

RSI

REMEDATION SERVICE, INT'L.

2060 KNOLL DRIVE, SUITE 200, VENTURA, CALIFORNIA 93003
(805) 644-5892 • FAX (805) 654-0720

CORRECTIVE ACTION PLAN
for
2844 Mountain Blvd.
Oakland, California

Prepared for:
DESERT PETROLEUM
P.O. Box 1601
Oxnard, CA 93032
(805) 644-6784

Prepared by:
RSI - REMEDIATION SERVICE, INT'L.
2060 Knoll Drive, Suite 200
Ventura, CA 93003
(805) 644-5892



Todd M. Porter
R.C.E. #C052699



Richard W. Pilat
Program Director

February 3, 1995

Table of Contents

		<u>Page</u>
Section 1	Introduction	1-1
	1.1 Site Location and Description	1-1
	1.2 Project Background	1-2
	1.3 Local Geology and Hydrogeology	1-3
	1.3.1 Hydrogeologic Characteristics of the Site	1-3
	1.3.2 Proximity and Quality of Nearby Groundwater	1-3
Section 2	<i>A Qualitative</i> Risk Assessment & Remediation Cleanup Levels	2-1
	2.1 Contaminant Identification	2-1
	2.1.1 Physical and Chemical Characteristics of Contaminant	2-2
	2.1.2 Toxicity	2-3
	2.1.3 Persistence	2-3
	2.1.4 Environmental Fate and Transport	2-3
	2.2 Exposure Assessment	2-5
	2.2.1 Potential for migration in water, soil and air	2-6
	2.2.2 Dose-Response Assessment	2-7
	2.2.3 Risk Characterization	2-7
	2.2.4 Risk Management	2-7
	2.3 Remediation Cleanup Levels	2-8
	2.3.1 Risk Based Cleanup Levels	2-8
	2.4 Objective and Scope of Work	2-11
Section 3	Feasibility Study of Remedial Alternatives	3-1
	3.1 No Action	3-2
	3.2 Containment	3-4
	3.3 In-situ Treatment	3-5
	3.3.1 Soil Vapor Extraction (SVE)	3-5
	3.3.2 Soil Flushing	3-6
	3.3.3 Bioremediation	3-6
	3.3.4 Chemical Oxidation	3-7
	3.3.5 Fixation	3-7
	3.4 Soil Excavation	3-8
	3.5 Ex-Situ Treatment	3-9
	3.5.1 Bioremediation	3-9
	3.6 Disposal	3-10
Section 4	Recommended Remedial Alternative	4-1
Section 5	Schedule	5-1
Section 6	References	6-1

List of Figures

- Figure 1. Location Map
- Figure 2. Site Map
- Figure 3. Site Map Showing Historic Sample Locations
- Figure 4. Site Map Showing Groundwater Flow Direction 11/94
- Figure 5. Site Map Showing Groundwater Analytical Results 11/94
- Figure 6. Site Map Showing Horizontal Extent of Soil Contamination 5/90
- Figure 7. Site Map with Cross Sections
- Figure 8. Cross Section A-A' Showing Vertical Extent of Soil Contamination 5/90
- Figure 9. Cross Section B-B' Showing Vertical Extent of Soil Contamination 5/90

List of Tables

- Table 1. Summary of Soil Sample Analytical Results
- Table 2. Summary of Groundwater Analytical Results
- Table 3. Groundwater Elevation Data
- Table 4. Summary of Remedial System Performance Data Table

List of Graphs

- Graph 1. Graph of Extracted Vapor Concentrations & Cumulative Pounds of Hydrocarbons Removed

List of Appendices

- Appendix A Fate and Transport
- Appendix B ACPW, Wells in 1/2 Mile Radius
- Appendix C RWQCB, Interim Guidance, Soil Screening Levels - LA Region
- Appendix D Laboratory Analytical Results, Soil Vapor, 1/95

Section 1 INTRODUCTION

Remediation Service Int'l. (RSI) has been contracted to prepare a Corrective Action Plan for the real property located at 2844 Mountain Boulevard in Oakland, Alameda County, California 94602 (Figure 1). Remediation has been on going at the site since 1991. This Corrective Action Plan (CAP) provides a summary of the assessment and corrective action conducted at the site to date, evaluates alternatives of remedial technologies capable of achieving appropriate cleanup levels for gasoline in soil and groundwater, and makes a recommendation for no further corrective action.

1.1 Site Location and Description

The subject property is located at 2844 Mountain Boulevard in Oakland, Alameda County, California. Figure 1 shows the location of the site on a United States Geological Survey topographic sheet, "Oakland East, California" Quadrangle, 1959, photorevised 1980.

The site is located on the northeast corner of the intersection of Mountain Boulevard and Werner Court in a commercial/residential area (Figure 2). The Warren Freeway, which is adjacent to Mountain Boulevard, lies approximately 50 feet southwest of the site.

The property is currently occupied by a retail gasoline station. Three underground storage tanks, two pump islands and an office/garage building are present on the site. The tanks contain various grades of unleaded gasoline and diesel and have individual storage capacities of 3,000, 4,000, and 10,000 gallons.

1.2 Project Background

The following historical summary of the above-referenced site is based on our review of the documents referenced. Historic site analytical results for soil samples are summarized in Tables 1 and sample locations are shown on Figure 3. A summary of groundwater analytical results are included as Table 2.

Soil contamination was originally identified by Diablo Tank & Equipment during replacement of the product lines in March, 1989. Analytical results for a soil sample collected from the southern edge of the premium unleaded tank reported a total petroleum hydrocarbons as gasoline (TPH) concentration of 8,400 mg/Kg (parts per million). Samples from beneath the lines near the pump islands reported TPH concentrations of less than 100 mg/Kg. In July, 1989, On-Site Technologies excavated and disposed of contaminated soil from the southern end of the premium unleaded tank. Analysis of twelve soil samples collected from the sides of the excavation reported TPH concentrations ranging between ND to 3,300 mg/Kg (On-Site Technologies, Soil Sampling Report dated 8/31/89).

In May, 1990 RSI conducted further assessment of the site (RSI, Site Assessment Report dated July 25, 1990). ~~Four groundwater monitoring wells (RS-1 through RS-4, Figure 2) were installed and sampled.~~ Analysis of soil samples collected above the water table reported TPH concentrations ranging from 1 to 240 mg/Kg. Hydrocarbons were detected in the groundwater samples collected from all the wells; the highest concentration was found in a sample from monitoring well RS-2 (Table 2).

Active remediation of soil contamination began at the site in June, 1991 using a ~~Soil~~ Vapor Extraction System (SVE) to vacuum extract gasoline hydrocarbons from the soil. Groundwater remediation began in October, 1991. Active remediation was suspended temporarily between February, 1992 and February, 1994.

The site has been monitored on a quarterly basis since the site assessment in May, 1990. Analytical results for groundwater samples collected during previous and current groundwater monitoring are summarized in Table 2. Groundwater elevation data is included in Table 3.

During the most recent groundwater monitoring in November 1994, TPH was detected in the four wells at low concentrations ranging between 0.069 to 0.62 mg/L (parts per million); benzene was also detected in the wells at concentrations between 2.5 to 6.6 µg/L (parts per billion; Table 2 & Figure 5).

1.3 Local Geology and Hydrology

1.3.1 Hydrogeologic Characteristics of the Site

The site is located in the eastern portion of the greater Oakland area approximately 6 miles inland from the San Francisco Bay. According to the USGS 7.5 minute series quadrangle for the Oakland East area, the subject property is at an elevation of approximately 700 feet above mean sea level (msl). The site and the surrounding area is on a slight gradient that slopes towards the southwest (Figure 1). The site is approximately one quarter mile southwest of Palo Seco Creek. The Upper San Leandro reservoir is located approximately 3.5 mile east of the site and San Leandro Bay is slightly more than 4 miles southwest of the subject property.

According to the Geologic Map of the San Francisco-San Jose Quadrangle (1990, Map 5A, California Division of Mines & Geology), the site is situated within the active Hayward Fault Zone. The fault is part of a northwest trending zone locally consisting of "slivers" or small blocks of bedrock. The rocks include Jurassic and Cretaceous-age ultramafic crystalline rocks and rhyolite of the Coast Range Ophiolite, marine sandstone and shale, and Franciscan complex rocks. The weathering of these rocks typically yields clayey soil.

According to the boring logs from the groundwater monitoring well installation in May 1990, the site is underlain by ~~predominantly silty clay, sandy clay and clayey sand from ground surface to total boring depths between 25 and 30 feet bgs.~~ Some medium dense silty sand was also encountered in well RS-1 ~~from 12 feet down to 22 feet bgs.~~ Groundwater was encountered during drilling of borings at depths between 6 and 8 feet bgs (RSI Site Assessment Report, July 25, 1990).

The clayey subsoils beneath the site could be responsible for the low hydraulic conductivity of groundwater through the formation. The maximum extraction rate for groundwater treatment is less than 0.32 gallons per minute. This low extraction rate is inefficient for effective groundwater treatment.

*check
it*

1.3.2 Proximity and Quality of Nearby Groundwater

The site lies east of the Alameda Bay Plain hydrologic subarea of the East San Francisco Bay Hydrologic study area (Bulletin 118-80, California Dept. of Water Resources). Small lenses of perched groundwater may lie beneath portions of this hydrologic area. Regional groundwater flow direction is expected to be southwesterly toward the Bay.

Depth to groundwater on November 20, 1994 ranged between 5.08 and 9.82 feet below ground surface (Table 3). Groundwater gradient was calculated to be approximately 0.170 ft/ft across the site with groundwater flow in a generally

southwesterly direction. A contour map of groundwater elevations is included as Figure 4.

According to Alameda County Public Works, the nearest beneficial use well, which is located approximately 2200 feet southwest of the site, draws irrigation water from a depth of 240 feet bgs (Appendix B).

1.3.3 The Potential Effects of Residual Contamination on Nearby Surface Water and Groundwater

Several layers of clay create an effective aquitard which separates the affected aquifer at 10 feet bgs from the aquifer at 240 feet bgs where beneficial use water is presently drawn. The aquifers within the Oakland area are not used for municipal purposes. Drinking water for the Oakland area is supplied by East Bay Municipal Water which imports water exclusively from the Sierras (Telecon with Mr. Godfrey, 2/1/95).

↓
for what?

Section 2 RISK ASSESSMENT

This qualitative risk assessment of the site examines the nature and magnitude of potential human risk and the likelihood that harmful human health effects would occur from exposure to the risk agent of gasoline in the groundwater and soil. Risk is sometimes defined as toxicity of the contaminant multiplied by the level of exposure.

Remediation goals have been established for soil and groundwater using health-based soil and groundwater exposure criteria. A conservative (health based) approach was used to calculate risk-based soil and groundwater levels.

The format used in this report to establish risk-based remediation goals is as follows:

- Identify the contaminant of concern, its physical & chemical characteristics, toxicity, persistence, and fate and transport.
- Identify exposure pathways.
- Establish soil and groundwater remediation goals.

2.1 Contaminant Identification

Hazard identification examines the substance(s) present in the emission and the associated health risks. Previous reports by On-Site Technologies and RSI, Inc. at the site have characterized the hazard as leaked gasoline from underground fuel storage tanks lines. The contaminants of concern at the site are those associated with gasoline fuel (TPH as gasoline and benzene, toluene, ethyl-benzene and xylenes or BTEX). Maximum levels of gasoline and associated BTEX constituents measured are listed below:

Substance	Maximum Concentration Measured
Soil sample analysis from <u>soil</u> excavation & well installation, 1989 & 1990:	
Gasoline	3,300 mg/Kg (1989, in SS325-1 @ 10' bgs, soil excavation, south of western most tank)
Benzene	6.2 mg/Kg (1990, in RS-1 @ 10 feet bgs)
Toluene	100 mg/Kg (1989, in SS325-1 @ 10' bgs)
Ethylbenzene	30 mg/Kg (1989, in SS325-1 @ 10' bgs)
Xylenes	270 mg/Kg (1989, in SS325-1 @ 10' bgs)

The most recent soil vapor analysis (Appendix D):

Gasoline	ND	(1/5/95 Comb. inlet, wells RS-1, RS-2 & RS-4)
Benzene	0.43 ppm-v	(1/5/95 Comb. inlet, wells RS-1, RS-2 & RS-4)
Toluene	0.57 ppm-v	(1/5/95 Comb. inlet, wells RS-1, RS-2 & RS-4)
Ethylbenzene	0.11 ppm-v	(1/5/95 Comb. inlet, wells RS-1, RS-2 & RS-4)
Xylenes	0.78 ppm-v	(1/5/95 Comb. inlet, wells RS-1, RS-2 & RS-4)

The most recent groundwater analysis:

Gasoline	0.62 mg/L	(11/94,well RS-2)
Benzene	0.0066 mg/L	(11/94,well RS-2)
Toluene	0.0039 mg/L	(11/94,well RS-2)
Ethylbenzene	0.0017 mg/L	(11/94,well RS-4)
Xylenes	0.047 mg/L	(11/94,well RS-2)

Contamination has only been detected in soil beneath the tank location on the west portion of the property.* Prior to in-situ soil remediation, the lense of contamination (above 125 mg/Kg TPH) extended horizontally approximately 1500 square feet and vertically between depths of 7 feet bgs and 15 feet bgs (Figures 7, 8 & 9). This area has diminished considerable since instigation of in-situ soil vapor remediation in June, 1991. Since that date, **over 1000 pounds of hydrocarbons have been extracted from soil and groundwater beneath the site (Table 4).*** A map delineating the horizontal extent of the soil contamination prior to soil vapor extraction is included as Figure 6.

The lens of contaminated soil is presently covered by approximately 5 feet of clean soil and the area is covered with asphalt paving; public exposure to the contaminated soil would be unlikely unless the soil is excavated at a future date.

2.1.1 Physical and Chemical Characteristics of Contaminant

Pure gasoline, the known contaminant on-site, has the following physical properties:

Boiling Point:	26.67 - 226.7 °C
Specific Gravity:	0.70 - 0.78
% Volatile:	100 @ 437
Vapor Pressure:	760 MM Hg @ 100 F
Evaporation Rate:	>1
Vapor Density	1.2 as Vapor
% Solubility in Water	Negligible
Flash Point	-43 °C

Chemically known as petroleum distillate and composed of a complex combination of hydrocarbons produced by the processing of crude oil, gasoline contains primarily aliphatic, olefinic and aromatic hydrocarbons in the range of C4 - C10.

2.1.2 Toxicity

Pure gasoline ingestion is moderately toxic. Human oral LDLo = 10-30 gms. The contaminant in its pure form contains the following toxic chemicals which are subject to regulation by the Superfund Amendments and Reauthorization Act (SARA) Section 311/312 (40 CFR 370):

<u>Component</u>	<u>CAS Number</u>	<u>Maximum %</u>
Xylene	1330-20-7	10.0
Toluene	108-88-3	7.0
1,2,4 -Trimethylbenzene	95-63-6	3.0
Benzene	71-43-2	2.0
Ethylbenzene	100-41-4	2.0
Cyclohexane	110-82-7	1.0

Gasoline contains a mixture of substances which are listed as toxic pollutants pursuant to 40 CFR 122.21, Appendix D, Tables II / III / IV. Gasoline contains ingredients known to the State of California to cause cancer, birth defects and other reproductive harm.

Levels of contaminant in soil beneath the site exceed naturally occurring background levels. However, potential exposure to contamination is considered insignificant. The site is completely paved and any remaining contamination is confined to beneath 5 feet.

2.1.3 Persistence

Although pure gasoline is listed as Bio-Hazardous, the low levels currently in the soil and groundwater beneath the site will naturally biodegrade over time. Non-toxic byproducts of the degradation process are carbon dioxide and water.

2.1.4 Environmental Fate and Transport

Appendix A of this report details the fate and transport of gasoline. The source of gasoline and its constituents in the soil beneath the site is known and has been replaced.

The gasoline was released slowly over several years into the soil below the tanks and/or dispensers and dispersed vertically and horizontally. As the gasoline moved through the soil interstices, a small portion was adsorbed onto the fine-grained soil

particles of silts and clays in the upper 10 feet of the site, and as interstitial vapor between soil particles. Biologic and abiotic or chemical degradation (such as oxidation/reduction reactions) processes began almost immediately. The prime effect of chemical degradation was the preferential breakdown of the more volatile hydrocarbons into water, carbon dioxide and complex but relatively harmless organic compounds.

2.2 Exposure Assessment

The exposure assessment examines what exposures are currently occurring and what experiences are anticipated under different conceivable conditions. This section includes a characterization of the exposed population, identification of receptors and exposure routes, and an estimation of toxic substances' intake.

Exposure occurs only when a receptor can potentially come into direct contact with a released constituent or a medium exists for released contamination to potentially be transported to a receptor. A complete pathway for exposure (with the release of contamination, a medium of transport, a point of contact and a receptor) must be in place for risk of exposure to exist. Without exposure, there is no risk; therefore an exposure assessment is significant when assessing potential risks at a site.

Potential Exposure Routes:

Groundwater	ingestion Dermal Contact
Air	Inhalation of vapor.
Soil/Dust	Incidental Ingestion Dermal Contact

Groundwater hydrocarbon concentrations have steadily decreased over time. As reported during the last groundwater analysis in November, 1994, most hydrocarbon constituents of concern are considerably below Title 22 CCR drinking water MCL (Table 2). The potential for migration of groundwater and the consequential dispersion of contaminants would serve to diminish the low concentrations of benzene (6.6 $\mu\text{g}/\text{L}$) in groundwater to drinking water action level, thus posing no significant health risk to the public.

According to Mr. Andreas Godfrey, Alameda Co. Public Works, the aquifers within the Oakland are not used for municipal purposes. Drinking water for the Oakland area is from East Bay Municipal Water which imports water exclusively from the Sierras (Telecon with Mr. Godfrey, 2/1/95). **The nearest well within a half mile radius of the site is located approximately 2200 feet southwest of the site and draws irrigation water from a depth of 240 feet bgs (Appendix B).** Several layers of clay separate the aquifer at 10 feet bgs from the aquifer in which any beneficial use water is presently drawn.

The volatile nature of the gasoline contaminants in the subsurface indicates that the most likely exposure routes to the current receptors, the staff and clients of the existing business, would be inhalation of hydrocarbon vapors migrating upward

through the soil medium. The presence of a concrete slab floor and adequate ventilation of the business, however, minimizes migration and accumulation of hydrocarbon vapors in the station facility.

The site is paved and contaminated soil is at depths of 7-15 feet bgs; the soil is not a current exposure medium. ~~If the site is excavated to these depths in the future, construction workers could potentially be exposed through dermal and inhalation exposure routes.~~ Touching gasoline-contaminated soil without skin protection may allow hydrocarbons to be absorbed into fatty tissues in the skin. Workers may also be exposed by ingestion of the contaminants when they accidentally consume small amounts of soil during hand to mouth activity (such as smoking or eating on the job without washing hands) or if wind blows loose soil into workers' faces. The volatile nature of the contaminant, however, suggests that most hydrocarbons will volatilize before they can be absorbed or ingested.

2.2.1 Potential for Migration in Water, Soil and Air

Based upon the hydrogeologic and soil characteristics of the site, the potential for migration in groundwater and soil is low. Soil beneath the site consists of interval layers of silty clay and sandy clay (with some dense sand) from ground surface to total boring depth (30 feet bgs). Vertical migration of any contamination confined to above the clay layers is considered minimal.

Groundwater hydrocarbon concentrations have steadily decreased over time. As reported during the last groundwater analysis in November, 1994, most hydrocarbon constituents of concern are considerably below Title 22 CCR drinking water MCL (Table 2). Present benzene concentrations of between 2.5 to 6.6 $\mu\text{g}/\text{L}$ are only slightly above Title 22 CCR drinking water MCL of 1 $\mu\text{g}/\text{L}$ (Table 2). Off-site migration of groundwater and dispersion of contaminants would diminish the already low concentrations of benzene (6.6 $\mu\text{g}/\text{L}$) down to below drinking water action level were it poses no significant health risk to the public.

Due to the subsurface location of low level hydrocarbons, an insignificant potential for migration in air exists at this time. Future deep excavation of soils on-site (in excess of 7 feet below ground surface (bgs) could cause aeration. As mentioned earlier in Section 2.1, recent state certified laboratory analysis of subsurface gaseous non-methane hydrocarbons (1/5/95) reported no detectable TPH concentrations and low benzene, toluene, ethylbenzene and xylene concentrations of 0.43, 0.57, 0.11 and 0.78 ppm-v, respectively.

The potential risk for exposure to humans or beneficial use supplies of groundwater therefore, is currently insignificant.

2.2.2 Dose-Response Assessment

Toxicological studies provide a relationship between the dose of an agent and the response. Appendix A describes the character of gasoline and benzene, which is a known carcinogen.

2.2.3 Risk Characterization

The total exposure of humans to significant levels of hydrocarbons via inhalation, ingestion or dermal exposure routes is insignificant.

2.2.4 Risk Management

Deed notifications should be in place and utility construction workers should be notified of the remaining hydrocarbons in the subsurface soils prior to any subsurface work.

2.3 Remediation Cleanup Levels

The current land use at the site is commercial/industrial. Since foreseeable future land use is not expected to change from the commercial/industrial application, remediation levels for all constituents detected in soil and groundwater are based on protection of workers' and customers' health. Risk based remediation levels for the constituents of concern were developed to protect the health of workers inhaling indoor vapors.

To ensure protection of human health, the procedures used for deriving remediation levels for soil and groundwater at the subject site were consistent with the procedures outlined for risk assessments prepared under the Regional Water Quality Control Board (RWQCB), the Department of Health Services (DHS) -Toxic Substances Control Program (California EPA) guidance document (DHS, 1990) and with other USEPA guidance documents (USEPA, 1986, 1989a).

2.3.1 Risk Based Cleanup Levels

Assuming continued commercial/industrial land use on the subject site, the cleanup levels in soil and groundwater for the constituents of concern are based on protection of worker's health.

No guidance document has been issued by the lead agency (ACEHD) for calculating risk-based remediation levels. In place of such a document, three recently published guidance documents from the Regional Water Quality Control Board were used to outline cleanup goals. These documents include the Memorandum from the San Francisco Bay Regional Water Quality Control Board, October 21, 1994; the California Regional Water Quality Control Board, Interim Guidance for Remediation of Petroleum Impacted Sites, Soil Screening Levels, November, 1994; and the California Regional Water Quality Control Board, Interim Guidance for Remediation of VOC Impacted Sites, December, 1994.

LA Region

NAA

Soil Cleanup Levels

The cleanup levels for soil were set according to the guidelines in the California Regional Water Quality Control Board, Interim Guidance for Remediation of Petroleum Impacted Sites, Soil Screening Levels, November, 1994, for soil above non-drinking water. This guidance document has been set in effect until the State Water Resource Control Board finalizes the new LUFT Manual. The guidelines were set up by the Water Quality Advisory Task Force to address soil only and were not meant to address groundwater directly (Appendix C).

Per the RWQCB Guidance document, the Soil Screening Levels (mg/Kg) for soil above non-drinking water (Level D) were set at 100x MCL for BTEX.

	MCL (ppm)	SOIL SCREENING LEVEL 100MCL (mg/kg or ppm)
Benzene	0.001	0.1
Toluene	0.1	10
Ethyl-Benzene	0.68	68
Xylene	1.75	175

TPH as gasoline is comprised of C4 to C12 hydrocarbons (hydrocarbons with 4 to 12 carbon atoms in their molecular structure). The soil screening level set for TPH in the C4 to C12 range was set at 1,000 mg/kg.

Groundwater Cleanup Levels

Risk based cleanup goals for groundwater were determined in accordance with the State of California Memorandum from the SFRWQCB definition of Non-attainment and in accordance with the RWQCB Interim Guidance for Remediation of VOC Impacted Sites.

As defined in the SFRWQCB memorandum, **Category II Non-Attainment Sites** are "Sites for which the Regional Water Board approved cleanup program has not resulted in compliance with water quality objectives." Although the site has undergone remediation for several years, current drinking water standards are too conservative for non-drinking water in the aquifer 10 feet beneath the site.

Non-drinking water, as defined by the California Regional Water Quality Control Board, Interim Guidance for Remediation of VOC Impacted Sites, is water not directly used for drinking, including surface and groundwater which are not usable for municipal or domestic supply as defined and exempted under SWRCB Resolution 88-63. According to Mr. Andreas Godfrey, Alameda Co. Public Works, the aquifers within the Oakland area are not used for municipal drinking water purposes (Telecon with Mr. Godfrey, 2/1/95). As noted in the California Regional Water Quality Control Board, Interim Guidance for Remediation of VOC Impacted Sites, December, 1994, in reference to Non-Drinking Water Aquifers, "cleanup standards should not be as stringent as would be the case for usable or drinking water bodies."

Groundwater beneath the site has already reached compliance with drinking water standards for toluene, ethyl-benzene, and total xylenes. Benzene concentrations are presently within 0.005 mg/kg of drinking water standards.

In accordance with both these documents, the recommended cleanup goal for the non-drinking water beneath the site has been calculated to be ten times the drinking water level for BTEX:

	MCL* (ppm)	GROUNDWATER CLEANUP LEVEL 10MCL (mg/L or ppm)
Benzene	0.001	0.01
Toluene	0.15	1.5
Ethyl-Benzene	0.7	7.0
Xylene	1.75	17.5

*CCR Title 22, Section 64444.5

2.4 Objective and Scope of Work

The object of this Corrective Action Plan, (CAP) is to present technologies capable of achieving the clean-up level for gasoline fuel in saturated soil and groundwater and to evaluate the alternatives in order to select an appropriate remediation for this site. Site specific clean up goals and remediation criteria are presented in Section 1.5.

Specific objectives:

Achieve established clean-up goals in a manner that is cost-effective, timely and protective of human health and the environment.

Monitor groundwater in the former UST area to determine if additional actions are necessary to achieve site closure.

Section 3 FEASIBILITY STUDY OF REMEDIAL ALTERNATIVES

Several potential remedial alternatives were investigated for possible application at the subject property to achieve regulatory site closure. The alternatives for soil and groundwater remediation are presented below along with a brief discussion of their feasibility as pertains to the site at this stage in the remedial effort, their physical effectiveness, their cost effectiveness and their potential adverse impacts. The final selection of the most appropriate method of remediation for the site will be based on the sites hydrogeology and hydrocarbon concentrations of the site and will encompass the appropriate considerations for each alternative.

Implementability -

The technical feasibility of implementing an alternative. Alternatives that are not technically feasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration.

Physical Effectiveness -

The degree to which an alternative reduces toxicity, volume or off-site migration through treatment; minimizes residual risks; affords long-term protection; complies with regulations; minimizes short-term impacts; and can be implemented in a timely manner. Significantly less effective alternatives that do not provide adequate protection of human health and the environment will be eliminated from further consideration.

Cost Effectiveness -

The costs of construction and any long-term costs to operate and maintain an alternative. Alternatives that are effective and easily implemented but are more expensive to implement than a similar alternative may be omitted from consideration. Costs that are excessive compared to the overall effectiveness of an alternative may also be a deciding factors for elimination of an alternative.

Potential Adverse Effects -

Alternatives that present an unacceptable risk of further spread of contamination, damage to the environment or risk to the health and safety of workers may be eliminated as an alternative.

Based upon current information, the soil contamination at the site appears to be very localized with an estimated volume of 360 yds³ (cubic yards) in-place. The following are potential corrective actions for remediating the soil at this site:

- | | |
|----------------------|----------------------|
| 1. No Action | 4. Soil Excavation |
| 2. Containment | 5. Ex-situ Treatment |
| 3. In-situ Treatment | 6. Disposal |

3.1 No Action

No action involves leaving the contaminated soil and groundwater in their present states and not conducting any further corrective actions. This alternative is technically feasible and inexpensive. This alternative is also in compliance with the State of California Memorandum from the San Francisco Bay Regional Water Quality Control Board, October 21, 1994 and the definition of Category II Non-Attainment.

Per the State of California Memorandum from the San Francisco Bay Regional Water Quality Control Board, October 21, 1994, this site should qualify for Category II Non-Attainment. As defined in the memorandum, Category II Non-Attainment Sites are "Sites for which the Regional Water Board approved cleanup program has not resulted in compliance with water quality objectives." Sites which fall under this criteria have (a) undergone an appropriate cleanup program for an adequate period of time necessary to understand the hydrogeology of the site and pollutant dynamics; (b) have groundwater pollutant concentrations that have reached asymptotic levels in which the mass removed from the groundwater is no longer significant; and (c) the best available technologies are not technically or economically feasible to achieve further significant reduction in pollutant concentrations.

NO!
In response to criteria (a) and (b), the site has been remediated by in-situ soil vapor extraction and groundwater treatment for four years. *continuously? NO* hydrocarbon levels today have reached asymptotic levels where in-situ remediation is no longer a cost effective method of hydrocarbon remediation. *where are they?* Recent calculations for in-situ hydrocarbon removal verify asymptotic remediation levels; based on average run times and laboratory results for inlet water and vapor hydrocarbon concentrations, only 0.0037 gallons of hydrocarbons were removed from groundwater in December, 1994. Further operation of the SVE at this level of remediation is not cost effective. *what about soil SVE removal?*

In response to criteria (c), TPH concentration in well RS-2 where original groundwater hydrocarbon concentrations were greatest have steadily declined from 23 mg/Kg in May, 1990 (RS-2) down to 0.62 mg/Kg as of the last quarterly sampling in November, 1994 (Table 2). Over time, a trend of rapidly decreasing hydrocarbon concentrations in groundwater has occurred at the site. However, achieving drinking water standards at this site is unlikely due to low yielding sediments (clay and silt) and resulting adsorbed hydrocarbons beneath the property. An operating business is present on the site, and further attempts at remediation of the remaining low levels of hydrocarbons at this site by any existing technology would not be economically feasible.

As outlined in section 1.4.4, the potential for off-site migration by air, soil or water is very low. The remaining gasoline plume is slow moving or stable at this stage.

Corrective Action Plan
February 3, 1995

2844 Mountain Blvd.
Oakland, CA

Any remaining hydrocarbons do not present an unacceptable risk of further spread of contamination, damage to the environment or risk to the health and safety of workers.

Present contamination levels would not present unacceptable risks to worker's health. No action, based on the SFBRWQCB definition of Category II Non-Attainment, is an appropriate alternative for this site.

3.2 Containment

Containment is the use of barriers to limit the movement of contaminants from migrating off-site. Containment can be installed at the surface, or vertically and horizontally into the soil. Concrete, steel or plastic panels or sheeting may be used.

Implementability - Due to the development of the site and the fact that this alternative requires extensive excavations, this alternative would be difficult to install and implement.

Physical Effectiveness - This alternative would be effective in controlling horizontal off-site migration of contaminants.

Cost Effectiveness - Vertical and horizontal barriers with associated excavation and shoring are very costly for controlling the minor remaining levels of hydrocarbons at this site. Closure of the operating business on-site to implement this alternative would also have an unacceptable economic impact on the business owner.

Potential Adverse Effects - Similar to the "No Action" alternative, this alternative involves leaving the contaminated soils as is. Barriers would hinder future natural dilution of contaminants below the site and/or the migration of oxygen and nutrients supplying natural biodegradation processes of the minor remaining hydrocarbons.

3.3 In-situ Treatment

In-situ treatment of hydrocarbon impacted soils includes physical/chemical, biological and thermal means of diminishing contamination in the soil. Examples of in-situ treatment are presented below.

3.3.1 Soil Vapor Extraction (SVE)

SVE is the passive or active injection of air into unsaturated soil and extraction of air and volatilized hydrocarbons from the soil. Introduction of fresh air into the affected area changes the equilibrium conditions in the soil promoting volatilization of the organics. A vacuum blower is then used to extract the soil gas. Vapors drawn by the vacuum are fed into an internal combustion engine and burned as part of the normal combustion process. An alternative technology for treatment of the vapor extracted by the SVE involves running the extracted vapor through a series of activated carbon canisters. A soil vapor extraction unit can also be used for the treatment of groundwater by spray aeration.

Implementability - Vapor extraction is relatively easy to install at most sites due to the small size of treatment units presently on the market and the minimal construction requirements. This alternative is also ideal for small sites where excavation is not an option.

Currently, a SVE system is present at the site for the treatment of soil and groundwater. Implementing this alternative would only require the continued operation of the unit.

Physical Effectiveness - SVE is effective for treating gasoline fuel contamination due to the fuel's high volatility. SVE has been successful at remediating soil within the tank location area. However, because clayey soil underlies portions of the site and because groundwater is minimal at this site (slow recharge of 0.32 gallons/minute), soil vapor extraction is limited in its ability to remediate the entire contamination plume. The effectiveness of this treatment at this stage of remediation would be diminished due to low hydrocarbon concentrations which have reached asymptotic levels.

Cost Effectiveness - The start up costs of SVE are relatively low since a system has already been installed at the site and would only require continued operation. The cost of continued operation of the system, however, is rapidly increasing compared to the pounds of hydrocarbons removed. Recent calculations for in-situ hydrocarbon removal verify asymptotic remediation levels; based on average run times and laboratory results for inlet water and vapor hydrocarbon concentrations, only 0.0037 gallons of hydrocarbons were removed from groundwater and 1.3 gallons were removed from the soil in December, 1994. Further operation of the SVE at this level of remediation is not cost effective.

*Who's
Soil
discussion?*

*how
many
days
it ran
in Dec?
what
about
other
months?*

3.3.2 Soil Flushing

Soil flushing is the recovery of absorbed hydrocarbons from impacted soil by flushing water and other mobilizing fluids (aqueous surfactants) through the impacted area. The fluids displace the petroleum constituents; these constituents are later extracted at a selected point.

Implementability - Although a flushing system could easily be implemented, the construction of a system that would completely control the mobilized hydrocarbons and allow for collection at selected points would be difficult to install. A system for complete control is not presently available.

Physical Effectiveness - Soil flushing would not be effective at this site due to the presence of clayey soil beneath the site.

Cost Effectiveness - The design, permitting and installation of a collection system would be cost prohibitive.

Potential Adverse Effects - The use of this alternative may result in expansion of the contamination plume and the increase in amount of impacted soil and groundwater. The unpredictability of movement of contamination and the potential adverse impact of this alternative excludes it as a corrective action.

3.3.3 Bioremediation

Bioremediation is the elimination of hydrocarbons from impacted soil by the use of naturally occurring and/or non-indigenous strains of microbial populations to consume hydrocarbons as part of their respiration process. Bioventing, the utilization of air injection to enhance aerobic biological degradation of subsurface contamination, should be used in conjunction with bioremediation.

Implementability - In-situ bioremediation is relatively easy to install and implement. However permitting is difficult.

Physical Effectiveness - This alternative is most successful when applied to medium to high permeability sediments. Microbial degradation requires the movement of air through the sediments in impacted soil. The clayey soil beneath the site would hinder successful bioremediation by limiting the availability of oxygen for hydrocarbon degradation.

Cost Effectiveness - In-situ bioremediation is a relatively inexpensive option to implement. However, because bioremediation would be limited in physical effectiveness, it would not be a cost effective option.

Potential Adverse Effects - Due to limited effectiveness over time, bioventing and/or the addition of microbial matter may result in the potential expansion of the contamination plume and the increase in amount of impacted soil.

3.3.4 Chemical Oxidation

Chemical oxidation is the injection of an oxidizing agent (e.g., hydrogen peroxide) into the soil to react in-situ with contaminants.

Implementability - In-situ chemical oxidation is relatively easy to install and implement.

Physical Effectiveness - This alternative is most successful when applied to medium to high permeability sediments. The less permeable zones (clayey subsoils) present beneath the site negate this alternative.

Cost Effectiveness - The design and installation of a collection system for retrieving oxidized hydrocarbons within the clay would be cost prohibitive.

Potential Adverse Effects - The injection of oxidizing agents may result in the expansion of the contamination plume and the increase in amount of impacted soil and groundwater. The unpredictability of movement of contamination and the potential adverse impact of this alternative excludes it as a corrective action.

3.3.5 Fixation

Fixation is the demobilizing of contamination by injection and intermixing of cement into subsurface contaminated soils. Fixation limits the movement of contaminants from migrating off-site.

Implementability - In-situ fixation requires the use of large, specialized machinery for the injection and intermixing process. Due to the size of site and the relative unavailability of specialized machinery, this alternative would be difficult to install and implement.

Physical Effectiveness - This alternative would be effective in controlling horizontal off-site migration of contaminants in soil that is effectively solidified with the cement. Saturation and lack of air at the capillary fringe may hinder congealing of the soil/cement mixture.

Cost Effectiveness - The costs for drilling and use of specialized machinery for subsoil mixing would be prohibitive for controlling the minor remaining levels of hydrocarbons at this site. Closure of the operating business on-site to implement this alternative would also have an unacceptable economic impact on the business owner.

Potential Adverse Effects - Similar to the "No Action" alternative, this alternative involves leaving the contaminated soils in place. Cement would hinder future natural dilution of contaminants below the site and/or the migration of oxygen and nutrients supplying natural biodegradation processes of the minor remaining hydrocarbons.

3.4 Soil Excavation

Soil Excavation is the complete removal of impacted soil material for onsite or off-site treatment and disposal.

Implementability - This alternative would not be difficult to implement. Backhoes, clamshell diggers, solid stem augers and bucket augers are easily obtained with OSHA-trained operators. Contamination extends to 15 feet bgs over a 1500 square foot area, which can be easily removed by a Backhoe. However, foundation support for the building and possibly adjacent struts could be undermined by such an excavation.

Physical Effectiveness - Excavation would effectively remove most of the contamination, thereby avoiding long term monitoring of in-situ remediation and avoiding future impacts to groundwater beneath the site.

Cost Effectiveness - This alternative would require the closure of the operating business on-site. The cost to implement this alternative would therefore have an unacceptable economic impact on the business. Compared to the overall effectiveness of this alternative in further reducing the minimal risk to health and safety of the public or damage to the environment, the cost that are associated with with this alternative are prohibitive.

Potential Adverse Effects - Operation of heavy equipment presents physical risks to personnel involved in the excavation. Excavation would also present an unnecessary risk of exposure to hydrocarbons that would have otherwise been confined to beneath the site.

Foundation support for the building could be undermined by an excavation.

3.5 Ex-situ Treatment

Ex-situ treatment is an effective remediation of soils after excavation. Some methods of ex-situ treatment include soil washing, thermal desorption, solidification/stabilization, and bioremediation. For the purposes of remediating soil at this site, only bioremediation will be discussed below. Soil washing, thermal desorption and solidification/stabilization will not be considered because of cost considerations.

3.5.1 Bioremediation

Ex-situ bioremediation is a technique that stimulates naturally occurring and non-indigenous strains of microbial populations within affected soil to consume hydrocarbons as part of their respiration process. Gasoline range hydrocarbons have been found to be readily degradable by aerobic microbes.

Implementability - This process involves the construction of above ground treatment cells (soil piles) where microbial degradation can take place. Landfarming, composting or injection of air into the cells will increase the availability of oxygen and potentially increase the rate of hydrocarbon degradation. Soil moisture monitoring and injection of supplemental nutrients will also speed up the bioremediation process. This alternative would be difficult to implement due to the presence of a structure on the site. A location for off-site bioremediation would be difficult to obtain.

Physical Effectiveness - This alternative is most effective when applied to medium to high permeability sediments impacted by VOCs. Gasoline range hydrocarbons have been found to be readily degradable by aerobic microbes. The uncompacted soil excavated from the contamination area can effectively be treated by this method to degrade VOC concentrations in the soil to non-regulated levels.

Cost Effectiveness - This alternative would require the closure of the operating business on site for excavation and for on-site bioremediation. The cost to implement this alternative would therefore have an unacceptable economic impact on the business. Construction of a vapor gallery, monitoring on a regular basis with an OVA and final laboratory analyses are also cost considerations.

Potential Adverse Effects - If volume of the soil or VOC concentration levels in the stockpile soil exceed reasonable levels (ACGIH TLV of 300 ppmv, 3 inches above the pile), on-site bioremediation would present unacceptable risk of exposure to surrounding community

Excavation for ex-situ treatment would present an unnecessary risk of exposure to hydrocarbons that would have otherwise been confined to beneath the site. Foundation support for the building could be undermined by an excavation.

3.6 Disposal

Disposal processes consist of both on-site and off-site options. On-site disposal options include ex-situ treatment and backfill of treated material. (Ex-situ treatment is discussed in section 2.5). Off-site disposal includes transportation and treatment at a licensed TSDF. Selection of this alternative is dependant upon an analysis of the economics, e.g. volume of the soil and moisture content; and VOC concentration levels of the stockpile. If soil can not be treated by bioremediation, it will go to a TSDF facility.

Implementability - On-site treatment for eventual backfill is relatively difficult to implement due to the presence of a structure on the site. Off-site disposal is relatively easy to implement.

Physical Effectiveness - Treatment of soil at a TSDF facility will effectively degrade VOC concentrations in the soil to non-regulated levels.

Cost Effectiveness - Unit costs for soil transportation and treatment range from \$65/cubic yards at facilities using landfarming techniques to greater than \$100/cubic yards at facilities using incineration techniques. On-site bioremediation is more cost effective form of disposal, but not easily implemented. This alternative would also require the closure of the operating business on-site. The cost to implement this alternative would therefore have an unacceptable economic impact on the business.

Potential Adverse Effects - Excavation for disposal would present an unnecessary risk of exposure to hydrocarbons that would have otherwise been confined to beneath the site. Foundation support for the building could be undermined by an excavation.

Section 4

CONCLUSION AND RECOMMENDED REMEDIAL ALTERNATIVE

Existing hydrocarbon contamination of soil and groundwater has been reduced by soil vapor extraction and groundwater treatment to asymptotic levels; these levels present an insignificant risk to the public and to groundwater. ~~The recommended course of remediation is no additional remedial action as described in Section 3.1.~~

As demonstrated previously, analytical data from well installation in 1990 indicated that the gasoline contamination at the site was localized with an estimated volume of 360 yds³ at a depth of 7 to 15 feet. Since that date, the site has been remediated by soil vapor extraction which has reduced hydrocarbon concentrations down to asymptotic levels. The site will be further remediated by natural biodegradation of hydrocarbons with no additional remedial action. This site has reasonably reached a level of Non-Attainment. The costs of removing asymptotic levels of remaining pollutants exceed the marginal benefit to the public and the reasonable beneficial use of water at the site.

~~The S.A.V.E.™ System should be removed from the site and, following a reasonable period of monitoring, the groundwater monitoring wells should be properly abandoned with bentonite and cement.~~

Section 5
SCHEDULE

Implementation of the programs described in this CAP will begin within sixty days after approval of this plan by the ACDEH. The ACDEH will be notified 48 hours prior to beginning work at the site.

Section 6
REFERENCES

California Air Resources Board, July, 1991, Soil Decontamination Manual

California Regional Water Quality Control Board, December, 1994, Interim Guidance For Remediation of VOC Impacted Sites.

California Regional Water Quality Control Board, November, 1994, Interim Guidance For Remediation of Petroleum Impacted Sites, Soil Screening Levels.

California Regional Water Quality Control Board, San Francisco Bay Area, October 21, 1994, Memorandum, Implementation of Ground Water Non-Attainment Areas.

Environmental Protection Agency, April, 1988, Cleanup of Releases from Petroleum USTs: Selected Technologies.

Environmental Protection Agency, April, 1991, Handbook Remediation of Contaminated sediments.

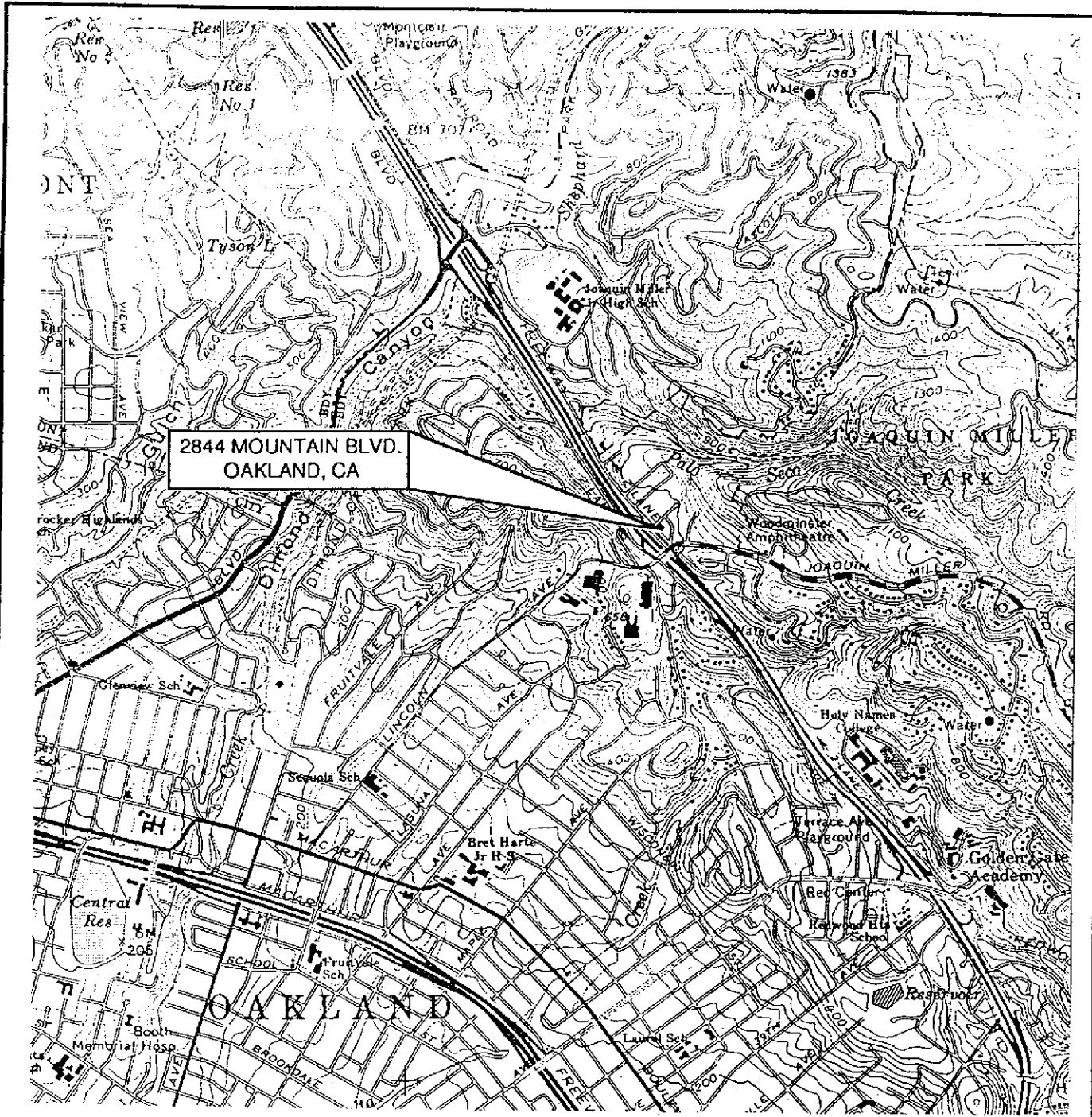
Environmental Protection Agency, November, 1991, Seminar Publication: Site Characterization for Subsurface Remediation.

National Fire Protection Association, 1980, Material Safety Data Sheet for British Petroleum Oil.

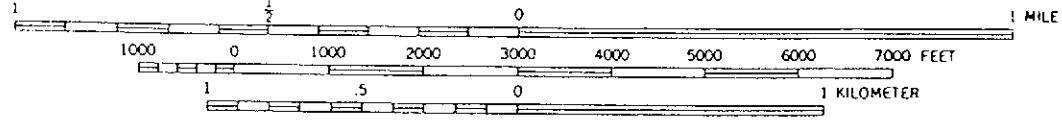
On-Site Technologies, August 31, 1989, Soil Sampling Report for Desert Petroleum (ARCO Station), Oakland, CA.

Remediation Service Int'l., July 25, 1990, Site Assessment Report for Desert Petroleum Inc., Station No. 796, Oakland, CA.

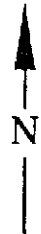
U.S. Geologic Survey Topographic 7.5 Minute Series, East Oakland Quadrangle.



SCALE 1:24 000



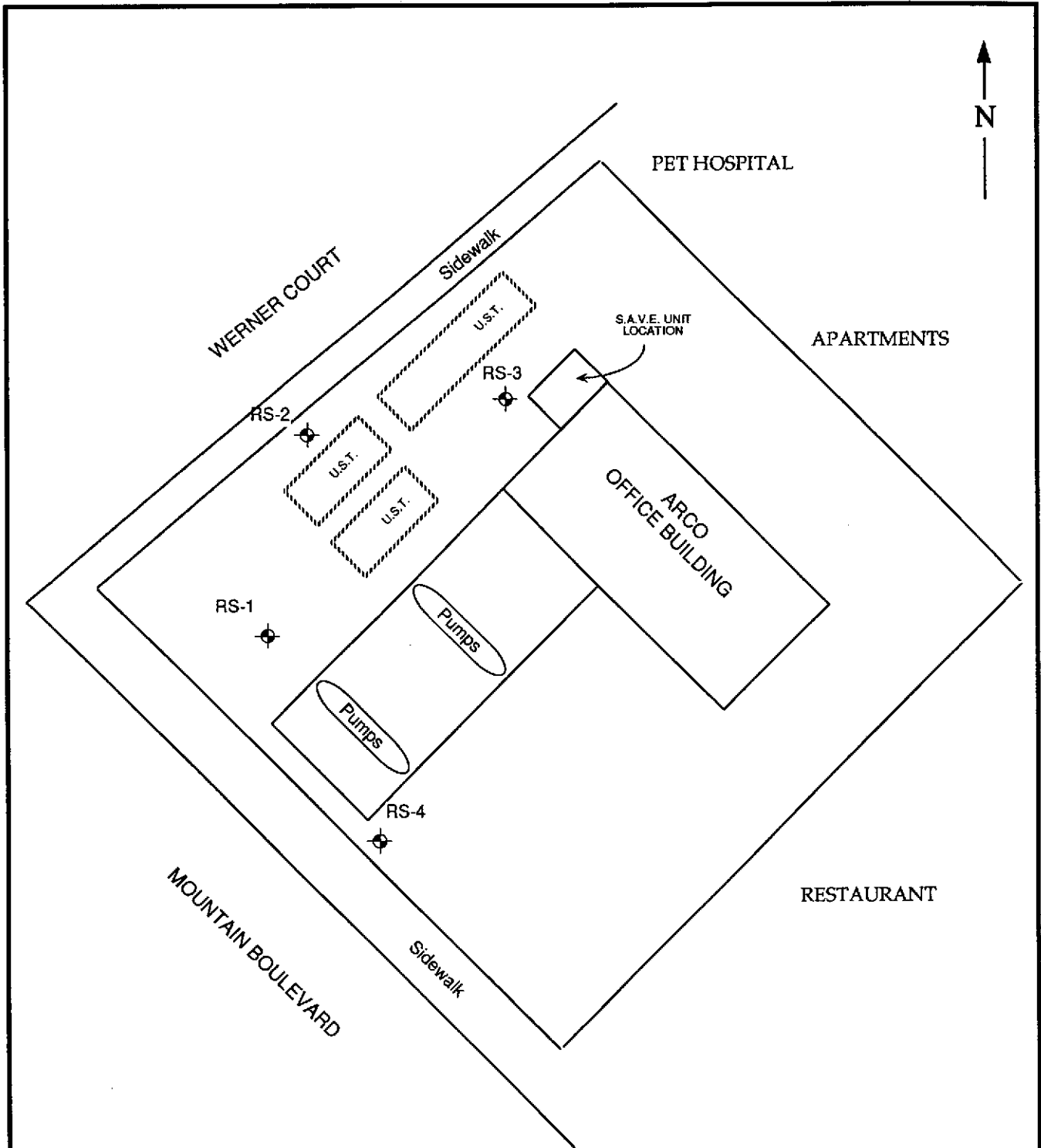
FROM U.S.G.S. 7.5' TOPOGRAPHIC
 QUADRANGLE "OAKLAND EAST,
 CALIFORNIA," 1959, PHOTOREVISED
 1980



2844 MOUNTAIN BLVD.
 OAKLAND, CA

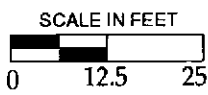
FIGURE 1: LOCATION MAP

RSI - REMEDIATION SERVICE, INT'L



LEGEND

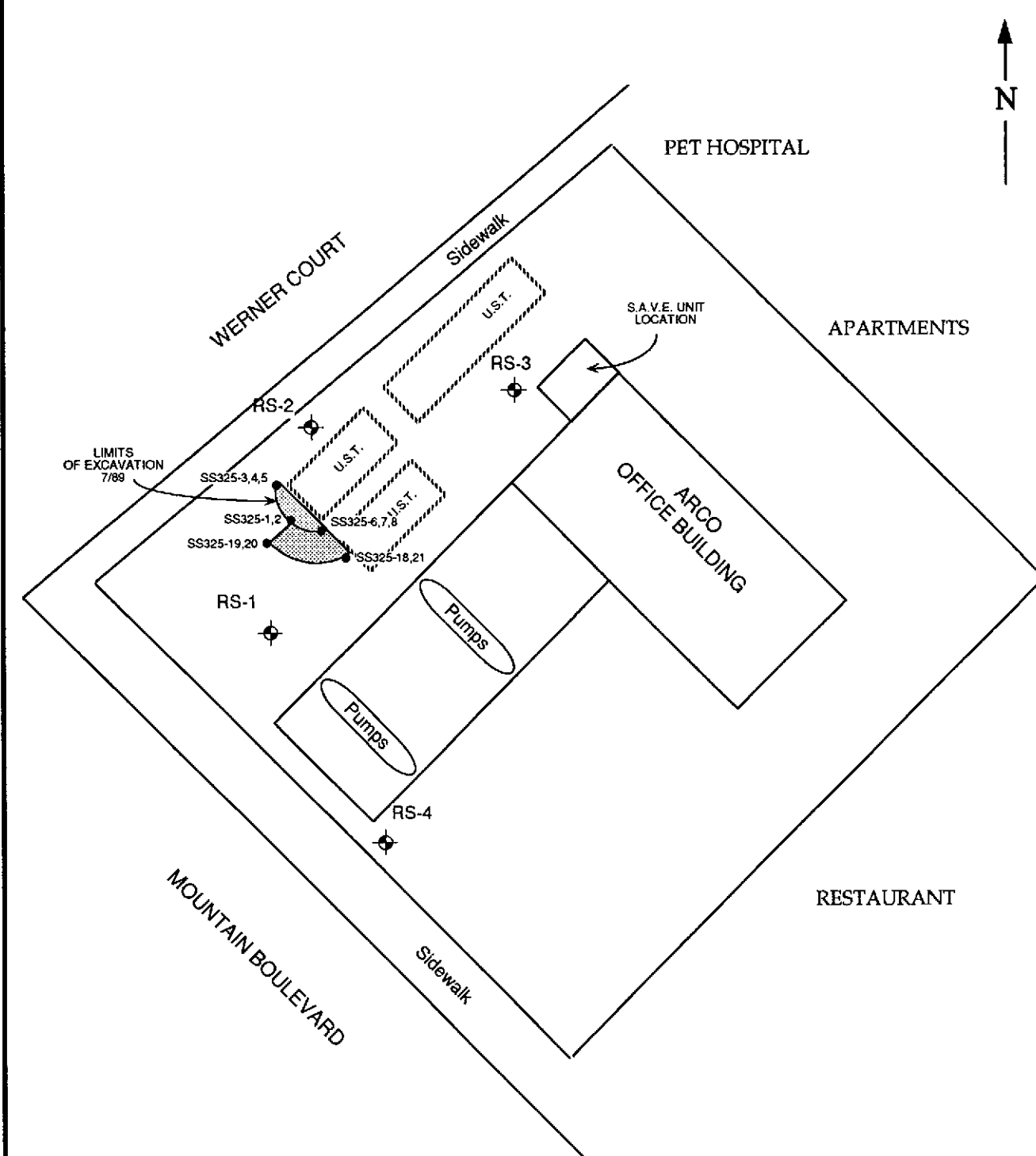
 MONITORING WELL LOCATION




2844 MOUNTAIN BLVD.
OAKLAND, CALIFORNIA

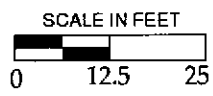
FIGURE 2: SITE MAP





LEGEND

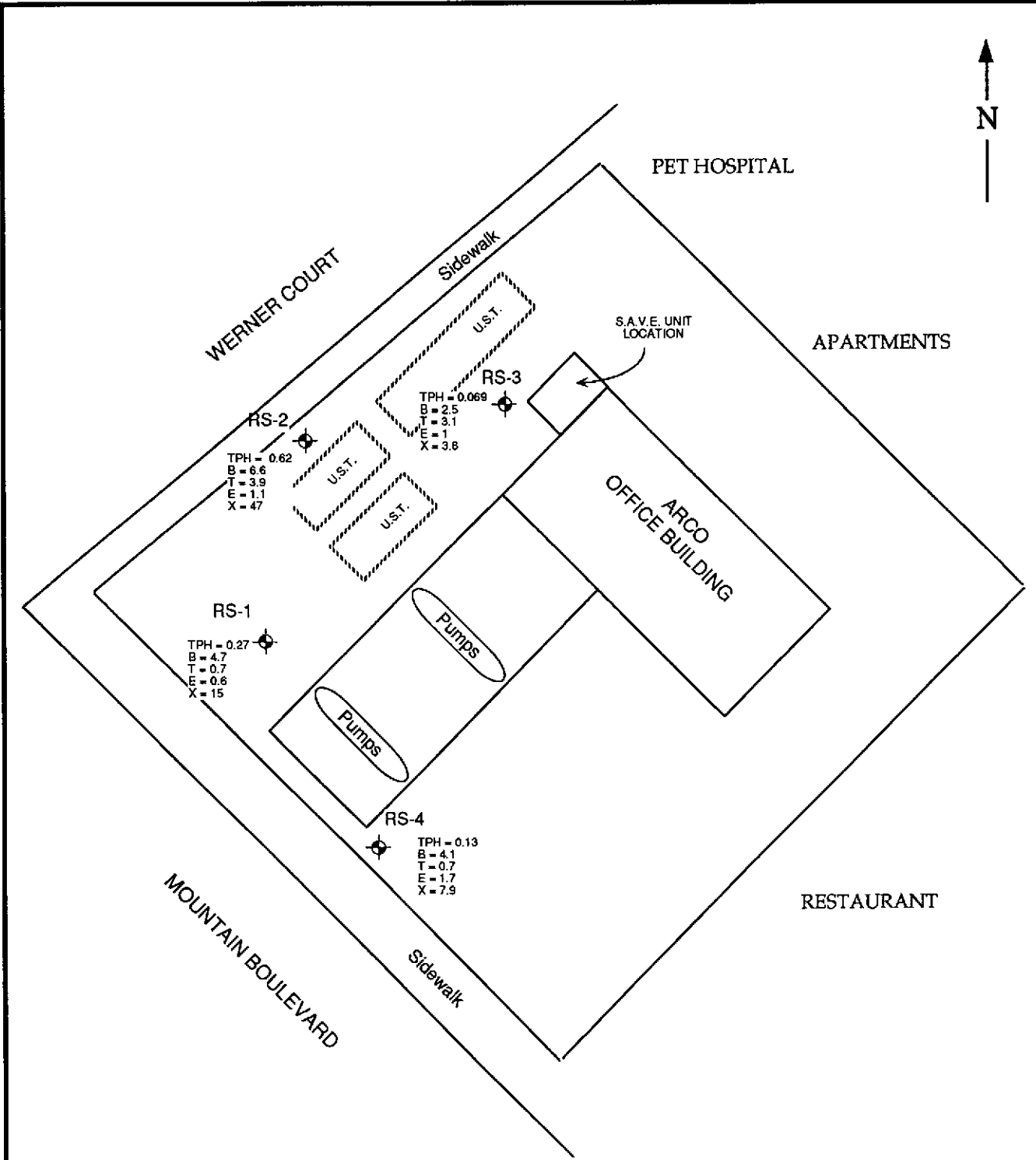
 MONITORING WELL LOCATION



2844 MOUNTAIN BLVD.
OAKLAND, CALIFORNIA

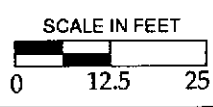
FIGURE 3: SITE MAP SHOWING HISTORIC
SOIL SAMPLE LOCATIONS





LEGEND

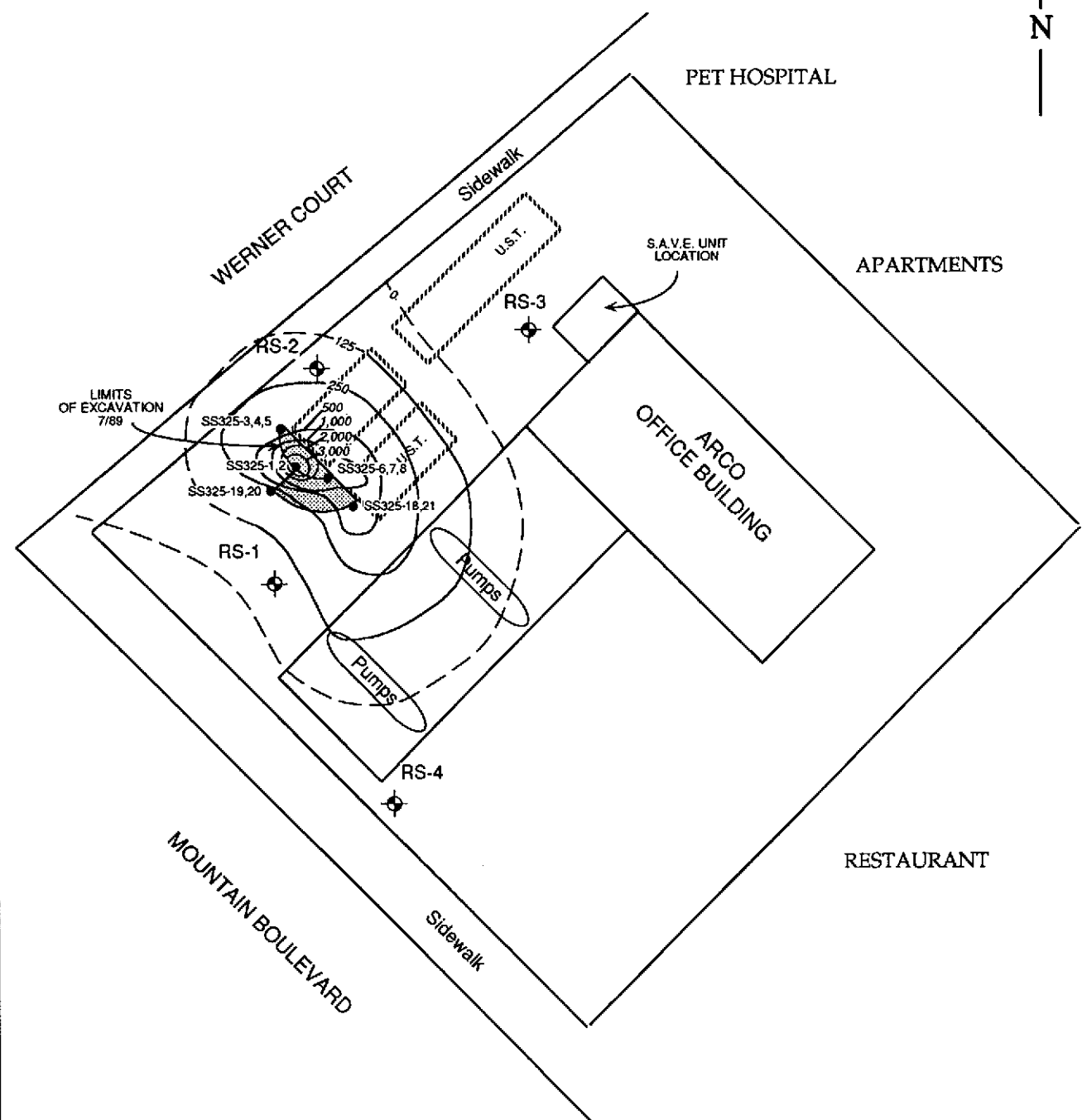
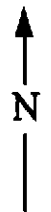
 GROUNDWATER MONITORING WELL LOCATION WITH TPH CONCENTRATIONS mg/L AND BTEX CONCENTRATIONS IN µg/L.



2844 MOUNTAIN BLVD.
OAKLAND, CALIFORNIA

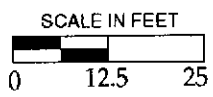
FIGURE 5: SITE MAP WITH GROUNDWATER ANALYTICAL RESULTS
NOVEMBER 20, 1994





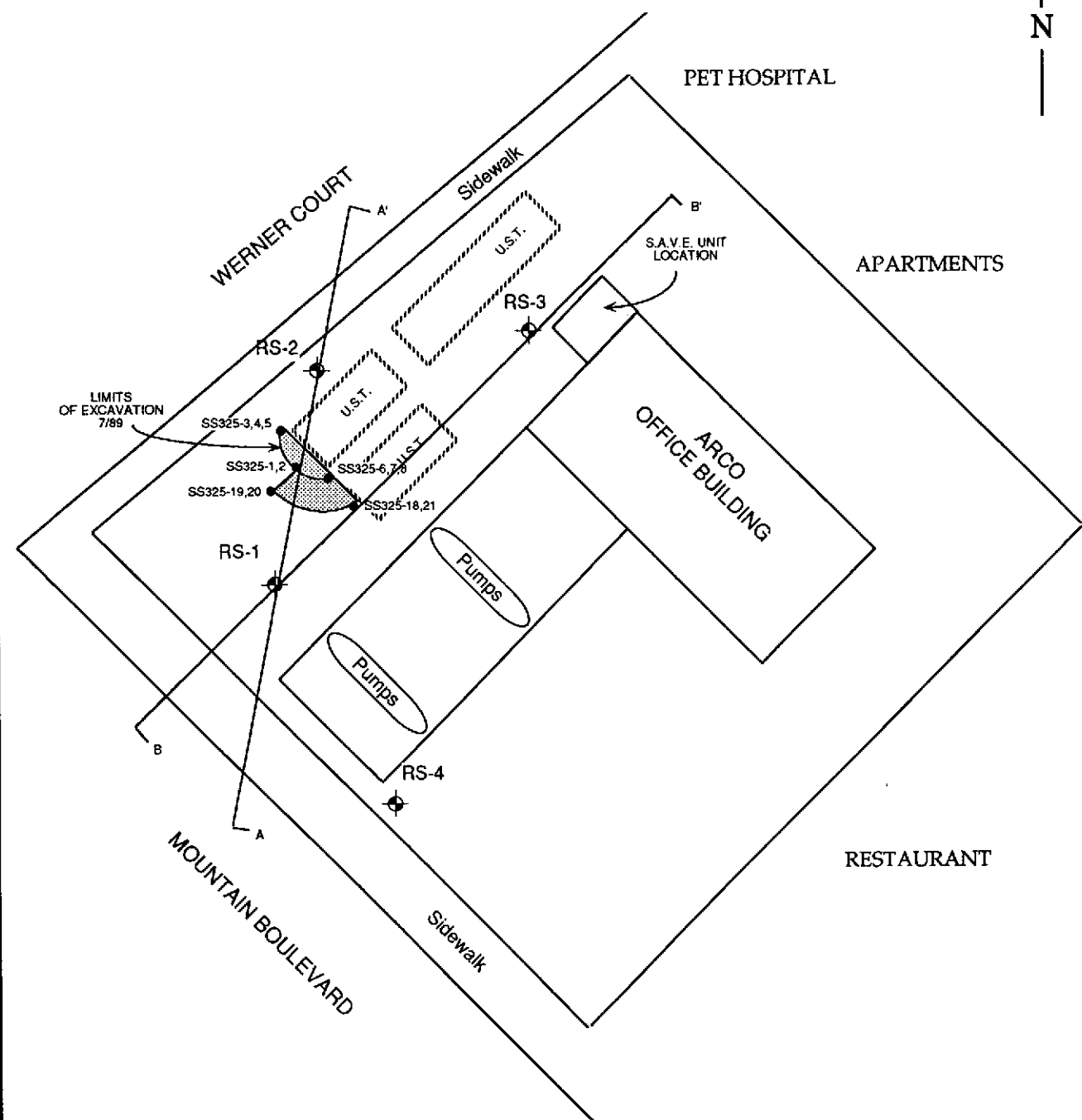
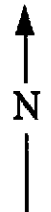
LEGEND

⊕ MONITORING WELL LOCATION
cones?
CO2?



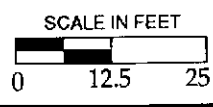
2844 MOUNTAIN BLVD.
OAKLAND, CALIFORNIA
FIGURE 6: SITE MAP WITH HORIZONTAL
EXTENT OF CONTAMINATION





LEGEND

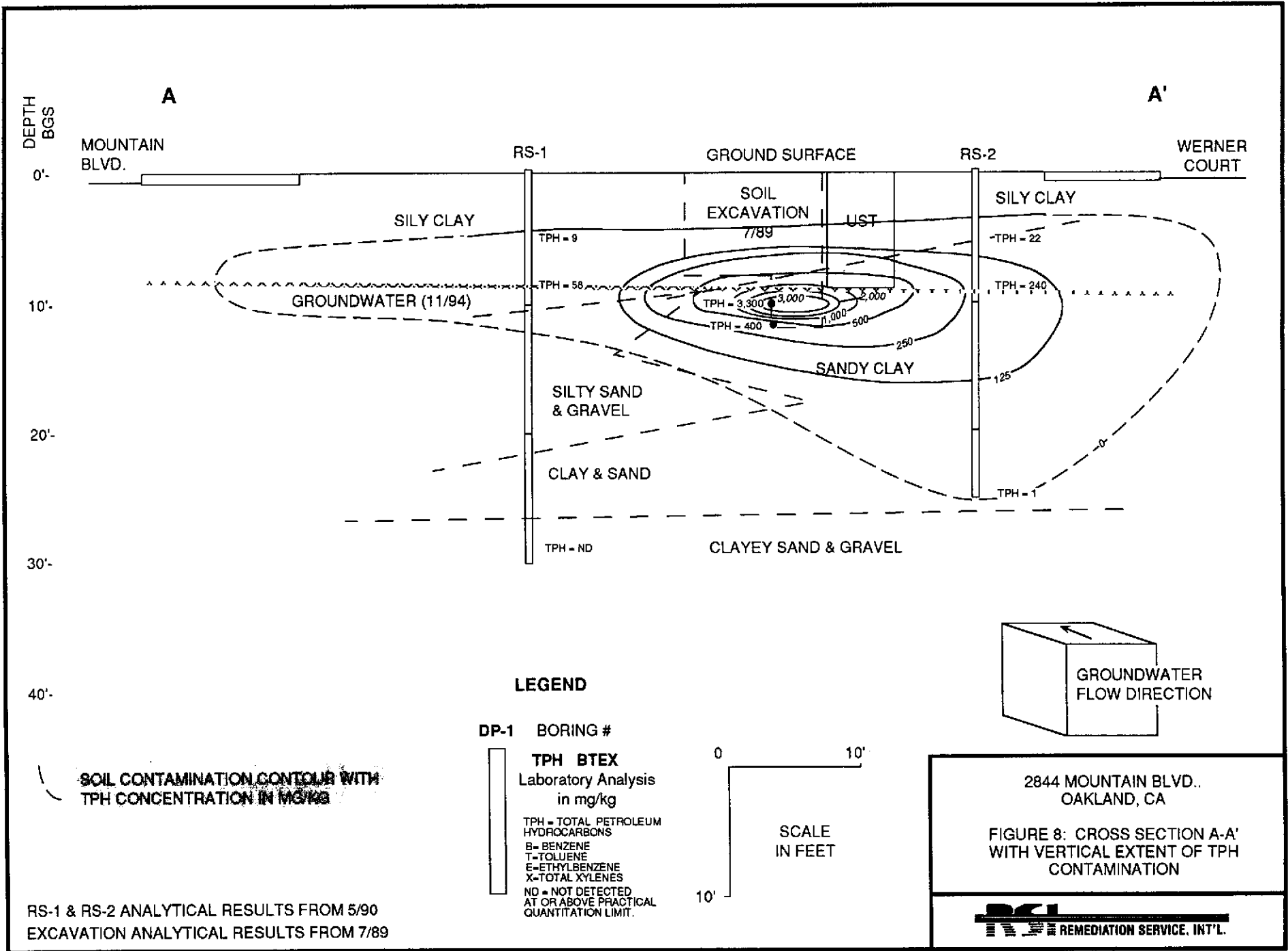
 MONITORING WELL LOCATION

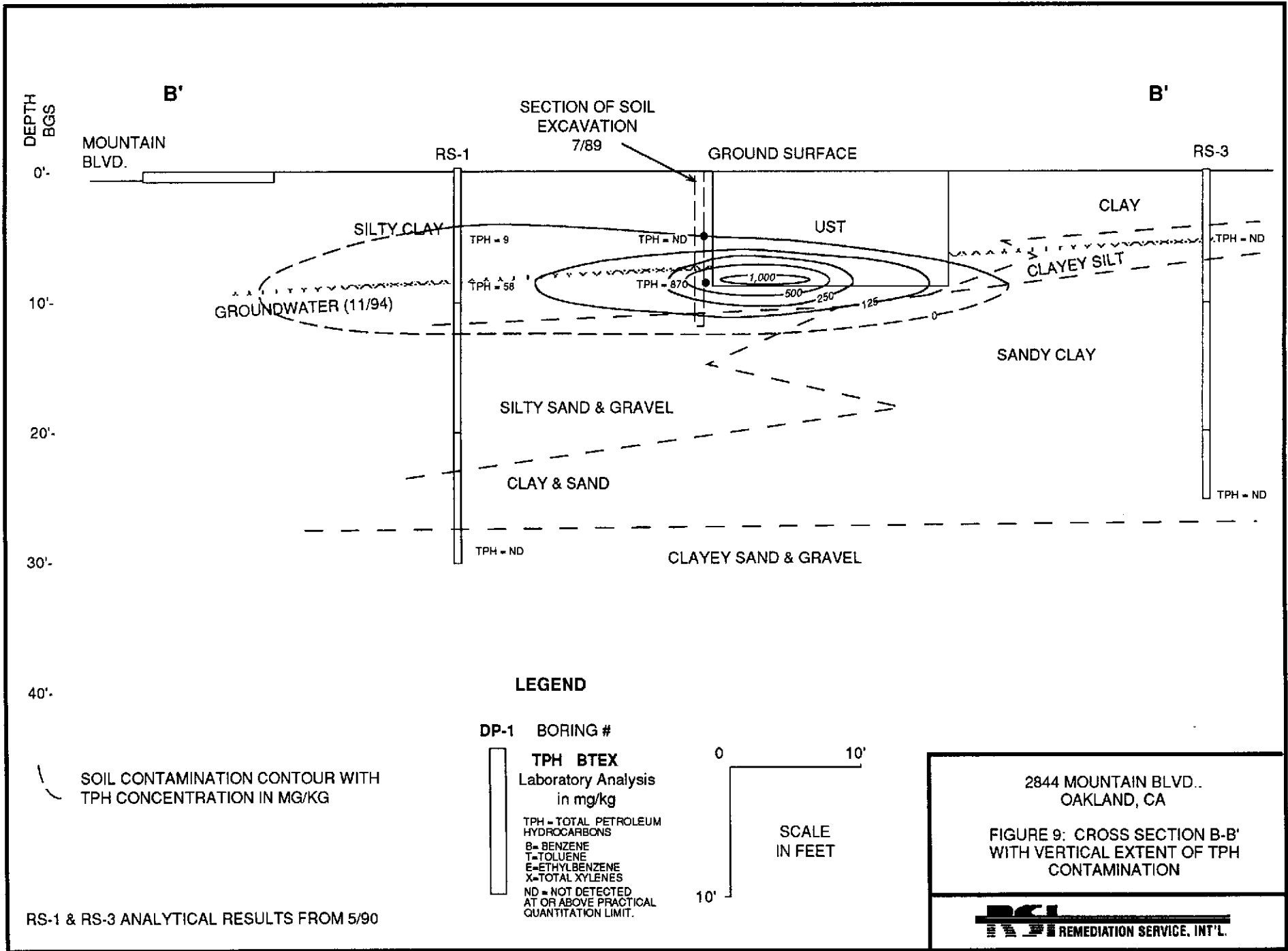


2844 MOUNTAIN BLVD.
OAKLAND, CALIFORNIA

FIGURE 7: SITE MAP WITH
CROSS SECTIONS







**TABLE 1
SUMMARY OF SOIL ANALYTICAL RESULTS**

**2844 MOUNTAIN BLVD.
OAKLAND, CA**

Results are in mg/Kg (parts per million).

SAMPLE DATE	SAMPLE DESCRIPTION	TPH	BENZENE	TOLUENE	ETHYL-BENZENE	TOTAL XYLENES
7/7/89	SS325-1 @ 10.0'	3,300	ND	100	30	270
7/7/89	SS325-2 @ 12.0'	400	ND	1	0.8	3.8
7/7/89	SS325-3 @ 4.0'	12	ND	0.4	ND	1.2
7/7/89	SS325-4 @ 10.0'	30	ND	ND	ND	0.3
7/7/89	SS325-5 @ 12.0'	13	0.4	1	0.2	1.3
7/7/89	SS325-6 @ 4.0'	2	ND	ND	ND	0.1
7/7/89	SS325-7 @ 10.0'	750	ND	25	15	75
7/7/89	SS325-8 @ 12.0'	5	0.1	0.4	ND	0.6
7/7/89	SS325-18 @ 5.0'	ND	0.0061	ND	ND	0.008
7/7/89	SS325-19 @ 5.0'	ND	0.0074	0.009	ND	0.0086
7/7/89	SS325-20 @ 8.0'	230	ND	3.8	1.3	8.5
7/7/89	SS325-21 @ 8.0'	870	ND	45	11	78
5/29/90	RS-1 @ 5'	9	0.59	0.53	0.085	0.76
5/29/90	RS-1 @ 10'	58	6.2	8	0.85	5.2
5/29/90	RS-1 @ 28'	ND	0.004	0.003	ND	ND
5/30/90	RS-2 @ 5'	22	4.1	0.85	0.26	2.5
5/30/90	RS-2 @ 8'	240	ND	7.3	2.9	20
5/30/90	RS-2 @ 25'	1	0.059	0.08	ND	0.068
5/30/90	RS-3 @ 5'	ND	0.084	0.014	0.004	0.03
5/30/90	RS-3 @ 25'	ND	0.004	0.009	ND	0.02
5/30/90	RS-4 @ 5'	ND	0.079	0.006	0.004	0.028
5/30/90	RS-4 @ 7'	ND	0.037	0.006	ND	0.006
5/30/90	RS-4 @ 25'	ND	0.006	0.007	ND	0.006

TPH = Total petroleum hydrocarbons as gasoline

ND = Not detected above minimum detection levels.

NA = Not analyzed for this constituent.

TPH & BTEX analyzed by EPA methods 8015M & 8020, respectively.

SS325-1 through SS325-21 analytical results from On-Site Technologies Soil Sampling Report 8/89.

**TABLE 2
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS**

**2844 MOUNTAIN BLVD.
OAKLAND, CA**

TPH analytical results are in mg/L (parts per million)
BTEX analytical results are in µg/L (parts per billion).

WELL #	DATE SAMPLED	TPH	BENZENE	TOLUENE	ETHYL-BENZENE	TOTAL XYLENES
RS-1	5/90	2.7	370	420	40	320
	5/91	1.3	580	130	62	240
	10/91	1.1	140	100	45	210
	1/92	1.7	9.9	31	9.7	170
	1/93	3.7	650	9.2	51	170
	8/93	0.9	14	0.6	2.1	7.8
	11/93	1.4	9.6	ND	0.9	4.9
	1/94	4.2	95	3.1	58	130
	5/94	7.5	270	11	37	96
	8/94	0.13	12	0.5	2.6	4.7
	11/94	0.27	4.7	0.7	0.6	15
RS-2	5/90	23	7,200	4,800	300	3,300
	5/91	26	14,000	1,800	750	2,900
	10/91	13	4,300	910	300	2,300
	1/92	8.3	1,800	920	140	1,700
	1/93	41	7,000	210	1,200	4,200
	8/93	19	5,300	62	810	1,600
	11/93	9.3	2,400	3.9	46	800
	1/94	30	4,900	ND	880	2,600
	5/94	120	3,300	330	ND	2,200
	8/94	0.51	7.3	3.8	3.5	32
	11/94	0.62	6.6	3.9	1.1	47
RS-3	5/90	0.33	2	1	1	150
	5/91	ND	0.4	ND	0.8	8.2
	10/91	ND	ND	ND	ND	ND
	1/92	ND	2.2	7.2	0.6	3.6
	1/93	ND	ND	ND	ND	ND
	8/93	ND	30	6	2.4	5
	11/93	ND	4.8	0.4	0.6	1.9
	1/94	0.33	25	3.2	3.9	12
	5/94	0.67	34	4	28	70
	8/94	ND	ND	ND	ND	ND
	11/94	0.069	2.5	3.1	1	3.8
RS-4	5/90	0.44	9	11	9	49
	5/91	ND	8	4	3	5
	10/91	0.83	280	120	24	170
	1/92	0.62	34	8.3	2.1	21
	1/93	0.15	32	1.7	5.8	13
	8/93	ND	0.9	0.7	ND	0.3
	11/93	ND	ND	ND	ND	ND
	1/94	ND	1.7	ND	0.81	2.2
	5/94	ND	ND	ND	ND	0.7
	8/94	0.42	6.5	4.1	1.9	40
	11/94	0.13	4.1	0.7	1.7	7.9
Title 22 CCR MCL		—	1	150	700	1,750

TPH = Total petroleum hydrocarbons (gasoline)

ND = Not detected above minimum detection levels.

**TABLE 3
GROUNDWATER ELEVATION DATA**

**2844 MOUNTAIN BLVD.
OAKLAND, CA**

Measurements are in feet.

Well	Date Measured	Depth to Water*	Well Head Elevation**	Water Table Elevation**	Change in Elevation
RS-1	5/90	7.20	689.25	682.05	
	5/91	8.35		680.90	-1.15
	10/91	10.22	689.17	678.95	—
	1/92	8.06		681.11	2.16
	1/93	5.30		683.87	2.76
	8/93	8.56		680.61	-3.26
	11/93	8.44		680.73	0.12
	1/94	6.88		682.29	1.56
	5/94	7.87	675.63	667.76	—
	8/94	16.28		659.35	-8.41
	11/94	8.02		667.61	8.26
RS-2	5/90	7.06	689.00	681.94	
	5/91	7.14		681.86	-0.08
	10/91	8.84	688.89	680.05	—
	1/92	7.34		681.55	1.50
	1/93	4.10		684.79	3.24
	8/93	7.32		681.57	-3.22
	11/93	7.34		681.55	-0.02
	1/94	5.52		683.37	1.82
	5/94	6.40	675.25	668.85	—
	8/94	22.11		653.14	-15.71
	11/94	9.82		665.43	12.29
RS-3	5/90	6.00	690.00	684.00	
	5/91	6.76		683.24	-0.76
	10/91	8.98		681.02	-2.22
	1/92	6.81		683.19	2.17
	1/93	4.05		685.95	2.76
	8/93	7.19		682.81	-3.14
	11/93	7.12		682.88	0.07
	1/94	5.42		684.58	1.70
	5/94	5.78	676.20	670.42	—
	8/94	5.86		670.34	-0.08
	11/94	5.08		671.12	0.78
RS-4	5/90	8.34	689.06	680.72	
	5/91	9.50		679.56	-1.16
	10/91	10.82	689.10	678.28	—
	1/92	9.31		679.79	1.51
	1/93	6.89		682.21	2.42
	8/93	9.68		679.42	-2.79
	11/93	9.83		679.27	-0.15
	1/94	8.17		680.93	1.66
	5/94	8.69	675.38	666.69	—
	8/94	9.04		666.34	-0.35
	11/94	8.00		667.38	1.04

*Depth of water measured from top of well cover.

**Elevations are in feet above mean sea level.

Well Head Elevations surveyed 5/94 to City of Oakland Bench Mark #2804,
Bench Mark elevation = 676.08', based on USGS Sea Level Datum 1929.

ENVIRONMENTAL FATE & TRANSPORT OF GASOLINE

The following section discusses the fate and transport of gasoline fuel. Behavior of gasoline in the subsurface must be understood before evaluating remedial methods that address contamination at the site.

1.0 Gasoline Composition

The fate and transport of fuels is complicated due to gasolines nature as a mixture of many individual compounds. Each compound exhibits unique properties in the subsurface and may behave differently depending on the conditions of the soil or rock in which it exists. Gasoline compounds may exist in one or all of the following states:

- As free product moving between soil particles,
- As product adsorbed to soil particles,
- As interstitial vapor between soil particles, and
- As solutes in groundwater or soil water.

The degree to which a compound within a mixture such as gasoline partitions into each state and migrates in the subsurface is dependant on several variables; these variables include moisture content, bulk density and permeability of the soil or rock formation, soil vapor pressure, temperature, pH and population of indigenous bacteria which may consume the compound. The degree of understanding of each of these variables and the nature of the fuel mixture defines the certainty with which fate and transport may be evaluated.

Fresh gasoline fuel contains approximately 42 separate hydrocarbons ranging from C3 to C21, and is dominated by straight chain alkenes and alkanes in the C4 to C8 range. Other hydrocarbons present in gasoline fuel include branched alkanes, cycloalkanes, alkenes, alkyl benzenes, and polynuclear aromatic hydrocarbons. The aromatic components of gasoline, such as benzene, toluene, and xylenes, are usually present in concentrations of less than 0.1 weight percent. Weathered gasoline fuel in soil would be expected to lose most of these lighter end hydrocarbons over time due to biodegradation. Table A-1 summarizes information on the concentrations of hydrocarbon compounds commonly found in fresh gasoline fuel (SWRCB, 1989).

TABLE A-1 Summary Of Fate and Transport and Toxicity Characteristics for Selected Constituents in Gasoline

Compound	Mass	Fate & Transport			Toxicity
	Maximum Weight %	Aqueous Solubility (mg/L)	Vapor Pressure (torr)	Expected Biotic Half Life (days)	Final RQ (Kg)
Benzene	<0.1	1,780	75.0	110	4.54
Toluene	<0.1	515	22.0	39	454
(o) - Xylene	<0.1	162	6.0	32	454
(m) - Xylene	<0.1	175	5.0	0.03	454
(p) - Xylene	<0.1	198	6.5	0.03	454
Ethylbenzene	<0.1	152	7.0	37	454
Naphthalene	0.13	31.1	1.0	—	4.54

Gasoline fuel possesses the following general characteristics that influence its movement in the subsurface:

- A. The density of gasoline ranges from 0.70 to 0.78 and averages approximately 0.75 grams per cubic centimeter (g/cm³) and is less viscous than water. Since gasoline is less viscous than water, it moves more easily through soil.
- B. Gasoline is mostly insoluble in water, but individual compounds of the gasoline mixture are slightly soluble,
- C. The aromatic compounds in gasoline are highly volatile, but comprise a small volume of the mixture. Soil vapor is not expected to contain high concentrations of gasoline related compounds,
- D. Some gasoline compounds are readily aerobically degraded by bacteria.

Table A-1 presents information on the aqueous solubility, vapor pressure, degree of biodegradability and toxicity of selected gasoline constituents. This comparison clearly shows the unique characteristics of each component, and illustrates the difficulties in assessing health risks and the behavior of the gasoline mixture in the subsurface.

3.0 Transport of gasoline

The transport of gasoline at the site is a function of the physical and chemical properties of the fuel mixture, and the characteristics of the subsurface soils.

Gasoline components may move as solutes with groundwater, as free phases through the unsaturated zone, or as vapor in the unsaturated zone. Multi-phase transport is further complicated by heterogeneities in the subsurface.

2.0 Subsurface Characteristics

Soil particles are separated by a network of interconnected voids or pores through which soil vapor or moisture may move. The subsurface is characterized by the nature of the pores and the degree to which they are filled with vapor or water. Three zones in the subsurface are usually recognized in this manner: the unsaturated (vadose) zone, the capillary zone, and the saturated zone.

The unsaturated zone extends from the ground surface to the top of the capillary zone. Water exists in the unsaturated zone on the surfaces of soil particles due to adsorption and in pore spaces due to capillary forces (adhesion and cohesion). The maximum amount of water that a soil may contain, the residual saturation, is the maximum amount of water that the soil may retain before movement of water occurs due to gravity. The remaining void space not occupied by water is occupied by vapor which moves due to forces explained below.

The capillary zone is a transition zone between the unsaturated and saturated zones. The moisture content in the capillary zone ranges from the residual saturation at the top of the zone, to saturation at the base of the zone. The thickness of the zone varies, depending on the sizes of soil particles and the sizes of pore spaces. Finer pore spaces usually produce higher capillary forces and thicker capillary zones. Heterogeneous formations produce capillary zones which vary in thickness.

The saturated zone begins at the base of the capillary zone, where saturated conditions exist. Water pressure in this zone increases with depth. The boundary where water pressure equals atmospheric pressure is the piezometric surface. Aquifers are present where groundwater exists in sufficient quantities to be useful domestically, commercially, or industrially.

Unconfined groundwater flows in the saturated zone in a manner dictated primarily by the following aquifer characteristics:

1. Porosity the total volume of pore spaces;
2. Permeability the soil's resistance to flow, which depends on the size, shape, and orientation of soil pores;
3. Hydraulic gradient the slope and direction of the piezometric surface.

Groundwater flow may be inconsistent across a site, depending on soil heterogeneities in the subsurface. Groundwater flow velocities may range from inches per year to feet per day.

3.1 The Unsaturated Zone

The movement of gasoline in the unsaturated zone is initially dependent on the volume discharged and soil type. In homogeneous, permeable soils, migration is primarily vertical due to gravity. Horizontal movement in this case is due to capillary adhesion of the product to soil particles. In interbedded soils, horizontal movement is more pronounced and the shape of the path is more irregular due to less permeable interbeds and greater capillary adhesion in those interbeds. The movement of released gasoline may be impeded by three methods:

1. The residual saturation of the formation with respect to the released fluid is reached,
2. An impermeable interbed is reached,
3. A water table aquifer is reached.

Over time, the residual product in the unsaturated zone is partitioned into pure, dissolved and vapor phases. The following physical and chemical processes influence the partitioning of gasoline components into these phases in the unsaturated zone:

1. Capillary Forces
2. Adsorption,
3. Volatilization,
4. Dissolution.

3.1.1 Capillary forces

Capillary forces which hold gasoline in the unsaturated zone include adhesion (the attraction of liquid molecules to solid surfaces) and cohesion (the attraction between molecules). These forces are also responsible for vertical and horizontal movement of water and product in the subsurface. In general, finer soils promote more movement of water and product due to capillary forces because smaller flow paths create greater adhesion to the gasoline.

3.1.2 Absorption

Absorption, the bonding of a solute to a site on a solid surface, occurs in the subsurface by many mechanisms, including: van der Waals forces, hydrophobic bonding, hydrogen bonding, charge transfer, ligand exchange, ion exchange,

ion/dipole interactions, magnetic interactions, and chemisorption. The extent to which a particular gasoline component will adsorb to soil particles can be assessed based on the absorption potential of the component, and the carbon content, texture, bulk density, clay content, moisture content, cation exchange capacity, and pH of the soil.

Compounds such as naphthalene have low organic carbon partition coefficient (K_{oc}) values and are expected to be adsorbed readily in the soil. Aromatic compounds such as benzene, toluene, and xylenes have higher K_{oc} values, are more mobile in the unsaturated zone, and would be expected to appear in higher concentration as dissolved or vapor phases. It should be noted that the aromatics components may be selectively retarded during transport by dissolving in soil moisture in the unsaturated zone.

3.1.3 Volatilization

Volatilized gasoline compounds may enter soil vapor through this process and may pose significant health and safety risks due to inhalation or explosion hazards under certain conditions. The degree to which gasoline components volatilize depends on soil conditions and the vapor pressure of the individual compounds. The vapor pressure of a compound is the pressure exerted at equilibrium by a vapor phase with respect to its liquid or solid phase. The vapor phase of a compound is directly proportional to its volatility. Environmental conditions such as temperature, wind speed, evaporation rate, and precipitation influence volatilization in the subsurface. Soil conditions such as moisture content, clay content, and the surface area of adsorbed product also impact the degree of volatilization in the subsurface.

The principal methods of vapor transport in the subsurface are diffusion and advection. Diffusion is caused by the random movement of molecules and generally results in the movement of molecules from areas of high concentrations to those of low concentrations. Advection is the movement of gases due to pressure changes in the subsurface due to the following causes:

1. Barometric Pumping - Soil vapor is typically at atmospheric pressure. A change in barometric pressure will result in a pressure gradient in the soil vapor, which will lead to movement of vapor toward or away from the surface. This effect is more pronounced in areas with shallow groundwater, and may increase volatilization by disrupting equilibria at liquid/vapor interfaces in the subsurface.
2. Imposed Pressure Gradients - Pressure gradients may be caused by temperature differences between substructures such as pipelines and basements, and the surrounding soil vapor.

3. Density Differences - Vapor produced by volatilizing product has a different density than the surrounding soil vapor. Organic vapor is influenced by gravity and may stratify, with the dense vapor lying below the lighter vapor. This effect also encourages mixing of vapors of different densities, which results in a larger area more uniformly impacted by soil vapor.

3.1.4 Dissolution

Dissolution occurs when a soluble component comes into contact with soil water in the unsaturated zone or groundwater in the saturated zone. The degree to which a compound enters the aqueous phase is a function of the compounds aqueous solubility. More soluble compounds tend to have lower adsorption coefficients, and also tend to be more easily biodegraded.

3.2 The Capillary Zone

When free product reaches the capillary zone, the higher moisture content present prevents further vertical migration. The increased moisture content in the capillary zone reduce volatilization and vapor transport, and increases dissolution and solute transport. The degree of solute transport increases from the top of the capillary zone where residual saturation exists, to the water table where dissolved product migrates with groundwater.

If a sufficient volume of product is present, a layer of product forms, hydrostatic pressure is exerted, and the water table is depressed. As buoyant forces act to restore the original water table, the layer spreads laterally and begins to thin. The movement of the layer is in all directions, but the most movement occurs in the direction of groundwater flow. The rate and degree of thinning of the product layer is a function of the permeability of the saturated zone. The product layer will be thicker and will move at a slower rate in lower permeability soils.

3.3 The Saturated Zone

Groundwater may be impacted by dissolved gasoline compounds in several ways. Among these processes are:

1. Infiltrating water passes through gasoline-impacted unsaturated zone, leaching soluble compounds as it passes. These compounds are carried to groundwater if a sufficient volume of groundwater exists;
2. Free product reaches groundwater and soluble compounds dissolve into groundwater;

3. Free product present as residual saturation in the unsaturated zone is leached during a rise in the water table. Capillary forces binding the product to the soil particles resist buoyant forces which tend to push the product toward the surface. The product adhering to the soil particles continues to leach soluble compounds during the period of submergence.

When soluble compounds enter the saturated zone, their movement is governed by advection and dispersion. Advection is the bulk movement of solutes with the flow of groundwater. Hydrodynamic dispersion is a mechanical mixing process which produce spreading of the dissolved compound normal to and in the direction of flow. It is responsible for the dilution of solutes away from the source. Molecular diffusion of the solute also occurs at this time, and may be a significant factor in the extent of dissolved phase hydrocarbons in low velocity systems.

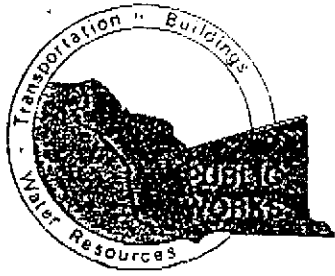
4.0 Subsurface Degradation

In addition to the physical processes that influence the concentrations and movement of gasoline compounds in the subsurface, chemical processes may significantly reduce the concentrations of the compounds after their release. Biotic processes and chemical (abiotic) processes are the most important of these processes.

There are two primary biotic processes, biodegradation and biotransformation, by which microorganisms (bacteria, fungi, and yeasts) consume gasoline compounds in oxidation/reduction reactions. Biodegradation is the complete mineralization of the compound into water, carbon dioxide, and energy for growth and reproduction. Biotransformation produces simpler compounds which may be more or less soluble and/or toxic than the original compound.

Degradation of compounds by oxidation/reduction reactions often produces compounds such as peroxides, primary alcohols, and monocarboxylic acids which are more readily mineralized by biotic processes.

APPENDIX B
ALAMEDA CO. PUBLIC WORKS
WELLS WITHIN 1/2 MILE RADIUS OF SITE



COUNTY OF ALAMEDA
PUBLIC WORKS AGENCY

399 Eimhurst Street • Hayward, CA 94544-1395
(510) 670-5480
FAX (510) 670-5262

FAX TRANSMITTAL FAX TRANSMITTAL FAX TRANSMITTAL FAX TRANSMITTAL

DATE: 2-1

TO: Heather Davis

FROM: Andreas Godfrey

ATTN: (805) 654-0720

OF PAGES (INCLUDING COVER SHEET) 2

COMMENTS:

Wells within 1/2 mile of 2844 Mountain Blvd.

If you do not receive the entire transmittal, or if it is illegible, please call _____ at (510) 670-5543

Tr	Section	Address	Locality	Owner	Drilldate	Elevation	Totaldepth	Waterdepth	Diameter	Use	Log	Wq	Wl	Yield
1S/3W	28N 2	4315 Lincoln Avenue	Oakland	The Head Royce School	8/89		0	260	240	IRR	D	0	0	14
1S/3W	28N 3	4315 Lincoln Avenue	Oakland	The Head Royce School	8/89		0	101	0	DES	D	0	0	0
1S/3W	28K 4	2844 Mountain Blvd	Oakland	Desert Petroleum	05/90		0	25	8	MON	D	0	0	0
1S/3W	28K 3	2844 Mountain Blvd	Oakland	Desert Petroleum	05/90		0	25	6	MON	D	0	0	0
1S/3W	28K 1	2844 Mountain Blvd	Oakland	Desert Petroleum	05/90		0	30	7	MON	D	0	0	0
1S/3W	28K 2	2844 Mountain Blvd	Oakland	Desert Petroleum	05/90		0	25	7	MON	D	0	0	0
1S/3W	28N 1	FUNSTON PLACE	Oakland	PG&E	1/75		0	120	0	CAT	D	0	0	0
1S/3W	33R 1	MONTEREY BLVD	Oakland	PG&E	7/76		0	120	0	CAT	D	0	0	0

"0" means no data

cat - cathodic protection

Mon - monitoring

IRR - irrigation

Des - destroyed

APPENDIX C
CRWQCB INTERIM GUIDANCE DOCUMENT
SOIL SCREENING LEVELS

**CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION**

101 CENTRE PLAZA DRIVE
MONTEREY PARK, CA 91754-2156
(213) 266-7500
FAX: (213) 266-7600

**INTERIM GUIDANCE FOR
REMEDiation
OF PETROLEUM IMPACTED SITES****SOIL SCREENING LEVELS**

(November 1994)

SUMMARY

This interim guidance contains numerical soil screening levels for the remediation of petroleum impacted soils. This guidance can be used to determine when a site requires remedial action or to what level a site must be cleaned up and for site closure. This guidance recognizes the differences in types of petroleum constituents and between drinking and non-drinking waters. Site-specific risk assessment and/or fate and transport models with a component of ground water protection considered can still be used for responsible parties to propose alternative soil cleanup levels. However, this guidance is not intended to substitute any site assessment requirements by the Regional Board. This interim guidance will be in effect until the State Water Resources Control Board finalizes the new LUFT manual at which time it will be reviewed for further use.

BACKGROUND

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) created a Water Quality Advisory Task Force with a charge of identifying and recommending ways to reduce the cost of compliance with existing clean water laws without compromising water quality and public health. The Task Force focused its deliberations on a few selected problem areas, one of which was Site Cleanup. Problems identified within this area included the fact that "there is no clear definition of what is clean", and that cleanup expectations were not consistent across all Regional Board programs.

The Task Force also recommended the formation of a Technical Review Committee (TRC), composed of representatives from the private sectors and other governmental agencies, to discuss existing and proposed programs, and to devise cleanup standards in concert with Regional Board staff. In particular:

INTERIM GUIDANCE FOR REMEDIATION OF PETROLEUM IMPACTED SITES (P.2)

"Establishing a set of clear and consistent standards for site cleanup should be the first task undertaken by the Regional Board staff and its Technical Review Committee. The Regional Board should establish standards for identifying when a threat or probable threat to ground water has occurred and when a site has been adequately remedied. ... the Regional Board should make every effort to ensure that the standards are consistent across all programs under its jurisdiction, and, whenever possible, consistent with those of other agencies in the Region. The standards should allow the community to use more cost-effective methods, such as risk-assessment approaches, and fate and transport models, where appropriate as means to determine if soil contamination poses a risk to ground water".

Because the majority of the Regional Board caseload involves petroleum-impacted sites, they are addressed separately through this interim guidance, as opposed to including the entire universe of petro-chemical sites (solvents, pesticides, etc.).

OBJECTIVE

The objective of this guidance is to simplify the remediation process by facilitating the selection of site-specific soil cleanup levels for the majority of petroleum-impacted sites in a way that is both protective of water resources yet cost effective. The guidance is intended to encourage prompt cleanups that result in sites being returned to their intended uses.

The guidance is for the cleanup of petroleum-impacted soils only and is not meant to address ground water directly*, or to replace current site assessment requirements. As such, site characterization and assessment must be completed to a sufficient level of detail to understand the contaminants and the spatial extent of impacted soil before the guidance can be applied. The Regional Board intends to close routine petroleum-impacted sites using this guidance. As is presently the case, the closure is subject to land use changes or new information that was not known at the time of closure. However, ground water monitoring may be required if soil contamination linkage to ground water impact has been confirmed.

The attached Table 1 forms the basis for the guidance as it defines the soil screening levels and contains clarifying footnotes. The primary constituents of concern at most petroleum-impacted sites

* = For cleanup of petroleum impacted groundwater, Water Quality Goals For Components Of Petroleum-Based fuels In "MUN" Designated Waters by Regional Board - Central Valley Region (May 1993) is recommended.

INTERIM GUIDANCE FOR REMEDIATION OF PETROLEUM IMPACTED SITES (P.3)

are benzene, toluene, ethylbenzene, and xylenes (BTEX). Analysis for lead, other additives, and PAHs (Polycyclic Aromatic Hydrocarbons) shall be performed where warranted based on the product (gasoline, diesel, fuel oil, etc.) found to have been discharged to soil. Since there is not an adequate measure of risk or toxicity for total petroleum hydrocarbons (TPHs) per se, screening levels are given in Table 1 based upon the carbon range numbers of the TPHs. These ranges may be more indicative of the mobility of the material with the lighter ends (C4-C12) being more mobile in soil than the heavier ends (C23+). The table is organized into a matrix of screening "Levels" based on depth to ground water and classification of ground water.

The screening level values in Table 1 are conservative for the protection of ground water. They are also protective of direct human health exposure pathways (as defined by the USEPA methodology referenced in the ASTM Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites ES 38-94). Alternative soil cleanup levels may be proposed by a responsible party when supported by the use of risk-assessment approaches and/or fate and transport modeling which include the component of ground water protection (i.e., ground water is considered as a receptor rather than as a pathway). The use of alternative approaches shall be discussed with the Regional Board staff.

PROCEDURES

The use of Table 1 will require:

1. An adequate site characterization/assessment that documents the contaminants of concern, the lateral and vertical extent of soil contamination, the existence of "clean zone" above ground water; and
2. A determination of beneficial use for ground water underlying the site. All Los Angeles Region's ground waters are considered drinking water, unless excluded pursuant to the criteria specified in State Water Resources Control Board (SWRCB) Resolution 88-63 (i.e., TDS > 3,000 mg/l, deliverability of < 200 gal/day, or pre-existing contamination that cannot reasonably be treated), or unless a site-specific non-drinking water determination is made by Regional Board staff.

A broad range of sample analyses is required for the guidance. BTEX components can be identified using the EPA Method 8020. However, a responsible party may confirm positive benzene results above the screening level with EPA Method 8260 (BTEX only) as the 8020 method may show false positives in certain cases. Initially, TPH levels shall be measured by EPA Methods 418.1 and 8015 (DHS Modified). Method 418.1 measures the total TPH range; however it may also detect non-petroleum related carbon compounds. Therefore,

INTERIM GUIDANCE FOR REMEDIATION OF PETROLEUM IMPACTED SITES (P.4)

method 8015 is needed to identify carbon ranges (e.g., gasoline, diesel, etc.). If the results of these two tests are below the applicable screening level for the C4-C12 range, no other type of TPH test is necessary. TPH levels greater than the C4-C12 screening level should be differentiated using GC/MS (Gas Chromatograph/Mass Spectrometry) carbon range methods (hydrocarbon screening or speciation) or EPA Method 8015 (DHS Modified). Most laboratories can give a GC/MS Hydrocarbon speciation across the three desired carbon ranges. Level A in Table 1 requires that the detection limit for benzene be at least 1 $\mu\text{g}/\text{kg}$ (ppb). EPA Method 8310 shall be used for PAH analysis to achieve detection limit of 0.2 ppb.

Site assessment results, proposed screening levels, and confirmation testing results shall be discussed with Regional Board staff. Consideration should be given to historical high water levels at certain sites.

EXAMPLES

EXAMPLE 1:

An underground storage tank was removed at a gasoline station. Gasoline contamination in soil has been confirmed and the lateral and vertical extents of the contamination have been adequately defined. Depth to ground water is 30 feet from the surface. Soil samples obtained at 2 feet and 15 feet below the bottom of the tank excavation showed the following results. TPH as gasoline was identified by EPA Method 8015(Modified).

Sample Depth (ft)	TPH				
	Gasoline (C4-C12)	B	T	E	X
2	360	1.6	9.1	2.9	33
15	39	ND(0.005)	0.27	0.067	0.23

Reporting Unit: mg/kg

Since ground water is designated as drinking water per Regional Board Basin Plan, Level A in Table 1 applies. The analytical results at 2 feet definitely warrant a soil cleanup action. Since the MCL for benzene is 1 ppb and the detection limit for benzene was reported as 5 ppb for 15 feet sample, no determination can be made regarding the presence of benzene in the 1-5 ppb range in sample at 15 feet. Also because the results of TPH (gasoline) and toluene in 15 feet sample exceeded the table values (Level A), soil cleanup shall be extended to at least 15 feet below the bottom of the excavation.

EXAMPLE 2:

A small area of property for development is impacted by petroleum product. The source has been determined and removed. Testing and analysis in a preliminary assessment indicates approximately 200 cubic yards of soil are impacted extending to a depth of 4' with at least 10' of clean soil below the impacted area. Geologic data from nearby sites indicate a shallow non-drinking wet interval at 50' to 60', and information obtained from the RWQCB Basin Plan indicates the first true drinking water starting at approximately 170'. Significant time delays could endanger the owners business. The owner has several options:

INTERIM GUIDANCE FOR REMEDIATION OF PETROLEUM IMPACTED SITES (P.5)

Option 1: Since time is of the essence and the volume of soil impacted is relatively small, the owner may determine the best course of action for his situation is to assume the worst case and immediately cleanup the area to the most conservative level. Thus, the Table 1 level A category would become the clean up levels.

Option 2: To determine if a different target level is appropriate, the owner could continue assessment work to verify conditions at his site. This would entail at least one boring through the impacted zone to verify the depth and condition of the first encountered water bearing interval. If the interval was found to be an unimpacted, fresh, deliverable water at 40', then the Level A category would still be clean up level. In this same case if the interval was found at 60', the appropriate category would become Level B. Alternatively, if this new data confirmed that the interval was a non-drinking water, then the owner could propose Level D as the appropriate level to use.

EXAMPLE 3:

When abandoning an oil and gas facility a responsible party (RP) discovers the site soils have been impacted by petroleum some time in the past facility operation. The source has been removed and the site adequately assessed to define the lateral and vertical extent of the impacted area. The impacted area is relatively small and extends to 8' below ground level. The assessment indicates the material is made up of weathered crude oil up to 30,000 ppm TPH and low BTEX levels, with Benzene up to 0.6 ppm. The carbon range analysis indicates an approximate 5/65/30% distribution between the Table 1 carbon ranges (i.e., C4-C12=1500, C13-C22=19500, C23+ = 9000). The assessment also indicates the area is underlain by a shallow perched water interval at 15' extending to approximately 25'. This water was confirmed as a brackish non-drinking water that has not been impacted by the petroleum components. The first true drinking water aquifer is located at approximately 100' and is separated from the shallower water by a 60-80' clay silt interval. Using Table 1, the RP sees that the impacted area is less than 40' to a non-drinking water thus indicating a Level D screening level. As the shallow water has not been impacted this level would be the most appropriate. However, since the impacted area is also between 40' and 150' to a true drinking water interval, Level B should be reviewed as an initial screening level. At this point the RP has several options:

Option 1: Assume the worst case, most conservative screening level. Proceed immediately with cleanup efforts using the Level B (40-150' above drinking water) as cleanup targets.

Option 2: Propose Level D (non-drinking water) screening levels as target based on the predominate mid to heavy TPH range and low BTEX range of the weathered material (low mobility/solubility), the fact that the shallow perched water has not been impacted over time, the distance to the drinking water, and the existence of the clay silt interval below the perched interval.

INTERIM GUIDANCE FOR REMEDIATION OF PETROLEUM IMPACTED SITES (P.6)

TABLE 1: SOIL SCREENING LEVELS (mg/kg or ppm)

DISTANCE ABOVE GROUND WATER (ft)	<40	40 - 150	>150
ABOVE DRINKING WATER	LEVEL A	LEVEL B	LEVEL C
BTEX + FA	MCL	10MCL	100MCL
TPH			
C4-C12	10	100	1000
C13-C22	100	1000	10000
C23+	1000	10000	10000
ABOVE NON-DRINKING WATER	LEVEL D (FOR ANY DEPTH TO GROUND WATER)		
BTEX + FA	100MCL		
TPH			
C4-C12	1000		
C13-C22	10000		
C23+	15000		

MCLs: B=0.001(ppm), T=0.1(ppm), E=0.68(ppm), X=1.75(ppm), Pb=0.015(ppm), EDB=0.02(ppb), PAH=0.2(ppb)

- FA = fuel additives; lead (Pb), ethylene dibromide (EDB), etc., including other components (i.e., PAH) of petroleum products which have MCLs.
- Use of Table 1 assumes the original source has been removed and an adequate site assessment has been completed.
- For BTEX or FA, each component is not to exceed 1, 10, or 100 times its MCL as specified.
- For TPH, the total allowable for each range is not to be exceeded and the overall total is not to exceed the given value for the heavier TPH (C23+).
- Soil levels below the appropriate Table 1 Level require no action, soil levels above the appropriate Table 1 Level must be remediated to or below provided levels, or a site-specific analysis must be conducted, or justification provided to determine more appropriate levels for an individual site. Ground water monitoring may be required if soil contamination linkage to ground water impact has been confirmed.
- BTEX to be analyzed by EPA Method 8020, or EPA Method 8260 (usually to confirm positive benzene).
- TPH to be analyzed by EPA Methods 418.1 and 8015 (Modified). Ranges of TPH to be analyzed by GC/MS carbon range methods or EPA Method 8015 (DHS Modified). PAH to be analyzed by EPA Method 8310.
- Use of Non-Drinking Water Levels are dictated by either water characteristics as defined and exempted under SWRCB Resolution 88-63 (TDS>3000 mg/L, deliverability <200 gal/day, or existing contamination that can not be reasonably treated), or as agreed upon by Regional Board staff for use at a particular site.
- Minimum clean interval below impacted area to be determined on a site-specific basis by Regional Board staff, generally 40' above drinking waters and 20' above non-drinking waters.

APPENDIX D
LABORATORY ANALYTICAL RESULTS
SOIL VAPOR, 1/95



Superior Precision Analytical, Inc.

A member of ESSCON Environmental Support Service Consortium

CERTIFICATE OF ANALYSIS

Laboratory No.: 80460
Client: REMEDIATION SERVICE INT'L.
Client Job No.: D.P. # 796

Date Received: January 19, 1995
Date Reported: January 20, 1995

Volatile Petroleum Hydrocarbons (VPH) and BTXE by EPA SW-846 5030/8015M/8020

#	Sample ID	Date Sampled	Date Analyzed	Analyte	Conc.	RL	Unit
01	EFF011995	01/19/95	01/19/95	Gasoline	ND	30	ppm-v
				Benzene	ND	85	ppb-v
				Toluene	ND	250	ppb-v
				Ethyl Benzene	ND	65	ppb-v
				Total Xylenes	ND	250	ppb-v
QC	Method Blank	Air	01/19/95	Gasoline	ND	30	ppm-v
				Benzene	ND	85	ppb-v
				Toluene	ND	250	ppb-v
				Ethyl Benzene	ND	65	ppb-v
				Total Xylenes	ND	250	ppb-v

QAQC Summary for : Air

QC Batch : BA192.03

Gasoline	LS/LSD % Recovery = 100/103	Duplicate RPD = 3 %
Benzene	LS/LSD % Recovery = 133/124	Duplicate RPD = 7 %
Toluene	LS/LSD % Recovery = 113/106	Duplicate RPD = 6 %
Ethyl Benzene	LS/LSD % Recovery = 105/100	Duplicate RPD = 5 %
Total Xylenes	LS/LSD % Recovery = 107/101	Duplicate RPD = 6 %

ND = Not Detected
NA = Not Applicable
RL = Reporting Limit

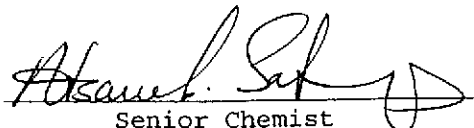

Senior Chemist
Account Manager

TABLE 4

REMEDIAL SYSTEM PERFORMANCE DATA FOR 1994

2844 MOUNTAIN BLVD.
OAKLAND, CA

SUMMARY OF OPERATIONS FOR	Feb-94	Mar-94	Apr-94	May-94	Jun-94	Jul-94	Aug-94	Sep-94	Oct-94	Nov-94	Dec-94	YTD-Sum	Proj.-Sum
Period Beginning	2/8	2/23	3/31	4/28	5/24	6/29	7/28	8/31	9/28	10/26	12/1	2/8/94	6/10/91
Period Ending	2/23	3/31	4/28	5/24	6/29	7/28	8/31	9/28	10/26	12/1	12/30	12/30/94	12/30/94
Days in Period <i>≠ days of operation</i>	15	36	28	26	36	30	33	28	28	36	29	325	1299
Hour meter - begin	775.8	891.2	1217.4	1333	1397.2	1668.8	1973.0	2241.2	2493.3	2738.3	2973.0	—	—
Hour meter - end	891.2	1217.4	1333	1397.2	1668.8	1973.0	2241.2	2493.3	2738.3	2973.0	3172.0	—	—
Hours of Operation	115.4	326.2	115.6	64.2	271.6	304.2	268.2	252.1	245	234.7	199	2396.2	3171.0
Percent Run Time	76.9%	90.6%	41.3%	24.7%	75.4%	100.0%	80.4%	88.7%	88.8%	65.8%	68.1%	73.7%	—
Total Pounds of HC's Removed	2.6	6.2	3.9	2.3	57.3	53.3	14.1	28.0	63.0	7.9	7.0	245.6	1076.7
Total Gallons of HC's Removed	0.5	1.1	0.7	0.4	10.4	9.7	2.6	5.1	11.4	1.4	1.3	44.6	195.5
TPH Concentration of Vapors (ppm-v)	190	330	290	290	1800	1400	430	430	520	82	82	—	—
Average Vapor Flowrate from wells (cfm)	9.2	4.5	10	10	10	10	10	21	40	34	35	18	—
Average Vacuum on wells ("H2O)	24	24	50	50	48	48	40	32	44	50	50	42	—
Average Ambient Temperature (°F)	60	60	70	75	76	69	64	70	51	57	48	64	—
Total Pounds of HC's Removed from vapor	2.6	6.2	3.9	2.2	57.0	50.3	14.1	28.0	63.0	7.9	7.0	242.3	1072.6
Total Gallons of HC's Removed from vapor	0.5	1.1	0.7	0.4	10.4	9.1	2.6	5.1	11.4	1.4	1.3	44.0	194.8
Water Flow Meter - begin	7909.4	7909.4	7909.4	7909.4	8000	8244	11227	13366	13800	14187	17265	—	—
Water Flow Meter - end	7909.4	7909.4	7909.4	8000	8244	11227	13366	13800	14187	17265	21205	—	—
Gallons of Water Treated	0	0	0	90.6	244	2983	2139	434	387	3078	3940	13295.6	21258.8
TPH Concentration of Water (ppm)	30	30	30	120	120	120	0.51	0.51	0.51	0.62	0.62	—	—
Pounds of HC's Removed from Water	0.0000	0.0000	0.0000	0.0907	0.2443	2.9870	0.0091	0.0018	0.0016	0.0159	0.0204	3.3709	7.3578
Gallons of HC's Removed from Water	0.0000	0.0000	0.0000	0.0165	0.0444	0.5424	0.0017	0.0003	0.0003	0.0029	0.0037	0.6121	1.3361

NOTE: Percent run 2/94 - 12/94 time based operation of only 10 hours/day

No water sample collected in 2/94, 3/94 & 4/94, 6/94, 7/94, 9/94, 10/94 & 12/94. TPH concentration used in calculation from earliest prior sampling.

No vapor inlet sample collected in 5/94, 9/94 & 12/94. TPH concentration used in calculation from earliest prior sampling.

Average Vapor Flowrate on wells 5/94, 7/94 & 8/94 from earliest prior reading.

Average Vacuum on wells 3/94 from earliest prior reading.

Average Ambient Temp. 2/94 & 3/94 from earliest prior reading.

ND = Not detected above minimum detection levels.