CAMBRIA

ENTAL
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AM 7:25

April 15, 1998

3769

Barney Chan
Alameda County Department
of Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

Re: **Remedial Action Plan**
Shell Service Station
4255 MacArthur Boulevard
Oakland, California
WIC #204-5510-0600
Cambria Project #240-0524

Dear Mr. Chan:

On behalf of Shell Oil Products Company (Shell), Cambria Environmental Technology, Inc. (Cambria) has prepared this remedial action plan (RAP) for the site referenced above, as requested by the Alameda County Department of Environmental Health (ACDEH) in the letter to Shell dated February 18, 1998. Presented below are a site summary, a remedial alternative evaluation and our proposed RAP.

SITE SUMMARY

Site Characteristics

Site Location and Topography: The site is an active Shell service station located at the intersection of MacArthur Boulevard and High Street in a mixed commercial and residential area of Oakland, California (Figure 1). An active Unocal service station and a former Chevron service station are located east of the site. A trailer park and adjacent California Department of Transportation (Caltrans) access to Interstate 580 are located immediately southwest of the site. Topography slopes toward the west, with a 5 feet (ft) elevation difference between grade at the Shell service station and the trailer park property, and an additional 5 ft elevation difference between grade at the trailer park property and the Caltrans property.

Site Lithology: The lithology beneath the site and vicinity typically consists of 12 to 15 ft of silts and clays, underlain by silty/clayey sands. Based on the boring logs for wells MW-1, MW- 2 and MW-4, the transition zone from the shallow fine-grained soil to the silty/clayey sand follows topography, sloping toward the west at 12 to 15 ft depth (Figure 2).

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Ground Water Depth: The depth to ground water has ranged from approximately 6 to 17 ft below ground surface since 1993.

Ground Water Flow Direction and Gradient: Ground water generally flows to the northwest with a gradient of approximately 0.1 ft/ft (Figure 1).

Soil and Ground Water Investigation Summary

June 1985 Subsurface Investigation: In June 1985, Emcon Associates of San Jose, California drilled three soil borings and installed one ground water monitoring well adjacent to the underground storage tanks (USTs). Up to 15,800 milligrams per kilogram (mg/kg) total petroleum hydrocarbons as gasoline (TPHg) were detected in the shallow soil samples from inside the UST area. In July 1992, GeoStrategies, Inc. of Hayward, California performed a site reconnaissance and verified that the original monitoring well had been destroyed during the 1985 UST replacement activities.

obvious - considerable soil/GW? contamination w/i tank pit area.

*

December 1985 UST Replacement: In December 1985, the USTs were replaced, and approximately 810 cubic yards of hydrocarbon-bearing soil were transported to a disposal facility. Up to 22,000 mg/kg total volatile hydrocarbons and 500 mg/kg benzene were detected in the soil samples from the excavation.

Assume all soils in 12/2/85 TAL [illegible] Rep removed - soil exc. to > 12.5'?

(BH-C
MW-3)

November 1993 Subsurface Investigation: In November 1993, Weiss Associates of Emeryville, California (WA) drilled soil borings BH-A, BH-B and BH-C that were converted into monitoring wells MW-1, MW-2 and MW-3, respectively. 1.1 B Up to 1,700 mg/kg TPHg and 3.3 mg/kg benzene were detected in soil boring BH-C (MW-3) between 11 ft and 16 ft depth. Up to 66 mg/kg TPHg and 0.07 mg/kg benzene were detected in soil boring BH-B (MW-2) between 9 ft and 14 ft depth.

November 1994 Subsurface Investigation: In November 1994, WA drilled on site soil borings BH-D and BH-E located on the northeastern end of the lot and off site boring BH-F (MW-4) located near the Highway 580 on ramp. Up to 5,900 mg/kg TPHg and 23 mg/kg benzene were detected at 5 ft depth in soil boring BH-E located adjacent to the central eastern pump island. Trace hydrocarbons concentrations were detected in the capillary fringe soil samples collected from each of the borings.

November 1995 Dispenser and Piping Removal and Sampling: In November 1995, WA collected 15 soil samples during dispenser and piping replacement activities. Up to 7,800 mg/kg TPHg were detected in samples collected from beneath the former middle dispenser and 2,800 mg/kg TPHg were detected in the sample collected from beneath the adjacent product piping. Up to 7,300 mg/kg TPHg were detected in the sample collected from beneath the northeast dispenser island. No benzene above 1 mg/kg was detected in any of the 15 samples collected. During the dispenser replacements, horizontal wells HW-1 through HW-4 were installed in the vadose zone about 5 ft below ground surface and adjacent to the former piping and dispensers to facilitate future removal of petroleum hydrocarbons from the impacted soil (Figure 3).

{B}
* detection limits for S-1, S-2, S3, S-8. were < 5, 15, 12, + 5 respectively

August 1997 Soil Vapor Extraction (SVE) Test: In August 1997, Cambria performed short-term SVE testing using a VR Systems Model V3 internal combustion engine (ICE) on horizontal vapor extraction wells HW-1 and HW-2 through HW-4 and monitoring wells MW-2 and MW-3 (Figure 3). Cambria measured vapor extraction flow rates, the vacuum applied to the wellheads, and the vacuum influence in nearby wells. Cambria calculated an effective radius of influence of 35 to 50 ft during testing of wells MW-3 and MW-2. The relatively high TPHg removal rates measured in horizontal wells HW-1 and HW-2 through HW-4 were most likely temporary, and are not believed to be representative of site conditions due to extensive well screen in permeable fill material. The results of the short-term testing indicated that SVE achieves only low hydrocarbon removal rates in wells MW-2 and MW-3, which are more representative of native soil conditions.

February 1998 Subsurface Investigation: In February 1998, Cambria drilled two off site borings (SB-1 and SB-2) in the trailer park adjacent to the Shell site (Figure 1). No TPHg or benzene were detected in the soil samples collected from the two borings. 1.4 mg/kg MTBE was detected in soil boring SB-2 at 7 ft depth. Up to 7,700 micrograms per liter (μg/L) TPHg, 210 μg/L benzene, and 46,000 μg/L MTBE were detected in the grab ground water sample collected from soil boring SB-2. 2,140 mg/kg to 7,210 mg/kg total organic carbon were detected in the soil samples analyzed from the two borings. Effective and specific permeability values for analyzed soil samples confirm the low permeability of the shallow soils beneath the site.

Ground Water Monitoring: Quarterly ground water monitoring has been conducted at the site since November 1993. Separate-phase hydrocarbon (SPH) skimmers were installed in wells MW-2 and MW-3.

Well Survey: Although local ground water is not used as a drinking water source, a well inventory survey was conducted by WA in 1994. WA identified 21 wells within 0.5 miles of the site. Sixteen of these wells are ground water monitoring wells, three are cathodic protection wells, one is an irrigation well and one is a domestic well. The irrigation and domestic wells are located at a BP service station approximately ? 0.25 miles down gradient of the site (Attachment A). No surface water bodies exist within a 0.5 mile radius of the site.

SUBSURFACE HYDROCARBON DISTRIBUTION

Hydrocarbon Distribution in Soil: According to previous investigations, petroleum hydrocarbons in soil appear to be limited to the vicinity of the current UST complex and dispenser island areas.

Separate-Phase Hydrocarbons (SPH): SPH have been detected in wells MW-2 and MW-3 at the site. As shown on Figure A, SPH thickness appears to be greatest when ground water is about 158 to 160 ft-msl, or about 10 to 12 ft deep, and varies with seasonal depth to water changes. The SPH thickness decreased with increasing depth to water (i.e., decreasing water level elevation), while exhibiting an overall decreasing trend. This pattern suggests that SPH is immobilized below the water table in the low permeability zone during the wet winter months and would potentially be mobile only during the drier summer months when the water table is lower (Figure 2). However, as discussed below, the SPH is not migrating even during the summer months.

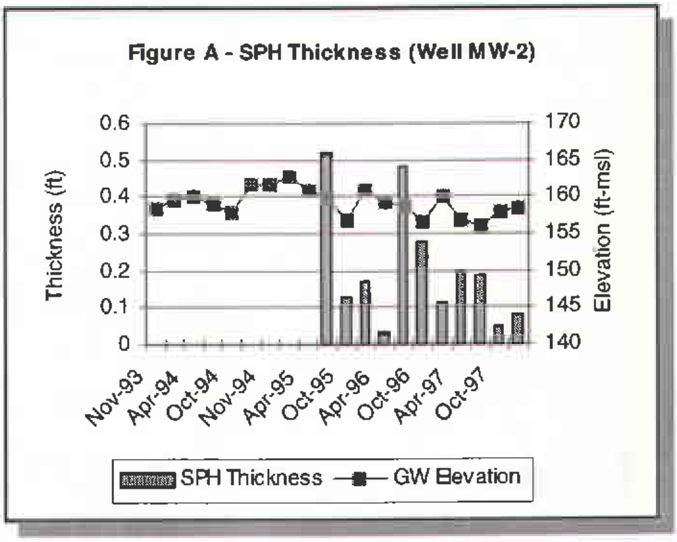
Figure A - SPH Thickness (Well MW-2)

Hydrocarbon Distribution in Ground Water: 0.08 ft of SPH were detected in well MW-2, located immediately down gradient of the USTs, during the first quarter of 1998. Consistent with historical trends, the highest aqueous-phase hydrocarbon concentrations were detected in well MW-3, located cross gradient of the UST area. Significantly lower hydrocarbon concentrations were detected in up gradient well MW-1, and down gradient well MW-4. The current benzene and MTBE distribution in ground water is shown in Figure 1.

Hydrocarbon Plume Stability: As shown on Figure B, benzene concentrations in down gradient well MW-4 are stable to decreasing. Because well MW-4 is the down gradient well, and hydrocarbon concentrations in this well are decreasing, it appears that the hydrocarbon plume is stable or shrinking toward the Shell site. In addition, because the hydrocarbon concentrations in down gradient well MW-4 are stable to decreasing, it is apparent that the SPH detected at the Shell site are ~~not migrating down~~ gradient, nor are they resulting in an expanding hydrocarbon plume. • MW4 does not rep. all down gradient locations + MTBE is ↑

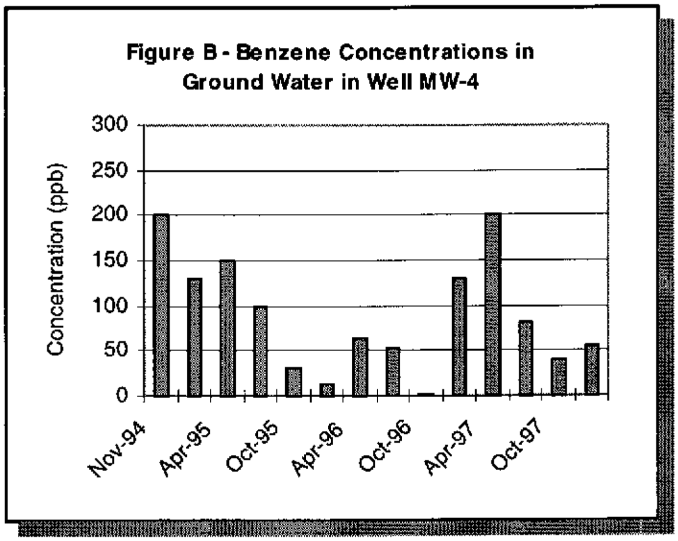
Figure B - Benzene Concentrations in Ground Water in Well MW-4

Estimated Benzene Concentration Gradient: Figure C shows the benzene concentration gradient relative to horizontal distance from well MW-2, which has historically contained SPH. The average benzene concentration in the absence of SPH (approximately 10,000 µg/l) was used as a baseline benzene concentration in well MW-2 for comparative purposes. Based on these assumptions, the benzene concentrations decrease by an order of magnitude over 25 to 30 lateral ft.

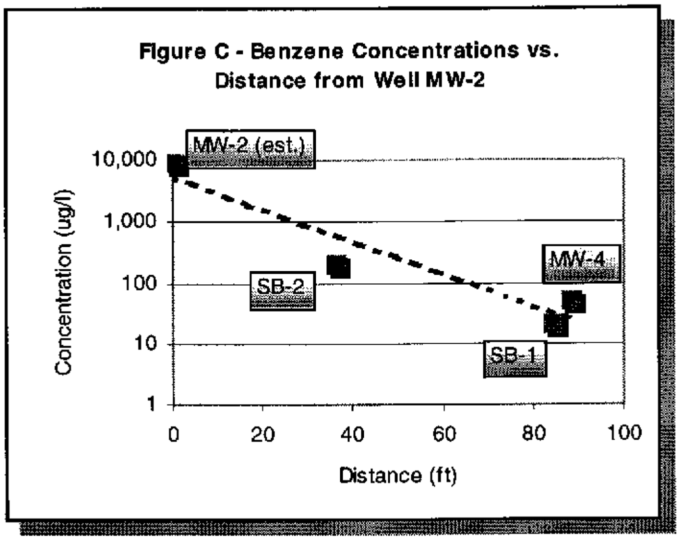
Figure C - Benzene Concentrations vs. Distance from Well MW-2

Risk to Human Health: Although health-based risk assessments are not typically applicable at sites containing SPH, Cambria conducted a preliminary evaluation for the site. Because the ground water is not used as a drinking water source, impacted soil and ground water are first encountered below 10 ft depth, and the adjacent site is occupied by trailer homes without foundations, the only current not potential exposure pathway is by hydrocarbon volatilization from ground water to outdoor air. Based on our experience at similar sites, benzene is typically the primary constituent of concern. According to the American Society of Testing and Materials (ASTM) standard for Risk-Based Corrective Action (RBCA), ASTM E-1739-95, Tier 1 lookup tables, the risk-based screening level (RBSL) for benzene is 3,190 micrograms per liter (μg/l), assuming a 1 E-06 cancer risk, California EPA slope factor correction of 0.29 and a *residentially-zoned* parcel. The RBSL is 319,000 μg/l if we assume a 1 E-04 cancer risk, a California EPA corrected slope factor of 0.29 and a *residentially-zoned* parcel.

→ not the only exposure pathway. Potential: GW vapor to bld, commerc

10^{-5} = 0.21 mg/l

Based on the concentration gradient described above, benzene concentrations above conservative Tier 1 RBSLs for a 1 E-06 cancer risk are limited to within 20 to 30 ft down gradient of well MW-2. This area of the adjacent site is currently asphalt-paved and vacant. Benzene RBSLs for the outdoor inhalation pathway are likely to be higher than the actual exposure concentrations due to 12 to 15 ft of low permeability soils underlying the site, and natural bioattenuation of hydrocarbon vapors. In addition, the risk calculations are based on a 70-year exposure time which is not likely based on the hydrocarbon biodegradation in ground water that is occurring.

- how about worker w/ Kiosk?

CLOSING

Cambria appreciates this opportunity to work with you on this project. Please call us if you have any questions or comments.

Sincerely,

Cambria Environmental Technology, Inc.

John Espinoza
Project Engineer

Khaled B. Rahman, R.G., C.H.G.
Senior Geologist

7/31/99

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Attachments: A - Figures and Tables from Previous Investigations

cc: A.E. (Alex) Perez, Shell Oil Products Company, P.O. Box 8080, Martinez, California 94553

RECOMMENDED REMEDIAL ACTION PLAN

Based on the evaluation of the remedial alternatives presented above, Cambria proposes remediating the hydrocarbon source area by conducting monthly manual bailing of wells MW-2 and MW-3 in conjunction with the installation of ORCs in selected on and off site wells to accelerate the natural attenuation of aqueous-phase hydrocarbons in ground water. The concurrent installation of ORCs in selected wells should increase DO concentrations and reduce hydrocarbon concentrations in ground water. Installing ORCs up gradient of the source area as proposed should allow oxygenated ground water to flow down gradient and remediate hydrocarbons beyond the source area. Using these two remedial techniques should achieve site cleanup objectives in a cost-effective manner. Cambria's recommended RAP is presented below.

Separate-Phase Hydrocarbon Removal

Manual Bailing: Cambria proposes to conduct monthly site visits to measure and remove any SPH that may accumulate in wells MW-2 and MW-3. Historically, up to 0.52 ft and 0.24 ft of SPH have been detected in wells MW-2 and MW-3, respectively. However, only 0.2 ft and 0.03 ft have been detected in wells MW-2 and MW-3, respectively, over the past year. Cambria will conduct monthly visits at the site until it appears that quarterly visits are sufficient to monitor and remove SPH. Cambria will also install ORC socks in well MW-2 once SPH are no longer present.

SPH Skimmer Maintenance: Cambria will maintain the existing SPH skimmers in wells MW-2 and MW-3 and empty them during manual bailing events.

On Site Aqueous-Phase Hydrocarbon Reduction

ORC Installation: To reduce on and off site aqueous-phase hydrocarbon concentrations, we also recommend installing ORCs in up gradient well MW-1, cross gradient well MW-3, and in down gradient well MW-4. We will install the ORCs below the water table from about 5 to 15 ft depth in each well to target the current and former capillary fringe (the hydrocarbon smear zone). If present, Cambria will also install ORCs in any submerged UST backfill wells. However, sufficient ground water is not anticipated for ORC installation to be effective in the UST backfill wells.

bio-att
add other parameters

ORC, DO and Hydrocarbon Monitoring: Cambria will analyze ground water samples collected from each well prior to installing ORCs for hydrocarbons and measure DO levels to establish baseline concentrations. After installing the ORCs, we will continue to monitor for DO concentrations on a monthly basis up until the next quarterly monitoring event. When the DO concentrations decrease to original concentrations, we will evaluate the necessity for replacement of ORC socks. The hydrocarbon and DO data will allow us to assess the effectiveness of ORCs and to monitor the natural bioattenuation of hydrocarbons in ground water.

+ORP

Natural Attenuation

Method Description and Comments: The natural attenuation alternative involves allowing hydrocarbons to biodegrade naturally and implementing a long-term ground water monitoring plan to confirm hydrocarbon degradation. For natural attenuation to occur by aerobic processes, a minimum of about 1 to 2 mg/l DO is required. At most hydrocarbon sites, DO concentrations are reduced in the hydrocarbon source area compared to the plume boundary due to biodegradation.

Once oxygen is depleted, hydrocarbon biodegradation may produce methane through anaerobic processes. In the hydrocarbon source area where oxygen is depleted, sulfates and nitrates can also act as electron receptors and allow anaerobic hydrocarbon degradation. As with the hydrocarbon/DO relationship, there is an inverse relationship with sulfates and nitrates and the hydrocarbon concentrations. Finally, since the source area is commonly oxygen deficient and often becomes a reducing environment, oxidation/reduction potential (ORP) is another indicator that natural attenuation is occurring. It is expensive and usually not necessary to analyze for each parameter listed above to confirm that hydrocarbons are biodegrading. Instead, we typically recommend analyzing for DO +ORP to confirm that sufficient DO exists to allow continued remediation by natural attenuation, and for hydrocarbons to document hydrocarbon concentration reductions. We also review the relationship between hydrocarbon and DO concentrations to document DO depletion due to biodegradation. These two parameters are more than sufficient to document biodegradation of hydrocarbons.

Cost-Effectiveness: Since the site is currently being monitored on a quarterly basis for TPHg, benzene, toluene, ethylbenzene and xylenes (BTEX) and MTBE, the cost for additional DO monitoring is relatively low in cost. +ORP

Recommendation: A natural bioattenuation monitoring protocol should be implemented upon approval of the RAP.

the amount of hydrocarbons removed by each mechanism, it is difficult to determine which removal mechanism is more effective. However, our experience suggests that stimulation of biodegradation is most likely the key removal mechanism after the initial, short-term volatilization stage.

The combination of these two techniques is most effective for sites with hydrocarbons in permeable materials where the injected air is easily captured by SVE. Hydrocarbon vapors created by the initial volatilization stage are typically captured and treated by a SVE system.

Cost-Effectiveness: Installing three new combination SVE/AS wells, associated piping and accessories and operating it for about six months would be relatively high in cost. Therefore, the combined SVE/AS system installation and operation and maintenance costs would be relatively high.

Recommendation: Cambria does not recommend remediating the remaining aqueous-phase hydrocarbons utilizing combination SVE/AS for the following reasons: (1) the site is underlain by low permeability soils to a depth of 10 to 15 ft below grade that would greatly reduce the effectiveness of SVE to capture vapors generated by air sparging and (2) as described above, air sparging removes aqueous-phase hydrocarbons through volatilization and by stimulation of aerobic biodegradation. Stimulation of biodegradation can be accomplished cost-effectively by other ground water oxygenation techniques, as described below.

Ground Water Oxygenation with Oxygen Releasing Compounds (ORCs)

Method Description and Comments: ORCs release dissolved oxygen (DO) into ground water to accelerate naturally occurring aerobic hydrocarbon biodegradation. ORCs are capable of providing up to 40 mg/l DO, while DO concentrations from air injection techniques such as air sparging can only achieve up to about 10 mg/l. ORCs are a solid magnesium peroxide compound that is activated by moisture. ORCs release oxygen slowly to the ground water and are environmentally safe to use. The byproducts of ORC reaction with water are oxygen and magnesium hydroxide, which is essentially milk of magnesia. ORCs can be installed in existing ground water monitoring wells in socks that extend through the anticipated ground water fluctuation depth range. Using ORCs to remediate the hydrocarbons in ground water may take 1 to 2 years, or longer depending on the final ground water quality objectives.

Cost-Effectiveness: Since ORCs do not require system operation or maintenance, remediation using ORCs is easy and low in cost. ORCs cost about $45 for each 1 foot long ORC sock installed in a 4-inch diameter well.

Recommendation: Because our objective is to safely and cost-effectively decrease hydrocarbon concentrations in ground water, oxygenation using ORCs appears to be the most cost-effective and appropriate remedial technique for this site. This approach would also avoid disruptive and noisy remediation equipment operation, which is a primary concern identified in residential zones. In addition, no vapor treatment would be required, which eliminates oxidizer emissions.

Soil Vapor Extraction (SVE)

Method Description and Comments: This alternative consists of extracting vapor-phase hydrocarbons by applying a vacuum to soil in the vadose zone and historic capillary fringe area. After the hydrocarbons are extracted in the vapor phase, they are typically either incinerated by thermal or catalytic combustion or adsorbed by activated carbon. This method can be an effective remediation tool when the current and former capillary fringe (hydrocarbon smear zone) consists of fairly permeable materials.

Cost-Effectiveness: Due to a relatively high ground water table and low estimated permeability soils at this site, several additional SVE wells would be required down gradient of the current UST area. Installing several SVE wells, and installing and operating a SVE system for about six months would be relatively high in cost.

Recommendation: As described above, the results of the short-term SVE testing indicated only low hydrocarbon removal rates in wells MW-2 and MW-3, which are more representative of native soil conditions. Although well MW-2 has historically contained SPH, the well yielded a hydrocarbon removal rate of only 11 ppd. Although an effective radius of influence ranging from 35 to 50 ft was measured during the testing of wells MW-2 and MW-3, the high vacuum applied indicates that vadose zone soil is relatively impermeable to vapor migration. The relatively high TPHg removal rates measured in horizontal wells HW-1 and HW-2 through HW-4 were most likely temporary, and are not believed to be representative of site conditions due to the extensive well screen in permeable fill material. Based on our experience at similar sites, the hydrocarbon removal rates from the horizontal wells would most likely reach low, asymptotic levels within a few days of continued SVE operation. The system would likely operate for a few months before reaching low, asymptotic hydrocarbon concentrations in the system influent. However, since the site is underlain by low permeability soils, SVE would not be significantly effective at reducing the remaining aqueous-phase hydrocarbons. Due to the relatively high cost and ineffectiveness, we do not recommend utilizing SVE at this site.

Combination Soil Vapor Extraction/Air Sparging (SVE/AS)

Method Description and Comments: As explained above, SVE involves applying a vacuum to vapor-phase hydrocarbons in the vadose zone. Extracted hydrocarbons are typically treated by activated carbon, oxidizers or internal combustion engines. SVE can improve ground water quality by removing source area hydrocarbons and encouraging hydrocarbon diffusion from ground water. This method is most effective for moderate to high permeability soils.

Air sparging involves injecting filtered, ambient air at flow rates ranging from 5-10 cubic feet per minute (cfm) via wells screened below the water table. The two main hydrocarbon removal mechanisms achieved by air sparging in ground water are (1) volatilization of aqueous-phase hydrocarbons and (2) stimulation of aerobic biodegradation of both aqueous and sorbed phase hydrocarbons resulting from increased DO levels. Air sparging can typically elevate DO concentrations up to about 10 mg/l, which is over five to ten times the amount of DO necessary for aerobic biodegradation of hydrocarbons. Due to the complexity of determining

REMEDIATION ALTERNATIVE EVALUATION

Cambria evaluated several alternatives to remediate ground water at the site. A description of each alternative is presented below. In accordance with Title 23 of the UST regulations, Cambria proposes to implement the most adequate and cost-effective alternative to remediate the remaining SPH and aqueous-phase hydrocarbons in ground water at this site within a reasonable time frame. Natural attenuation as a remedial alternative is included in this evaluation. A description of each alternative is presented below.

Ground Water Extraction (GWE)

Method Description and Comments: GWE uses pumps to extract hydrocarbon-bearing ground water. Extracted ground water is typically treated with granular activated carbon (GAC), air stripping or biological reactors prior to permitted discharge into the sanitary or storm sewer. Since GWE was the primary remedial technique required by regulatory agencies through the 1970s and 1980s, there is abundant data indicating that GWE is not typically effective at removing aqueous-phase hydrocarbons. Industry studies and our experience indicates that GWE alone rarely results in significant aqueous-phase hydrocarbon concentration decreases in ground water, even after years of pumping. However, GWE can be effective, but costly, method for removing significant amounts of SPH.

Cost-Effectiveness: Installing a GWE system and operating and maintaining it for about 2 years would be relatively high in cost depending on flow rates, number of wells required, etc.

Recommendation: Due to the low permeability of site soils and the limited remaining SPH, operation of a GWE system would not result in any significant decrease in SPH or aqueous-phase hydrocarbon removal at this site. Therefore, we do not recommend utilizing GWE at this site.

Manual Bailing or Skimming of SPH

Not really!

Method Description and Comments: Significant amounts of SPH can be removed from wells by frequent manual bailing events or by the use of SPH skimmers. Manual bailing consists of lowering a bailing device into a well and removing SPH periodically in designated wells. SPH skimmers can be installed in wells and can be emptied periodically depending on the amount of SPH captured. The SPH removed by manual bailing or from SPH skimmers is typically stored on site in a designated area and transported periodically to a recycling facility.

Cost-Effectiveness: Conducting monthly manual bailing events during the initial SPH removal phase in concurrence with the SPH skimmers already installed at the site, and continuing manual bailing on a quarterly basis for about 2 years would be relatively low in cost depending on event frequency.

Recommendation: Since SPH thickness is decreasing at the site, manual bailing and the continued use of SPH skimmers can be effective tools for removing the remaining SPH.

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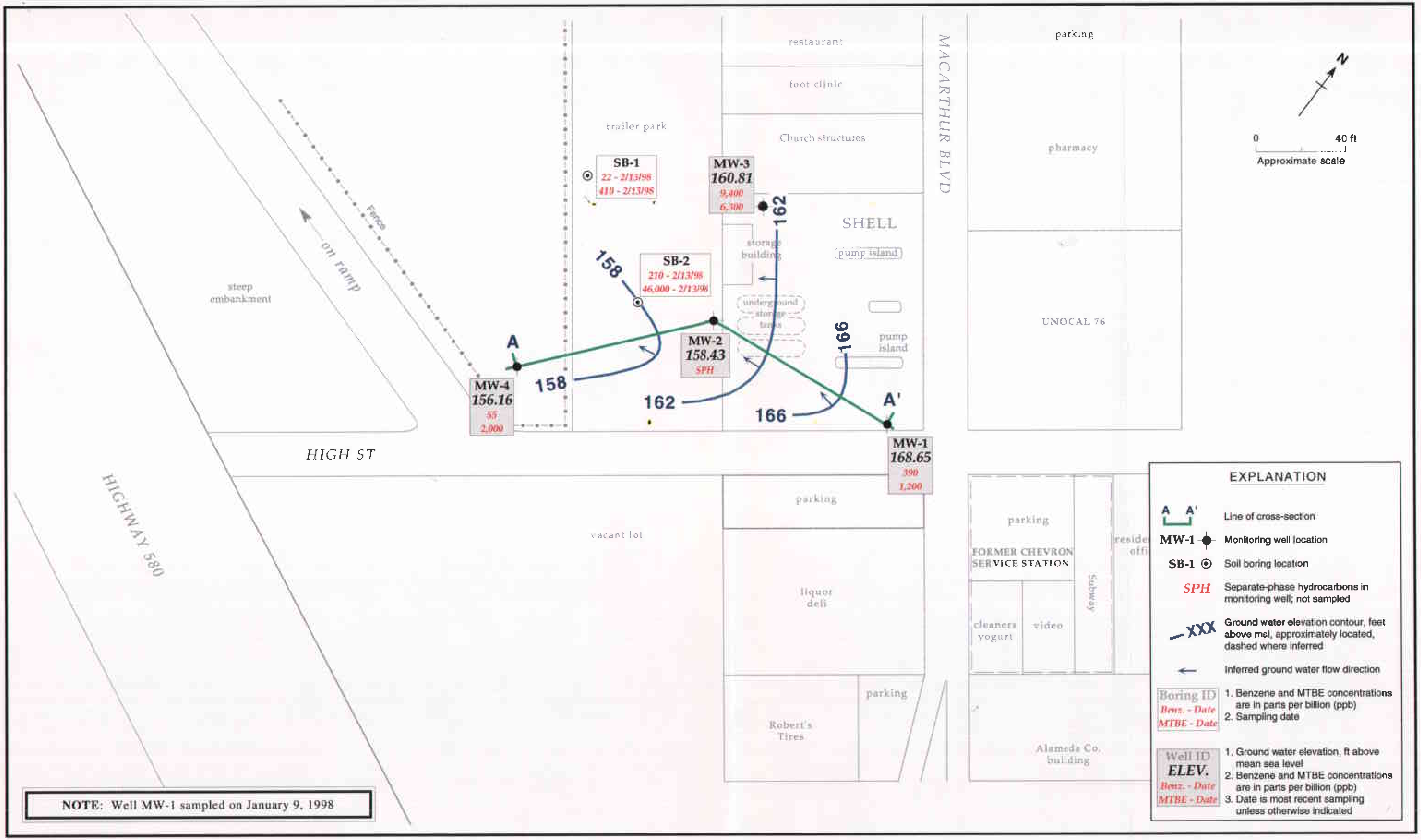
Environmental Technology, Inc.



NOTE: Well MW-1 sampled on January 9, 1998

Figure 1. Ground Water Elevation Contours - January 8, 1998 - Shell Service Station WIC #204-5510-0600, 4255 MacArthur Boulevard, Oakland, California

G:\SHELL\OAK4255\FIGURES\1QM98-MP.AI

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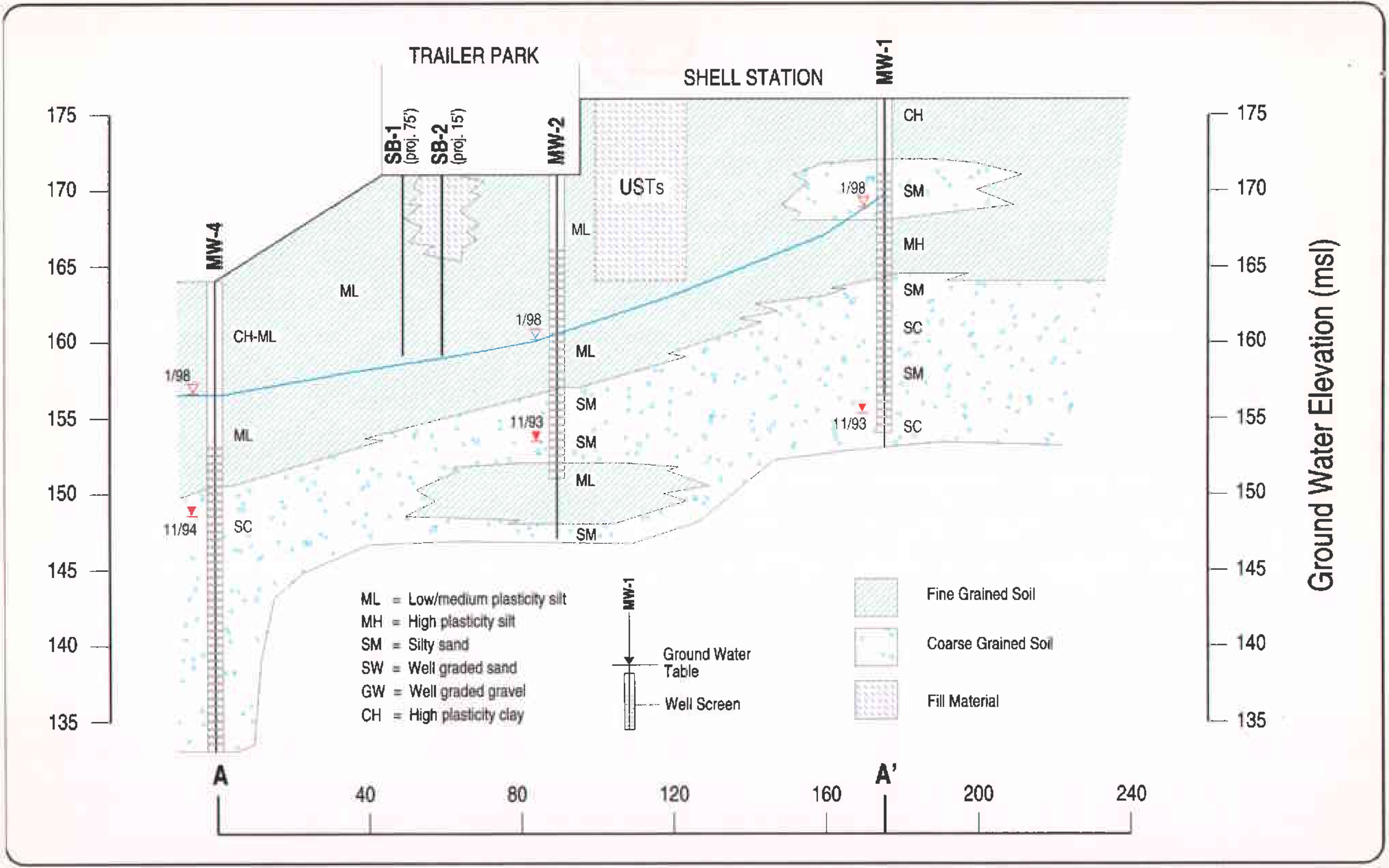


CAMBRIA
Environmental Technology, Inc.

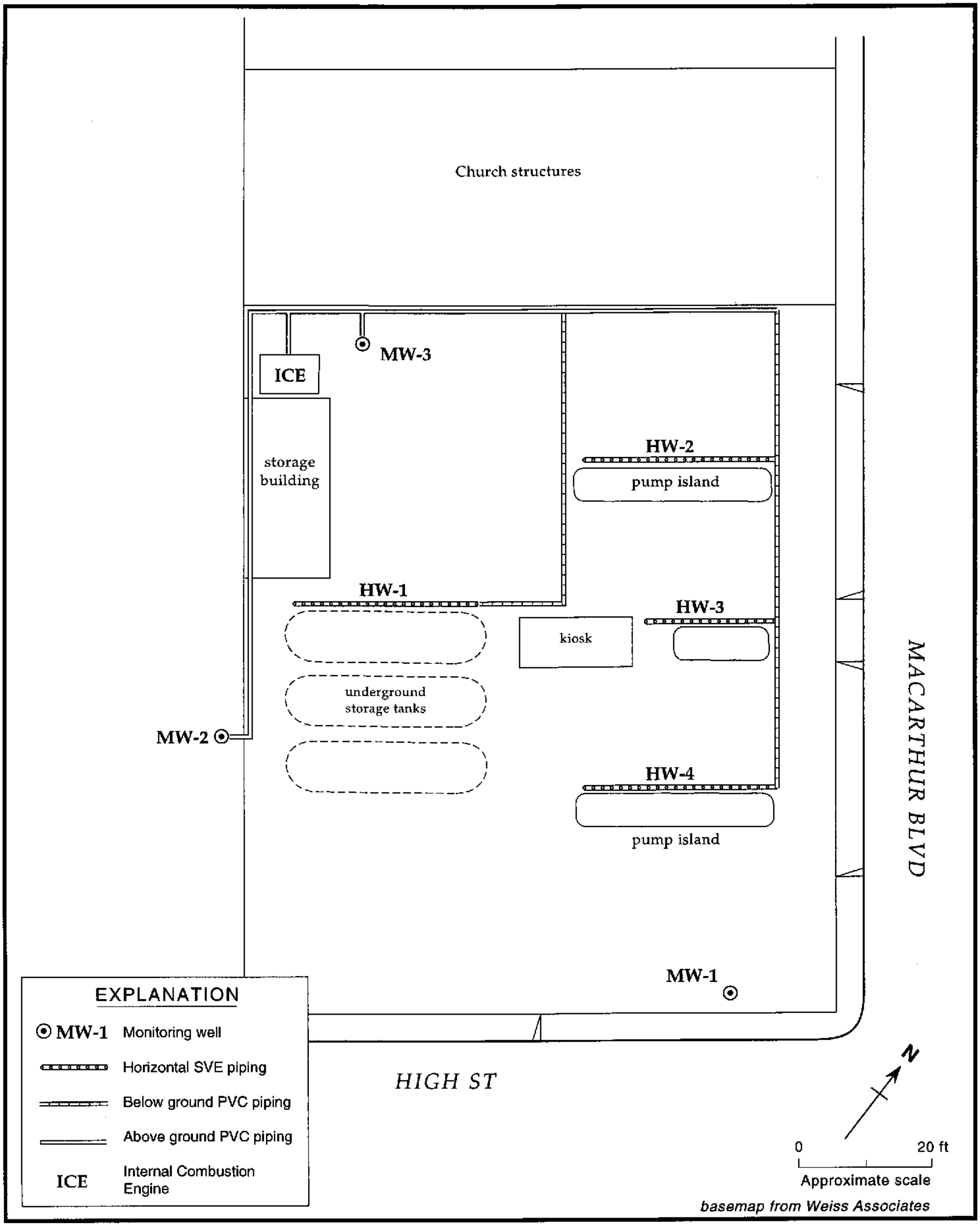
Shell Service Station
4255 MacArthur Boulevard
Oakland, California

G:\OAK4255\FIGURES\CRSS-SEC.DWG

Cross Section A - A'

FIGURE
2

04/09/98



basemap from Weiss Associates

Figure 3. SVE Test System Schematic Layout - Shell Service Station WIC #204-5510-0600, 4255 MacArthur Boulevard, Oakland, California

Table 1. **Separate-Phase Hydrocarbon Removal** - Shell Service Station WIC #204-5510-0600, 4255 MacArthur Blvd., Oakland, California

Well ID	Date	SPH Thickness (ft)	SPH Removed (lbs)	Cumulative SPH Removed (lbs)
MW-2	11/17/93	0.0	0.0	0.0
	01/20/94	0.0	0.0	0.0
	04/25/94	0.0	0.0	0.0
	07/07/94	0.0	0.0	0.0
	01/13/95	0.0	0.0	0.0
	04/12/95	0.0	0.0	0.0
	08/10/95	0.52	5.98[a]	5.98
	10/18/95	0.13	0.0	5.98
	01/17/96	0.17	1.74	7.72
	04/25/96	0.03	0.65	8.37
	07/17/96	0.48	2.11	10.48
	10/01/96	0.28	0.81	11.29
	01/22/97	0.11	0.48	11.77
	04/08/97	0.20	0.97	12.74
	07/08/97	0.19	0.97	13.71
	10/08/97	0.05	0.81	14.52
	01/08/98	**0.08**	**1.29**	**15.81**
MW-3	11/17/93	0.0	0.0	0.0
	01/20/94	0.0	0.0	0.0
	04/25/94	0.0	0.0	0.0
	07/07/94	0.0	0.0	0.0
	01/13/95	---	0.02	0.02
	04/12/95	---	0.02	0.04
	08/10/95	0.06	0.69[a]	0.73
	10/18/95	0.05	0.0	0.73
	01/17/96	0.24	2.62	3.35
	04/25/96	0.02	0.33	3.68
	07/17/96	0.03	0.70	4.38
	04/08/97	0.03	0.16	4.54
	07/08/97	0.0	0.0	4.54
	10/08/97	0.0	0.0	4.54
	01/08/98	**0.0**	**0.0**	**4.54**
TOTAL HYDROCARBONS REMOVED				**20.35**

Notes and Abbreviations:

SPH = Separate-phase hydrocarbons
ft = Feet
lbs = Pounds
--- = Not measured
a = SPH in 10" boring and 4" well estimated by following factor: 1 ft of SPH = 11.5 lbs of SPH
Weight of SPH converted from volume using the relation: 1 liter gasoline = 1.61 pounds

Table 2. **Ground Water Elevations** - Shell Service Station WIC #204-5510-0600, 4255 MacArthur Blvd., Oakland, California

Well ID	Date Gauged	Top-of-Casing Elevation (ft above msl)	Depth to Water (ft below TOC)	Separate-phase Hydrocarbons (ft)	Ground Water Elevation[a] (ft above msl)
MW-1	11/17/93	175.79	8.59	---	167.20
	01/20/94		8.22	---	167.57
	04/25/94		7.63	---	168.16
	07/07/94		8.31	---	167.48
	10/27/94		8.84	---	166.95
	11/17/94		7.60	---	168.19
	11/28/94		7.56	---	168.23
	01/13/95		7.11	---	168.68
	04/12/95		7.08	---	168.71
	07/25/95		7.73	---	168.06
	10/18/95		8.42	---	167.37
	01/17/96		7.83	---	167.96
	04/25/96		7.35	---	168.44
	07/17/96		7.70	---	168.09
	10/01/96		8.07	---	167.72
	01/22/97		7.21	---	168.58
	04/08/97		7.75	---	168.04
	07/08/97		8.01	---	167.78
	10/08/97		8.10	---	167.69
	01/08/98[b]		**7.14**	**---**	**168.65**
MW-2	11/17/93	170.91	12.31	---	158.60
	01/20/94		11.48	---	159.43
	04/25/94		10.84	---	160.07
	07/07/94		11.89	---	159.02
	10/27/94		12.89	---	158.02
	11/17/94		9.11	---	161.80
	11/28/94		9.22	---	161.69
	01/13/95		8.10	---	162.81
	04/12/95		10.12	---	160.79
	07/25/95		11.53	0.52	159.80
	10/18/95		14.02	0.13	156.99
	01/17/96		10.27	0.17	160.78
	04/25/96		11.68	0.03	159.25
	07/17/96		12.78	0.48	158.81
	10/01/96		14.21	0.28	156.70
	01/22/97		10.92	0.11	160.08
	04/08/97		14.12	0.20	156.95
	07/08/97		14.98	0.19	156.08
	10/08/97		12.97	0.05	157.98
	01/08/98		**12.54**	**0.08**	**158.43**
MW-3	11/17/93	174.61	15.40	---	159.21
	01/20/94		14.61	---	160.00

Table 2. **Ground Water Elevations** - Shell Service Station WIC #204-5510-0600, 4255 MacArthur Blvd., Oakland, California (continued)

Well ID	Date Gauged	Top-of-Casing Elevation (ft above msl)	Depth to Water (ft below TOC)	Separate-phase Hydrocarbons (ft)	Ground Water Elevation[a] (ft above msl)
	04/25/94		13.12	---	161.49
	07/07/94		14.54	0.02	160.07
	10/27/94		15.62	0.05	159.03
	11/17/94		13.83	---	160.78
	11/28/94		14.02	---	160.59
	01/13/95		12.13	---	162.48
	04/12/95		12.96	---	161.65
	07/25/95		14.28	0.06	160.38
	10/18/95		15.88	0.05	158.77
	01/17/96		13.86	0.24	160.94
	04/25/96		13.82	0.02	160.81
	07/17/96		16.11	0.03	158.52
	10/01/96		16.56	---	158.05
	01/22/97		13.07	---	161.54
	04/08/97		17.09	0.03	157.54
	07/08/97		15.85	---	158.76
	10/08/97		16.22	---	158.39
	01/08/98		**13.80**	**---**	**160.81**
MW-4	11/17/94	164.06	6.62	---	157.44
	11/28/94		6.11	---	157.95
	01/13/95		6.05	---	158.01
	04/12/95		6.31	---	157.75
	07/25/95		7.36	---	156.70
	10/18/95		8.54	---	155.52
	01/17/96		8.48	---	155.58
	04/25/96		7.40	---	156.66
	07/17/96		7.75	---	156.31
	10/01/96		8.82	---	155.24
	01/22/97		7.51	---	156.55
	04/08/97		7.18	---	156.88
	07/08/97		9.00	---	155.06
	10/08/97		8.97	---	155.09
	01/08/98		**7.90**	**---**	**156.16**

Notes and Abbreviations:

a = When separate-phase hydrocarbons are present, ground water elevation is corrected using the relation: Corrected ground water elevation equals top of casing elevation minus depth to water plus (0.8 x separate phase hydrocarbon thickness)
b = Well MW-1 sampled on January 9, 1998
--- = Separate-phase hydrocarbons not present
msl = Mean sea level
TOC = Top of casing
ft = Feet

Table 3. **Ground Water Analytical Results for Petroleum Hydrocarbons -** Shell Service Station WIC #204-5510-0600, 4255 MacArthur Boulevard, Oakland, California

Well ID	Date Sampled	Depth to Water (ft)	TPH-G	MTBE	B	T	E	X
			←		parts per billion (µg/L)			→
MW-1	11/17/93	8.59	410	---	21	11	7.9	47
	01/20/94	8.22	1,200	---	180	19	48	47
	04/25/94	7.63	3,100	---	610	<10	130	27
	07/07/94	8.31	2,400	---	1,000	10	250	20
	10/27/94	8.84	2,200	---	500	3.1	72	1.8
	01/13/95	7.11	570	---	75	2.5	6.7	11
	04/12/95	7.08	1,800	---	480	<5.0	79	<5.0
	07/25/95	7.73	120	---	15	1.1	2.1	2.9
	07/25/95^{dup}	7.73	300	---	88	2.4	11	6.5
	10/18/95	8.42	130	---	9.5	0.8	1.3	1.7
	10/18/95^{dup}	8.42	120	---	11	0.8	1.4	1.8
	01/17/96	7.83	250	---	22	0.9	1.6	2.3
	04/25/96	7.35	<50	500[b]	4.6	<0.5	<0.5	0.60
	07/17/96	7.70	<250	540	15	<2.5	<2.5	<2.5
	10/01/96	8.07	1,200	1,900	500	12	57	82
	01/22/97	7.21	640	1,200	170	4.3	33	33
	04/08/97	7.75	<200	950	34	<2.0	3.3	4.3
	04/08/97^{dup}	7.75	<200	740	66	<2.0	6.4	8.0
	07/08/97	8.01	190	560	49	1.2	5.8	8.6
	10/08/97	8.10	<100	620	7.0	<1.0	<1.0	<1.0
	01/09/98[c]	**7.14**	**970**	**1,200**	**390**	**12**	**48**	**71**
MW-2	11/17/93	12.31	31,000	---	9,400	4,600	1,000	3,900
	01/20/94	11.48	40,000	---	6,900	5,600	780	4,100
	01/20/94^{dup}	11.48	41,000	---	7,200	6,200	900	4,800
	04/25/94	10.84	60,000	---	9,300	6,100	1,400	6,200
	07/07/94	11.89	280,000[a]	---	40,000	26,000	8,100	32,000
	07/07/94^{dup}	11.89	53,000	---	13,000	6,600	2,000	8,400
	10/27/94	12.89	130,000	---	14,000	12,000	2,400	13,000
	10/27/94^{dup}	12.89	390,000	---	8,800	7,000	1,700	11,000
	01/13/95	8.10	75,000	---	5,900	12,000	3,100	17,000
	04/12/95	10.12	100,000	---	8,500	11,000	2,400	12,000
	04/12/95^{dup}	10.12	80,000	---	4,200	9,300	2,500	12,000
	08/10/95^{SPH}	11.53	---	---	---	---	---	---

Table 3. **Ground Water Analytical Results for Petroleum Hydrocarbons** - Shell Service Station WIC #204-5510-0600, 4255 MacArthur Boulevard, Oakland, California (continued)

Well ID	Date Sampled	Depth to Water (ft)	TPH-G	MTBE	B	T	E	X
			parts per billion (µg/L)					
	10/18/95^{SPH}	14.02	---	---	---	---	---	---
	01/17/96^{SPH}	10.27	---	---	---	---	---	---
	04/25/96^{SPH}	11.68	---	---	---	---	---	---
	07/17/96^{SPH}	12.78	---	---	---	---	---	---
	10/01/96^{SPH}	14.21	---	---	---	---	---	---
	01/22/97^{SPH}	10.92	---	---	---	---	---	---
	04/08/97^{SPH}	14.12	---	---	---	---	---	---
	07/08/97^{SPH}	14.98	---	---	---	---	---	---
	10/08/98^{SPH}	12.97	---	---	---	---	---	---
	01/08/98^{SPH}	**12.54**	**---**	**---**	**---**	**---**	**---**	**---**
MW-3	11/17/93	15.40	18,000	---	5,400	660	720	2,200
	01/20/94	14.61	55,000	---	13,000	2,600	2,200	6,500
	04/25/94	13.12	96,000	---	11,000	1,600	3,100	9,900
	04/25/94^{dup}	13.12	78,000	---	12,000	1,900	2,600	7,300
	07/07/94^{SPH}	14.54	---	---	---	---	---	---
	10/27/94^{SPH}	15.62	---	---	---	---	---	---
	01/13/95	12.13	180,000	---	3,200	2,700	1,700	5,200
	01/13/95^{dup}	12.13	23,000	---	4,000	690	960	3,000
	04/12/95	12.96	56,000	---	8,700	1,500	2,100	6,300
	08/10/95^{SPH}	14.28	---	---	---	---	---	---
	10/18/95^{SPH}	15.88	---	---	---	---	---	---
	01/17/96^{SPH}	13.86	---	---	---	---	---	---
	04/25/96^{SPH}	13.82	---	---	---	---	---	---
	07/17/96^{SPH}	16.11	---	---	---	---	---	---
	10/01/96	16.56	46,000	3,200	7,300	530	1,700	3,900
	10/01/96^{dup}	16.56	47,000	2,900	7,100	530	1,700	4,000
	01/22/97	13.07	82,000	1,100	5,200	1,300	2,800	8,900
	01/22/97^{dup}	13.07	61,000	2,700	8,400	1,100	2,300	7,000
	04/08/97^{SPH}	17.09	---	---	---	---	---	---
	07/08/97	15.85	56,000	2,800	8,800	580	2,000	4,900
	10/08/97	16.22	48,000	5,100	8,000	590	1,700	3,400
	01/08/98	**13.80**	**47,000**	**6,300**	**9,400**	**810**	**2,300**	**4,700**
	01/08/98^{dup}	**13.80**	**48,000**	**5,800**	**8,100**	**750**	**2,000**	**4,100**

Table 3. **Ground Water Analytical Results for Petroleum Hydrocarbons -** Shell Service Station WIC #204-5510-0600, 4255 MacArthur Boulevard, Oakland, California (continued)

Well ID	Date Sampled	Depth to Water (ft)	TPH-G	MTBE	B	T	E	X
			←		parts per billion (µg/L)			→
MW-4	11/28/94	6.11	2,900	---	200	17	76	260
	01/13/95	6.05	1,900	---	130	5.6	13	40
	04/14/95	6.31	680	---	150	<2.0	10	13
	07/25/95	7.36	340	---	100	0.8	8.8	3.0
	10/18/95	8.54	150	---	31	<0.5	3.5	0.8
	01/17/96	8.48	290	---	14	<0.5	1.8	0.8
	04/25/96	7.40	<500	1,700	65	<5	<5	<5
	04/25/96^{dup}	7.40	<500	1,500	66	<5	8.7	<5
	07/17/96	7.75	<500	1,500	84	<5.0	6.5	<5.0
	07/17/96^{dup}	7.75	<500	1,700 (2,100)	54	<5.0	<5.0	<5.0
	10/01/96	8.82	<500	3,000	1.9	<5.0	<5.0	<5.0
	01/22/97	7.51	580	1,200	130	<2.5	18	5.2
	04/08/97	7.18	770	1,500	200	7.0	26	55
	07/08/97	9.00	570	1,200	78	<5.0	14	11
	07/08/97^{dup}	9.00	640	1,600	81	<5.0	16	19
	10/08/97	8.97	<500	1,400	40	<5.0	7.4	5.4
	10/08/97^{dup}	8.97	<500	1,400	36	<5.0	5.9	<5.0
	01/08/98	**7.90**	**<1,000**	**2,000**	**55**	**<10**	**13**	**<10**
Trip Blank	01/20/94		<50	---	<0.5	<0.5	<0.5	<0.5
	04/25/94		<50	---	<0.5	<0.5	<0.5	<0.5
	07/07/94		<50	---	<0.5	<0.5	<0.5	<0.5
	10/27/94		<50	---	<0.5	<0.5	<0.5	<0.5
	01/13/95		<50	---	<0.5	<0.5	<0.5	<0.5
	04/12/95		<50	---	<0.5	<0.5	<0.5	0.89
	07/25/95		<50	---	<0.5	<0.5	<0.5	<0.5
	10/18/95		<50	---	<0.5	<0.5	<0.5	<0.5
MCLs			NE	NE	1	150	700	1,750

Table 3. **Ground Water Analytical Results for Petroleum Hydrocarbons** - Shell Service Station WIC #204-5510-0600, 4255 MacArthur Boulevard, Oakland, California

Abbreviations:

TPH-G = Total petroleum hydrocarbons as gasoline by modified EPA Method 8015
MTBE = Methyl tert-butyl ether by EPA Method 8020. Result in parentheses indicates MTBE by EPA Method 8260
B = Benzene by EPA Method 8020
T = Toluene by EPA Method 8020
E = Ethylbenzene by EPA Method 8020
X = Xylenes by EPA Method 8020
SPH = Separate-phase hydrocarbons present, well not sampled
--- = Not analyzed/Not available
<n = Below detection limits of **n** µg/L
dup = Duplicate sample
ft = Feet
µg/L = Micrograms per liter
MCLs = California primary maximum contaminant levels for drinking water (22 CCR 64444
NE = MCLs not established

Notes:

a = Ground water surface had a sheen when sampled
b = MTBE value is estimated by Sequoia Analytical of Redwood City, California
c = Well MW-1 gauged on January 8, 1998

ATTACHMENT A

Figures and Tables from Previous Investigations

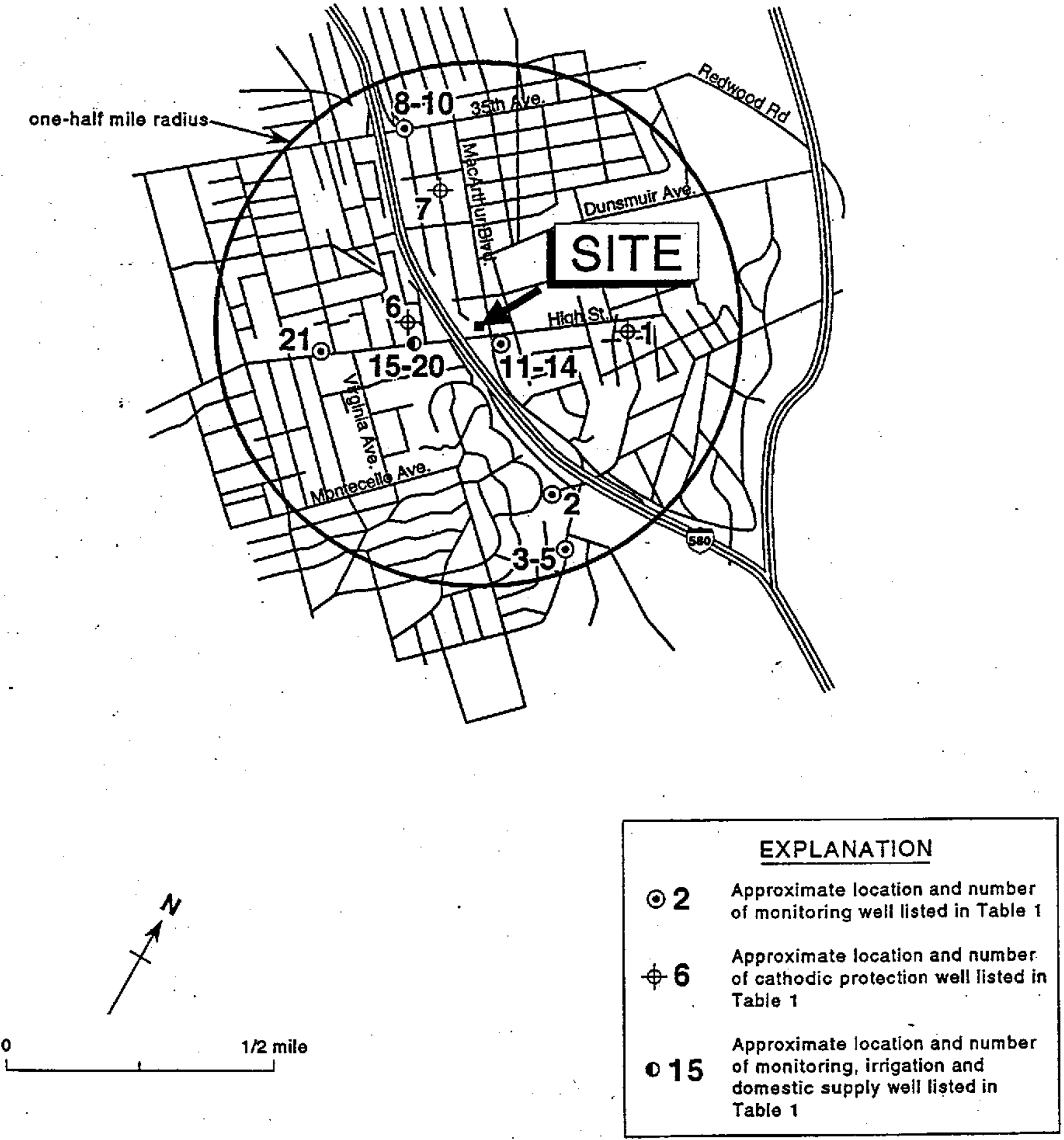


Figure 2. Wells Within One-Half Mile of Shell Service Station WIC #5510-0600, 4255 MacArthur Boulevard, Oakland

Table 1. Wells Located Within One-Half Mile of Shell Service Station WIC #204-5510-0600; 4255 MacArthur Boulevard, Oakland, California

ID	Owner	Location	Use	Year Drilled
1	PG&E	Steele St.	Cathodic Protection	1976
2	Unocal Corp.	3535 Pierson St.	Monitoring	1990
3-5	Mills College	5000 MacArthur Blvd.	Monitoring	1989
6	EBMUD	Vale Ave.	Cathodic Protection	1975
7	PG&E	Redding St.	Cathodic Protection	1973
8-10	Unocal Corp.	3420-35th Ave.	Monitoring	1989
11-14	Chevron USA Inc.	4300 MacArthur Blvd.	Monitoring	1989, 1992
15-20	Mobil/BP Oil Corp.	3315 High St.	4 Monitoring 1 Irrigation 1 Domestic	1986, 1991 1991 1991
21	Blue Chip Business Broker	2951 High St.	Monitoring	1990