3], and Theis recovery (1935)[2] methods. The aquifer transmissivity (T) and hydraulic conductivity (K) values calculated using these methods are shown in Table 2. Because the water levels in the pumping well appeared to approach quasi-steady state, the aquifer parameters obtained from the Cooper-Jacob method were considered to be more reliable. Water level data from observation well C-3 were analyzed to calculate aquifer parameters (Table 2) and an aquifer storativity of about 0.06, which is indicative of an unconfined or slightly confined aquifer.

Table 2. Estimated Hydraulic Parameters from Well CR-1 Pump Test Data.

Theis (1935)		Cooper and Jacob (1946)		Theis Recovery (1935)		Observation Well C-3 Theis (1935)	
T (gpd/ft)	K (gpd/ft^2)	T (gpd/ft)	K (gpd/ft^2)	T (gpd/ft)	K (gpd/ft^2)	T (gpd/ft)	K (gpd/ft^2)
1,000	80	1,100	92	730	60	1,100	140

2 Theis, C.V., The relation between lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage. Am. Geophys. Union Trans. 16, pp 519-524.

3 Cooper, H.H., and C.E. Jacob, 1946, A generalized graphical method for evaluating formation constants and summarizing well field history, AM. Geophys. Union Trans. 27, pp. 526-534.

VEW-3 HYDRAULIC TEST

Hydraulic testing of well VEW-3 was conducted the following day. Ground water was extracted from monitoring well VEW-3 at an average pumping rate of about 0.7 gpm for about six hours. Water levels in the pumping well and observation wells C-1, C-2, C-3, C-4, C-5, CR-1, and VEW-1 were monitored throughout the test. As in the CR-1 test, monitoring wells C-6, C-7, C-8, C-9, and MW-10 were not monitored during the test because of the excessive traffic along Harrison and 14th Streets.

During the first hour of the test, the flow rate was fairly constant at about 0.7 gpm. However, when the flow rate was increased to about 1 gpm for about 20 minutes, the water level rapidly declined. As a result, the flow rate was reduced to maintain a water level above the pump, and the resultant data were not considered in the analyses. Water level recovery in all the instrumented wells was measured for about one hour after the pump was shut off.

A significant response to pumping well VEW-3 was observed in five of the six observation wells (Table 3). The transducer in well VEW-1 did not read accurately because there was not enough water in

Table 3. Observation Well Responses During Pumping of Well VEW-3 at 0.7 gpm for 6 hours.

Observation Well	Distance from Pumping Well (ft)	Maximum Drawdown (ft)
C-1	28	0.14
C-2	34	0.20
C-3	58	0.25
C-4	105	0.30
C-5	56	0.05
CR-1	56	<0.01

the well. Observation well C-4 had the greatest response to pumping with 0.3 ft of drawdown, despite being located the greatest distance from VEW-3. Observation well C-5 showed the least response to pumping (about 0.05 ft of water level drawdown), and observation well CR-1 showed no response (less than 0.01 ft of drawdown).

Due to the variable flow rate at later times, only data from the initial portion of the test were analyzed using Theis (1935) and Cooper and Jacob (1946) methods. The aquifer transmissivity and hydraulic conductivity values calculated using each method are shown in Table 4. The Theis method was considered to be more appropriate for this test because the drawdown in the pumping well was still changing at a significant rate prior to the flow rate fluctuations. The Theis recovery method was not used because the time period that water level recovery was monitored was insufficient for accurate analysis. Because of the minimal responses in the observation wells, a storativity value was not calculated for this test.

Table 4. Estimated Hydraulic Parameters from Well VEW-3 Pump Test Data.

Theis (1935)		Cooper and Jacob (1946)	
T (gpd/ft)	K (gpd/ft^2)	T (gpd/ft)	K (gpd/ft^2)
200	33	140	23

CAPTURE AREA ANALYSIS

as proposed in GWE wp

To estimate the long-term effects of ground water extraction from proposed extraction wells CR-1, VEW-3 and C-5, we simulated ground water extraction using the semi-analytical models EQUIPLOT and CAPTURE. EQUIPLOT calculates water level changes due to pumping a homogeneous isotropic aquifer by superimposing the effects of extraction from each extraction well using the Theis transient drawdown equation. CAPTURE also uses the same conceptual model, but calculates ground water flow paths resulting from pumping. Both programs require hydraulic conductivity (ft/min), regional gradient (ft/ft), direction of regional flow, specific storage (ft^{-1}), and location and pumping rates (gpm) of extraction wells as input parameters.

Model input parameters described above were obtained from the hydraulic tests on wells CR-1 and VEW-3, and from the historical hydraulic gradient. First, the model was calibrated by simulating the individual hydraulic tests on wells CR-1 and VEW-3. The simulation results for CR-1 were considered to be more reliable due to the more consistent flow rate and longer-duration test. An averaged hydraulic conductivity from Table 1 of about 100 gallons per day per foot per foot (gpd/ft^2), or 0.009 feet per minute (ft/min), a ground water gradient of 0.0025 ft/ft to the northwest, and a storativity of 0.06 were used as input parameters. The actual pumping durations and flow rates were used to simulate the individual hydraulic tests on CR-1 and VEW-3. The simulated drawdowns in the observation wells were less than observed, so the storativity was reduced to 0.03 because there was a greater degree of confidence in the hydraulic conductivity and hydraulic gradient values. With the reduced storativity value, the predicted well drawdowns more closely matched the observed drawdowns. This indicated that the model input parameters were sufficient to represent the aquifer, and the model could reasonably be used to estimate long-term effects of ground water extraction at the site.

The calibrated model was used to evaluate long-term capture areas of the pumped wells and to determine whether additional extraction wells may be necessary to achieve plume capture. Initially, capture areas for CR-1 and VEW-3 were simulated to determine if they could sufficiently achieve plume capture. Due to the limited available drawdown of about 4 ft of water above the top of the screen in virtually all the wells, more conservative flow rates of 2.0 gpm and 0.3 gpm were used for CR-1 and VEW-3, respectively, as long-term extraction rates for the capture area analysis.

The capture areas for CR-1 and VEW-3 appear to be sufficient for capturing the hydrocarbon-bearing ground water beneath the site (Figure 5). By including the expected capture area for well C-5 pumping 1.5 gpm, the capture area throughout the site is enlarged and complete plume capture is achieved (Figure 6). In both scenarios, long-term drawdowns do not exceed 4 ft, suggesting these pumping rates are sustainable and should not cause excessive aquifer dewatering.

CONCLUSIONS AND RECOMMENDATIONS

Aquifer hydraulic parameters beneath the site were evaluated using several methods of analysis. A hydraulic conductivity of 100 gpd/ft^2 was calculated for the saturated sediments. Hydraulic influence and capture areas were estimated using analytical models calibrated with pump test data from wells CR-1 and VEW-3.

The hydraulic test results indicate that proposed extraction wells CR-1, VEW-3 and C-5 should be sufficient to achieve plume capture and that the relatively flat hydraulic gradient enhances the capture area. Reconstructing existing well C-5, as a 4-inch diameter extraction well, as planned, should capture hydrocarbons which may have migrated northward, offsite.

WA is pleased to provide environmental consulting services to Chevron and trusts this letter meets your needs. Please call us if you have any questions regarding this project.

Sincerely,
Weiss Associates

Janet K. Macdonald
Senior Staff Hydrogeologist

Eric M. Nichols, P.E.
Senior Project Engineer

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Enclosures:
- Figure 1. Site Location Map.
- Figure 2. Well Locations and Pre-Pumping Ground Water Elevation Contours.
- Figure 3. Ground Water Elevations during Pump Test on CR-1.
- Figure 4. Ground Water Elevations during Pump Test on VEW-3.
- Figure 5. Predicted Flow Lines and Capture Area for Wells CR-1 and VEW-3.
- Figure 6. Predicted Flow Lines and Capture Area for Wells CR-1, VEW-3, and C-5.

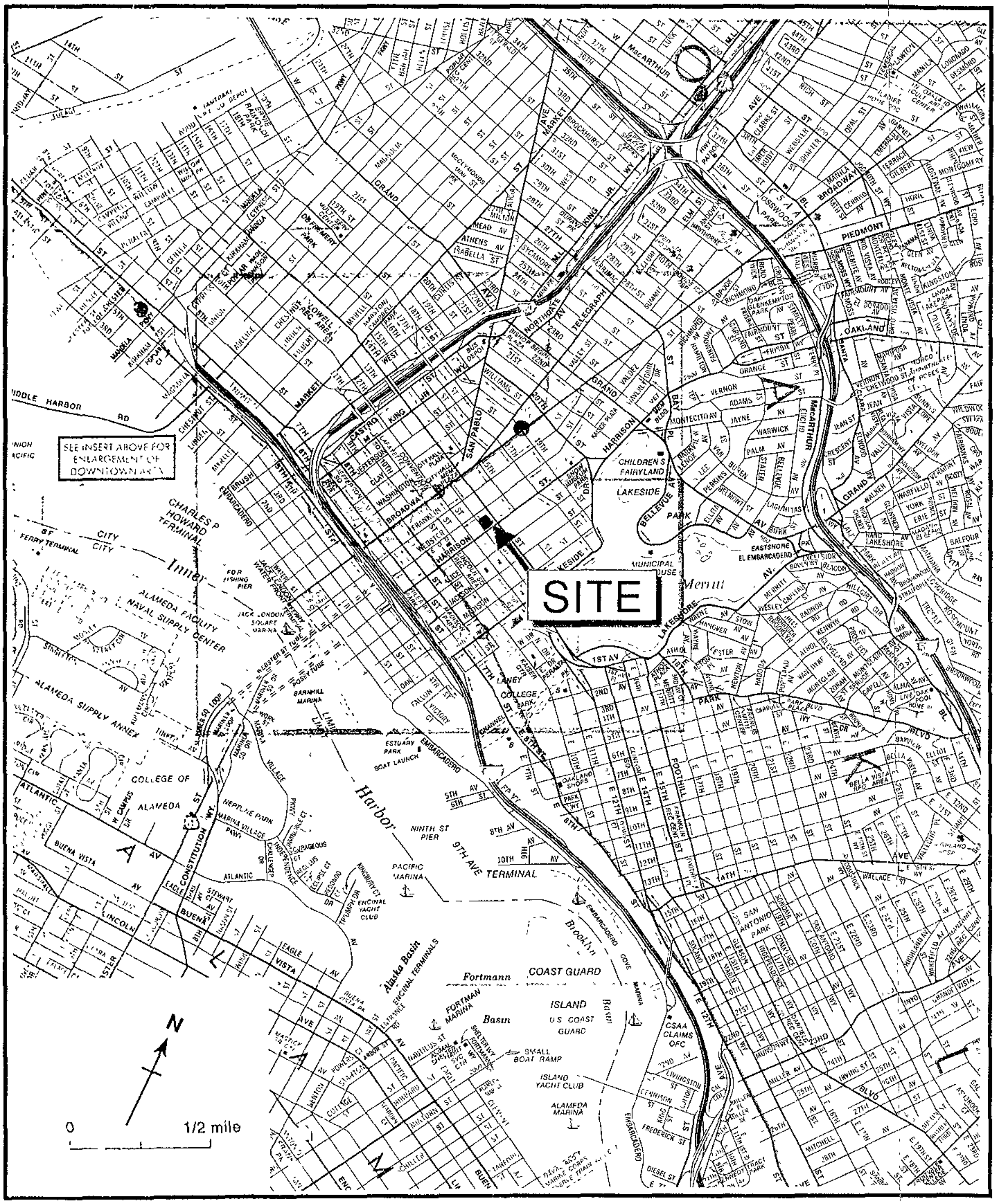

Figure 1. Site Location Map - Former Chevron Service Station #9-4816, 301 14th Street, Oakland, California

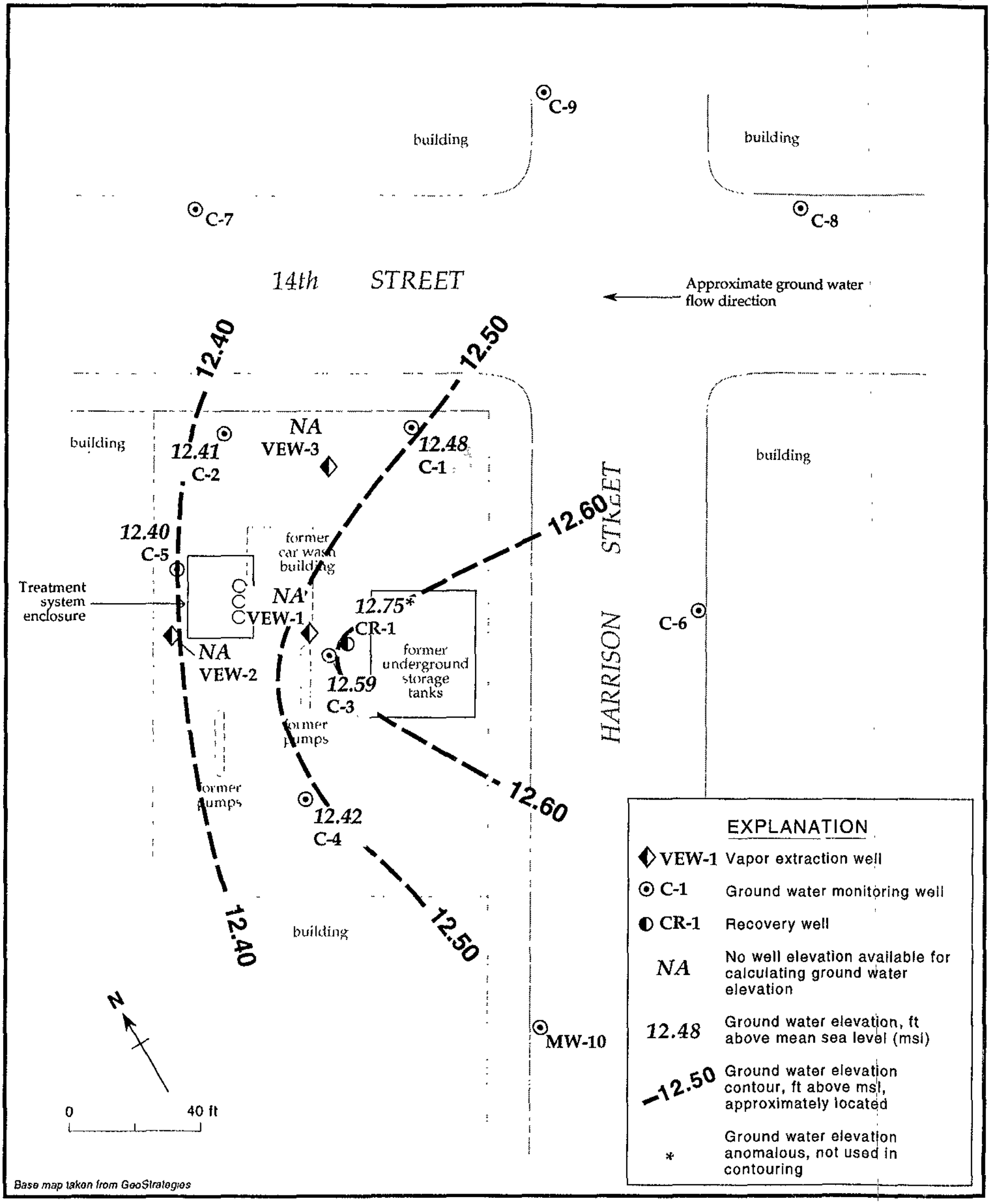

Figure 2. Well Locations and Pre-Pumping Ground Water Elevations - January 26, 1994 - Former Chevron Service Station #9-4816, 301 14th Street, Oakland, California

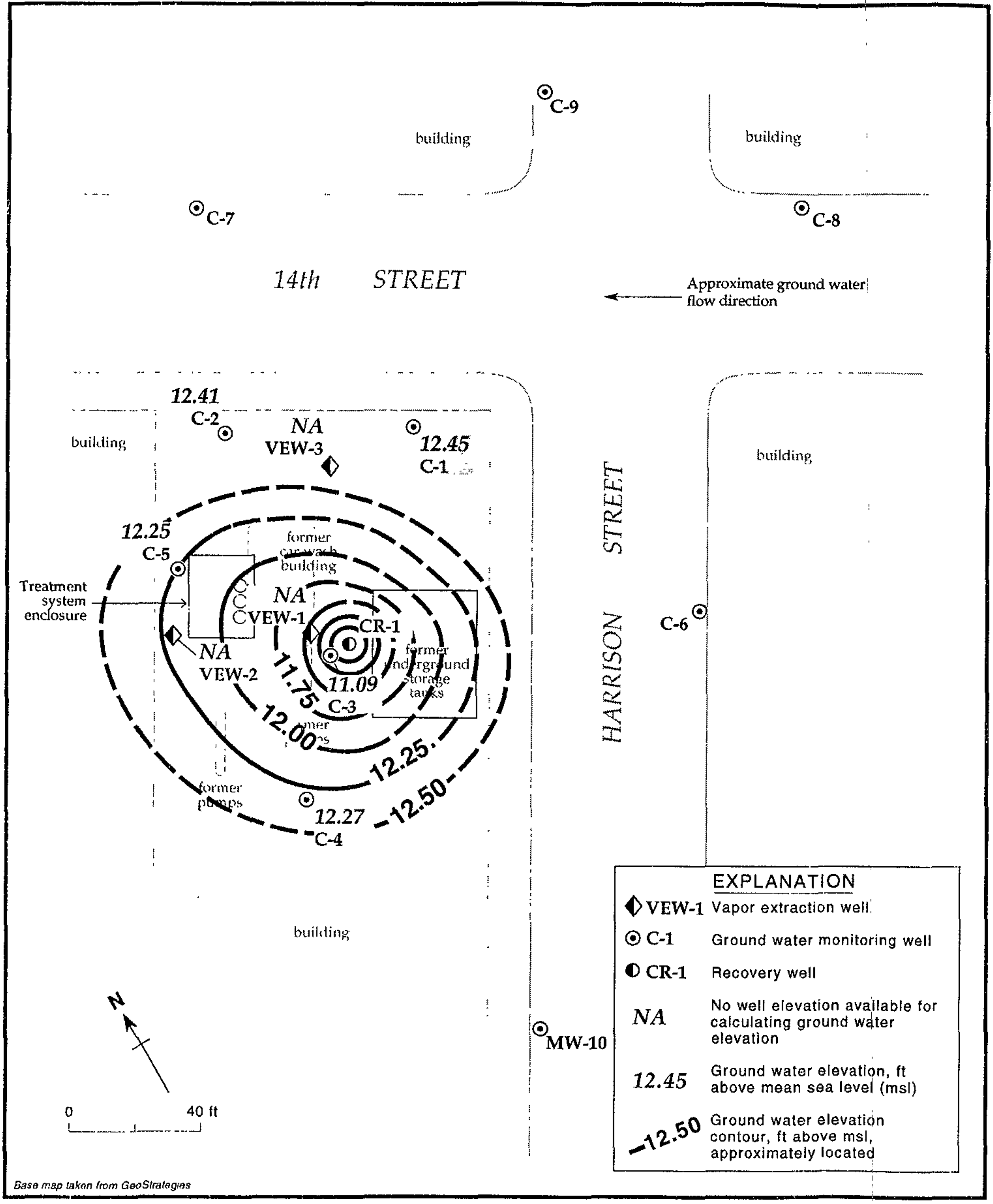

Figure 3. Ground Water Elevations During Pump Test on CR-1 - January 26, 1994 - Former Chevron Service Station #9-4816, 301 14th Street, Oakland, California

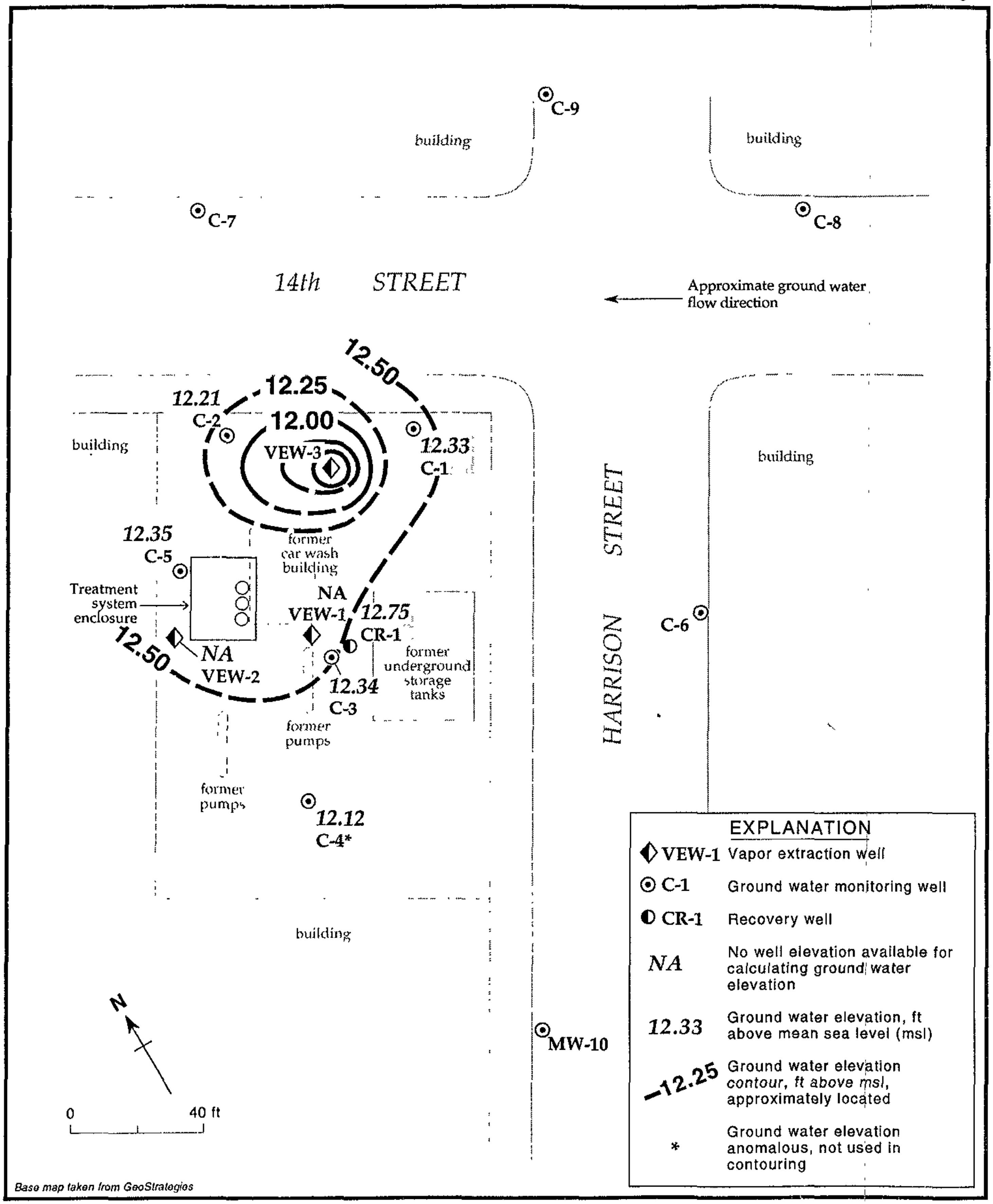

Figure 4. Ground Water Elevations During Pump Test on VEW-3 - January 27, 1994 - Former Chevron Service Station #9-4816, 301 14th Street, Oakland, California

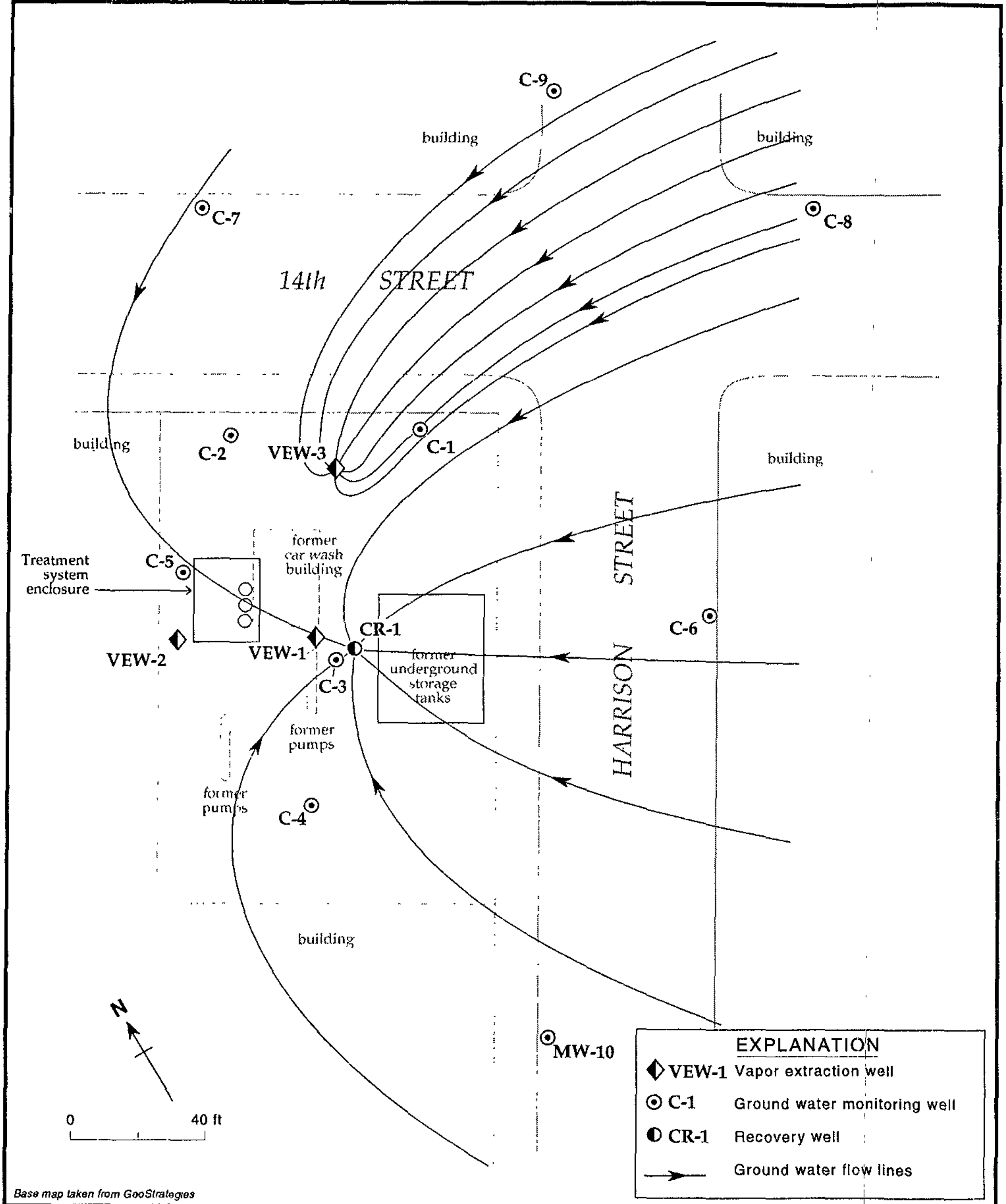

Figure 5. Predicted Flow Lines and Capture Area for Wells CR-1, VEW-~~1~~ 3 - January 26, 1994 - Former Chevron Service Station #9-4816, 301 14th Street, Oakland, California

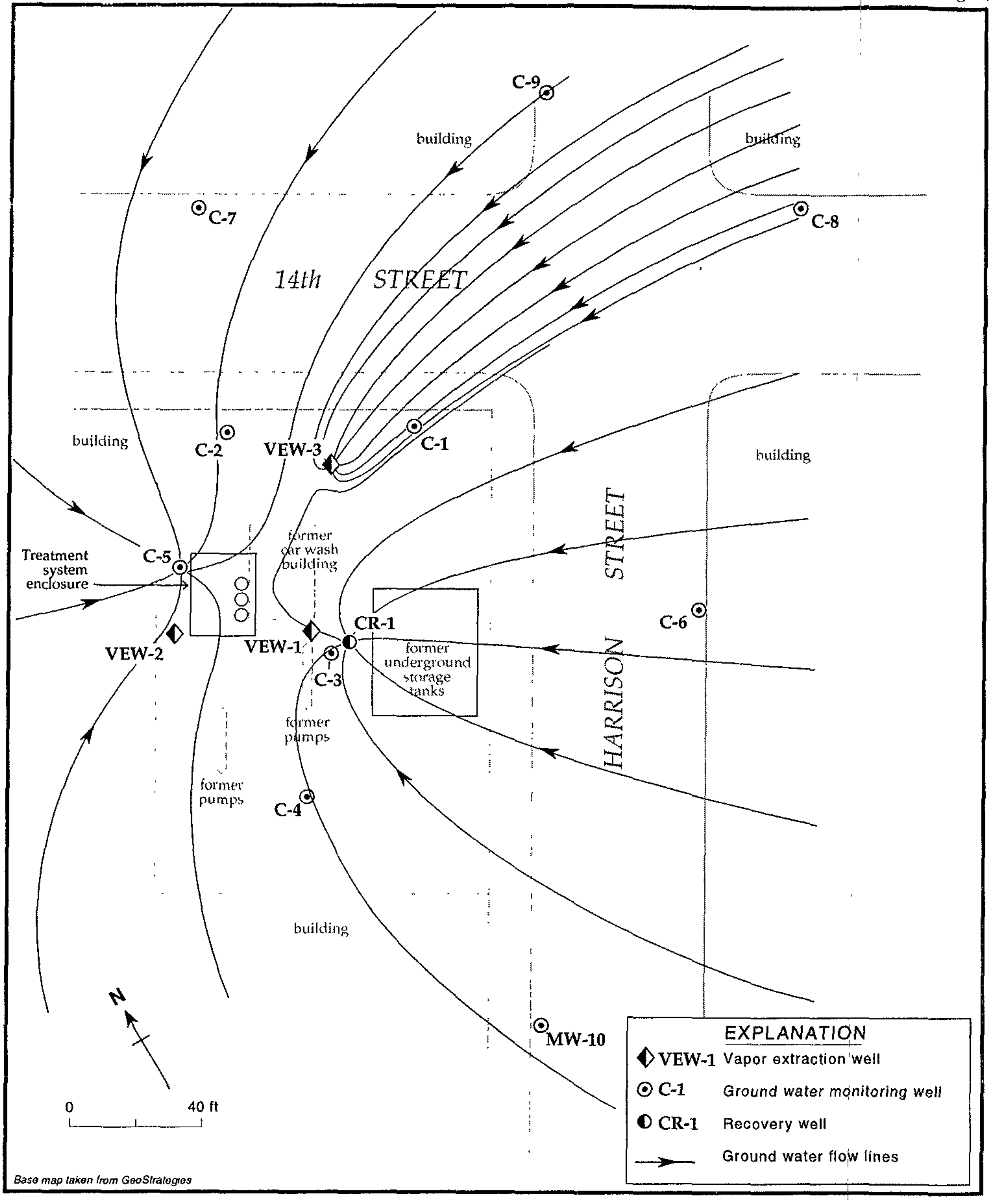

Figure 6. Predicted Flow Lines and Capture Area for Wells CR-1, VEW-3 and C-5 - January 26, 1994 - Former Chevron Service Station #9-4816, 301 14th Street, Oakland, California