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**LETTER OF TRANSMITTAL**

PARSONS ENGINEERING SCIENCE, INC.  
2101 Webster Street  
Suite 700  
Oakland, CA 94612  
Phone: (510) 891-9085  
Fax: (510) 835-4355

DATE: March 24, 1998

PARSONS ES PROJECT: 729457

**TO:**  
Alameda County Health Care Services Agency  
Division of Hazardous Materials  
Department of Environmental Health  
1131 Harbor Bay Parkway, Suite 250  
Alameda, CA 94502

**ATTN:** Ms. Pam Evans

**RE:** Redwood Regional Park Site Investigation, Oakland, California - 7867 Redwood Rd

**WE ARE SENDING YOU:**

ATTACHED XXX UNDER SEPARATE COVER \_\_\_\_  
DOCUMENTS XXX OTHER: \_\_\_\_\_  
VIA MAIL XXX EXPRESS MAIL \_\_\_\_ FED EX \_\_\_\_ OTHER: \_\_\_\_\_

QUANTITY	DATE	ITEM
1	3/24/98	Progress Report 12 and Annual Summary Assessment (March 1997 to February 1998), Groundwater and Surface Water Characterization Program at Redwood Regional Park Service Yard, Oakland, California

cc: W. Gee, East Bay Regional Parks District

**REMARKS:**

SIGNED: Bruce M. Rucker  
Bruce M. Rucker, Project Manager

# PARSONS

Parsons Engineering Science, Inc. A Unit of Parsons Infrastructure & Technology Group Inc.  
2101 Webster Street • Suite 700 • Oakland, California 94612 • (510) 891-9085 • Fax (510) 835-4355

March 24, 1998  
Ref: 729457

Ms. Pam Evans  
Alameda County Health Care Services Agency  
Department of Environmental Health, Hazardous Materials  
1131 Harbor Bay Parkway, Suite 250  
Alameda, California 94502

Subject: Progress Report 12 and Annual Summary Assessment: (March 1997 to February 1998)  
Redwood Regional Park Service Yard, Oakland, California

Dear Ms. Evans:

Please find attached the referenced report for the site investigation at Redwood Regional Park Service Yard, Oakland, California. This report describes March 1997 through February 1998 site characterization activities and summarizes historical activities related to the two former leaking underground fuel storage tanks at the site.

Please note our report's recommendations, including:

- Discontinue sampling in monitoring well MW-5 and at surface water location SW-1;
- Evaluate the discontinuation of well purging prior to sampling;
- Reduce the frequency of ground water sampling from quarterly to annual; and
- Reduce the frequency of surface water sampling from semi-annual to annual.

Please contact me or Mr. Ken Berger of EBRPD regarding Alameda County's position on our implementation of these recommendations, or if you have any questions.

Very truly yours,

PARSONS ENGINEERING SCIENCE, INC.

*Bruce M. Rucker*

Bruce M. Rucker  
Project Manager

*Frederick T. Stanin* for FT Stanin  
Frederick T. Stanin, R.G., C.E.G., C.H.G.  
Principal Geologist

cc: W. Gee, East Bay Regional Parks District

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**Quarterly Progress Report 12 and Annual Summary Assessment  
(March 1997 to February 1998)**

**REDWOOD REGIONAL PARK SERVICE YARD, OAKLAND, CALIFORNIA**

*Prepared for*

**EAST BAY REGIONAL PARKS DISTRICT  
Oakland, California**

**March 1998**

*Prepared by*

**PARSONS ENGINEERING SCIENCE, INC.**  
2101 WEBSTER STREET, SUITE 700, OAKLAND, CA 94612 • 510/891-9085  
OFFICES IN PRINCIPAL CITIES

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## TABLE OF CONTENTS

	<u>Page</u>
LIST OF FIGURES .....	iii
LIST OF TABLES .....	iii
EXECUTIVE SUMMARY .....	iv
SECTION 1 INTRODUCTION	
1.1 Site Description and History .....	1-1
1.2 Previous Site Investigations .....	1-1
SECTION 2 SITE HYDROGEOLOGY	
2.1 Geology .....	2-1
2.2 Hydrology.....	2-1
SECTION 3 CURRENT QUARTER ACTIVITIES	
3.1 Groundwater Level Monitoring and Sampling .....	3-1
3.2 Creek Surface Water Sampling .....	3-2
SECTION 4 EVALUATION OF RESULTS	
4.1 February 1998 Groundwater and Surface Water Analytical Results ..	4-1
4.2 Summary of Groundwater and Surface Water Chemistry.....	4-3
SECTION 5 REGULATORY CONSIDERATIONS	
5.1 Relevant Criteria for Groundwater and Surface Water .....	5-1
5.2 Groundwater and Surface Water Regulatory Evaluation .....	5-2
SECTION 6 RECOMMENDATIONS.....	6-1
REFERENCES .....	R-1
APPENDIX A Historical Groundwater Elevation Maps	
APPENDIX B February 1998 Water Level Data and Groundwater Monitoring Notes	
APPENDIX C February 1998 Chain-of-Custody Record and Analytical Laboratory Report	

## LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1.1 Site Location Map .....	1-2
1.2 Site Plan.....	1-3
2.1 Cross Section A-A' Location .....	2-2
2.2 Cross Section A-A' .....	2-3
2.3 Groundwater Elevation Map, February 4, 1998 .....	2-5
4.1 Historical Groundwater Analytical Results - Four Quarter Moving Average: Well MW-4.....	4-4

## LIST OF TABLES

<u>Table</u>	<u>Page</u>
3.1 Groundwater Monitoring Well Construction Data.....	3-1
4.1 Groundwater and Creek Surface Water Sample Analytical Results - February 4, 1998.....	4-2
4.2 Groundwater Analytical Summary.....	4-5
4.3 Creek Surface Water Analytical Summary.....	4-7

**EXECUTIVE SUMMARY**  
**PROGRESS REPORT 12**  
**and**  
**ANNUAL SUMMARY ASSESSMENT**

This report presents the results of the February 1998 groundwater and surface water monitoring event conducted by Parsons Engineering Science, Inc. (Parsons) at the Redwood Regional Park Service Yard, Oakland, California. This report also summarizes the third year of quarterly groundwater monitoring and sampling, conducted between March 1997 and February 1998, which has been conducted under the oversight of the Alameda County Health Care Service Agency, Department of Environmental Health, Hazardous Materials Division (ACHCSA). The report also contains a regulatory evaluation of site contamination, and presents recommendations for revising the current groundwater and surface water sampling program.

Current quarter activities described in this report include:

- Collection of static water levels from available wells to evaluate the local groundwater flow direction.
- Laboratory analysis of groundwater samples from three of the site wells for total petroleum hydrocarbons in the gasoline and diesel ranges (TPH-G,-D) and aromatic hydrocarbons (benzene, toluene, ethylbenzene and total xylenes [BTEX]). The ACHCSA approved discontinuation of sampling wells MW-1, MW-3, and MW-6 following the August 1995 event due to lack of detectable fuel analytes in groundwater in these wells over four consecutive quarters of monitoring.
- Collection and laboratory analysis of creek surface water samples for TPH-G, TPH-D and BTEX.

Local Groundwater Flow Direction. Static water level elevations measured during the current event confirm the northeast to southwest local groundwater flow direction at the site. This direction of groundwater flow is consistent with data collected during previous events.

Groundwater Chemistry. Concentrations of all fuel analytes have shown a generally decreasing trend since groundwater monitoring was initiated in 1994 (12 events). Downgradient well MW-4 continues to show greater fuel concentrations than that in source-area well MW-2, indicating that the fuel plume in groundwater has migrated at least 100 feet downgradient of the source area. Algal blooms observed in well MW-4 suggest that a bacterial population may be utilizing the petroleum carbon as a food source. Seasonal maxima of fuel concentrations in wells MW-2 and MW-4 are generally observed during the February monitoring events (corresponding to periods of significant precipitation). In the past year of monitoring, only benzene was detected at concentrations in excess of regulatory agency standards for drinking water. Concentrations of ethylbenzene and xylenes exceeded proposed secondary drinking water standards. No fuel analytes have been detected in

transgradient well MW-5 since 1996 (six events). The spatial extent of fuel analytes in groundwater is well defined by the site wells.

Creek Surface Water Chemistry. Surface water samples have been collected from Redwood Creek from February 1994 through February 1998. The only fuel analyte detected at upstream location SW-1 was gasoline, which was detected only in 1994 and just above the method reporting limit. Groundwater seepage into the creek bank and associated petroleum sheen and discolored soil have been observed downgradient of the former UFSTs, at creek sampling location SW-2. Fuel analytes have been detected at that location in three events, including February 1994, August 1996 and August 1997. The presence of algal blooms on the creek water surface has been observed during periods when petroleum sheen is present at this location, suggesting that the fuel serves as a carbon source for the organisms. Gasoline and diesel have been detected once each (May and August 1996) at downstream location SW-3 at concentrations just above the method reporting limit.)

Regulatory Evaluation. Groundwater at the project site is not a current drinking water source, but may constitute a potential drinking water source based on the measured electrical conductivity and the inferred sustained yield. Groundwater chemistry may therefore be evaluated by regulatory agencies with respect to Maximum Contaminant Levels (MCLs) for drinking water. Additionally, groundwater and surface water quality data may be considered with respect to numerical water quality objectives (WQOs) for Redwood Creek and Upper San Leandor Reservoir, which are considered inland surface water bodies.

Fuel analytes detected in groundwater in excess of drinking water standards or WQOs in the previous year of monitoring include benzene, ethylbenzene and total xylenes. Benzene is the only analyte detected in creek surface water samples in excess of WQOs. The samples collected provide instantaneous concentrations, and are not comparable to the 30-day average concentration specified in the WQO. BTEX constituents have never been detected in the downstream sampling location (SW-3), hence it is unlikely that site-sourced groundwater or surface water contamination would impact Upper San Leandro Reservoir.

Recommendations. Based on the data presented in this and previous reports, Parsons recommends continuation of the established groundwater and creek surface water monitoring program, with the following revisions.

- Discontinue hydrochemical monitoring in transgradient well MW-5 based on the absence of significant detectable contamination.
- Reduce the frequency of sampling in wells MW-2 and MW-4 from quarterly to annually, as seasonal hydrochemical fluctuations are well established. Conduct annual sampling in February when annual fuel concentrations are greatest.
- Evaluate the discontinuation of purging wells MW-2 and MW-4 prior to collecting groundwater samples, in accordance with a 1997 ACHCSA recommendation.
- Discontinue surface water sampling at Redwood Creek upstream location SW-1.

- Reduce the frequency of surface water sampling at locations SW-2 and SW-3 from semi-annual to annual. Conduct the annual sampling event between May and August when fuel concentrations in surface water show the annual maxima.



## SECTION 1

### INTRODUCTION

This report presents the results of the February 1998 groundwater sampling event, and summarizes the results of the third year of the quarterly groundwater and surface water monitoring program at the Redwood Regional Park Service Yard in Oakland, Alameda County, California. The ongoing investigation being conducted by Parsons Engineering Science, Inc. (Parsons) (formerly Engineering-Science, Inc. [ES]) is designed to characterize and evaluate the extent and magnitude of surface water and groundwater contamination associated with two former underground fuel storage tanks (UFSTs) which contained gasoline and diesel fuel.

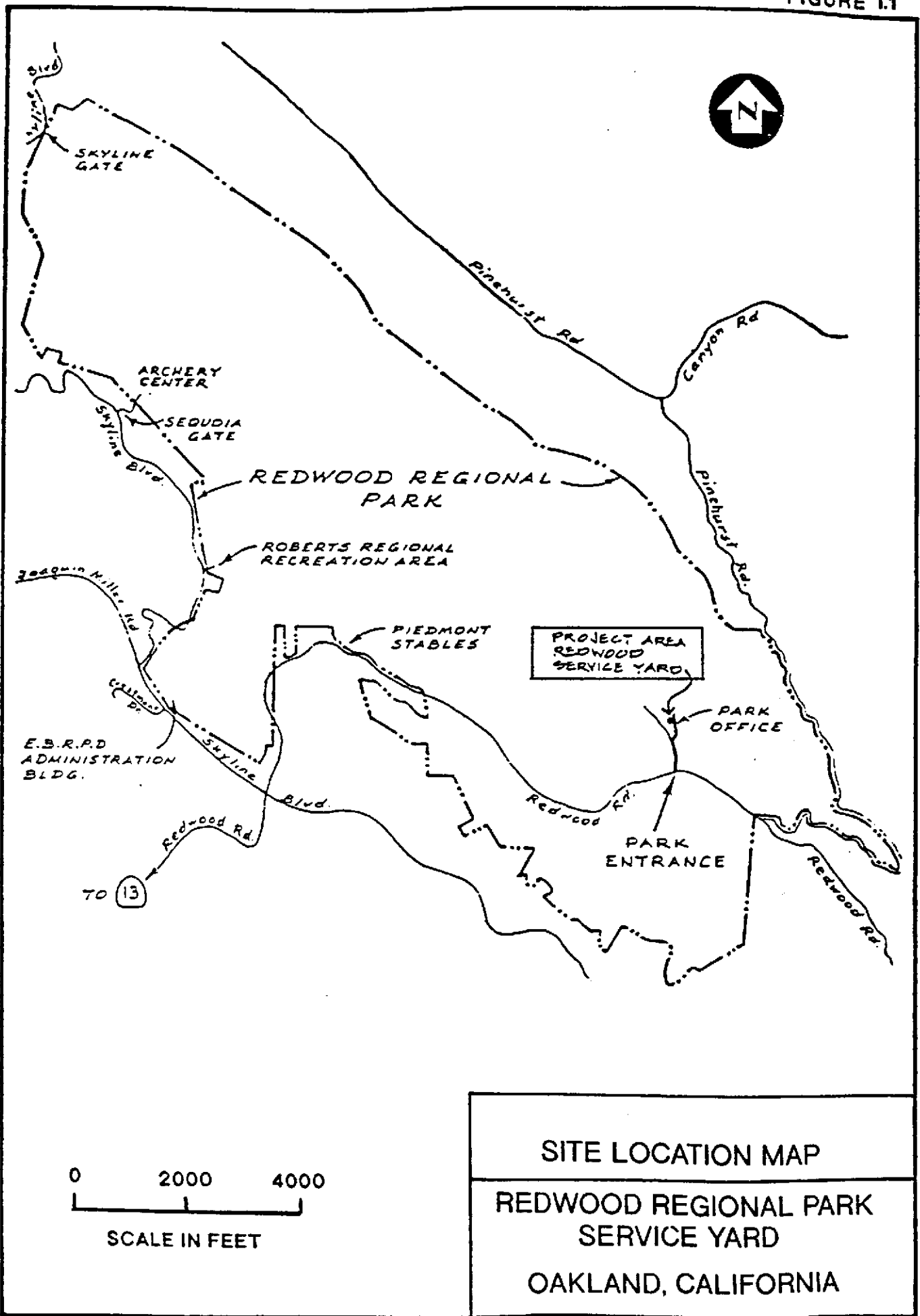
#### 1.1 SITE DESCRIPTION AND HISTORY

The project site is located at **7867 Redwood Road in Oakland**, Alameda County, California. Figure 1.1 shows the location of the project site. The site slopes to the west, from an elevation of approximately 564 feet above mean sea level (MSL) at the eastern edge of the service yard to approximately 545 feet above MSL at Redwood Creek, which approximately defines the western edge of the project site. Figure 1.2 is a site plan of the project site.

The project site is a service yard for Redwood Regional Park, and utilized two UFSTs (one 2,000-gallon diesel fuel and one 5,000-gallon unleaded gasoline) from the mid-1960's to 1993. Figure 1.2 shows the location of the UFSTs. Both UFSTs were reportedly installed between 1965 and 1968 (Parsons 1993a). The 5,000-gallon steel UFST contained unleaded gasoline and was reportedly a converted channel buoy purchased from the Navy (Parsons 1993a). The tanks and piping underwent integrity testing in 1984, 1986, 1988 and 1989. The unleaded gasoline UFST system failed the 1988 and 1989 tests (Parsons 1993a).

#### 1.2 PREVIOUS SITE INVESTIGATIONS

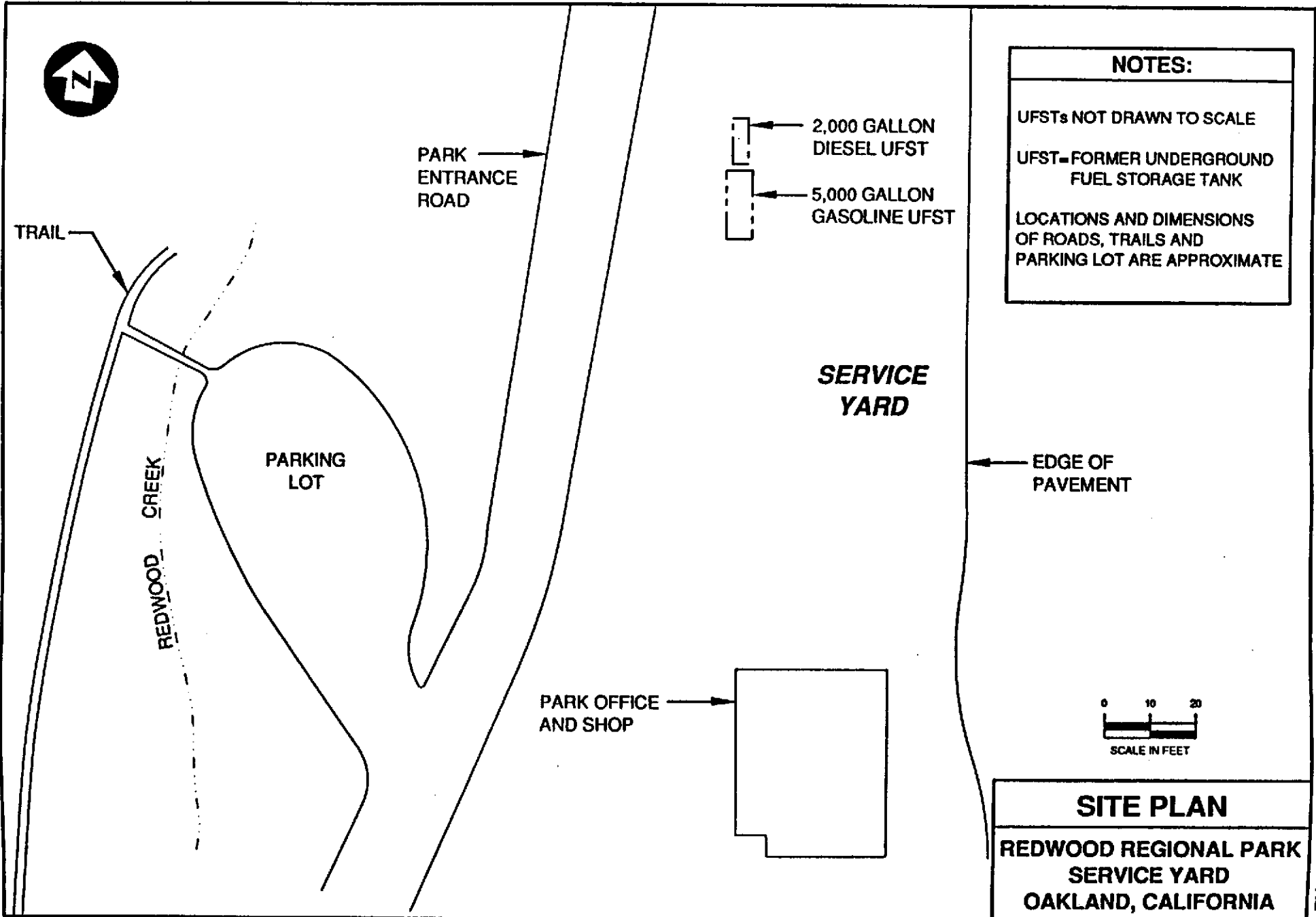
Documented fuel analytes in soil, groundwater and surface water at the project site is the result of leaks from the former UFSTs. Soil and groundwater characterization and remediation activities related to the former UFSTs has been conducted by Parsons since April 1993. Detailed discussions and evaluations are given in previous reports and workplans (Parsons 1993a, 1993b, 1994a, 1994b, 1994c, 1994d, 1995a, 1995b, 1995c, 1996a, 1996b, 1997a, 1997b, 1997c, 1997d and 1998). The following summarize the results of investigations conducted prior to the most recent (February 1998) sampling event.



SITE LOCATION MAP

REDWOOD REGIONAL PARK  
SERVICE YARD

OAKLAND, CALIFORNIA



TRAIL

REDWOOD CREEK

PARKING LOT

PARK ENTRANCE ROAD

SERVICE YARD

PARK OFFICE AND SHOP

EDGE OF PAVEMENT

0 10 20  
SCALE IN FEET

FIGURE 1.2

### 1.2.1 UFST Closure and Soil Remedial Activities

The two project site UFSTs were excavated and transported off-site for disposal in April 1993, at which time discolored soil was observed in the excavation pit below the gasoline UFST location. Initial confirmation soil samples collected from beneath each UFST indicated soil impacts by total petroleum hydrocarbons - gasoline (TPH-G) range and aromatic hydrocarbons (benzene, toluene, ethylbenzene and total xylenes [BTEX]) (Parsons 1993a). No elevated levels of lead were detected in those soil samples.

Approximately 600 cubic yards of contaminated soil in the vicinity of the UFSTs were excavated and stockpiled for on site aeration in June 1993. The excavation covered a surface area of approximately 5,000 square feet, and had a maximum depth of approximately 25 feet (below grade relative to the eastern edge of the excavation). Soil excavation activities were halted due to the potential for slope instability, the presence of significant facility constraints (roads and buildings) and the infiltration of spring water into the excavation.

Five confirmation excavation soil samples were collected by Parsons in June 1993 prior to excavation backfilling. Discolored soil was noted only in the eastern wall of the excavation. However, confirmation soil samples from other areas contained up to 1,700 parts per million by volume (ppmv) total ionizable vapors as measured with a photoionization detector (PID) and a total hydrocarbon vapor analyzer (THVA). **Maximum concentrations detected in excavation confirmation soil samples include 12,000 milligrams per kilogram (mg/Kg) TPH-G, 1,300 TPH-D, 80 mg/Kg benzene, 390 mg/Kg toluene, 230 mg/Kg ethylbenzene and 1,100 mg/Kg total xylenes (Parsons 1993c).**

The excavation was backfilled between June and August 1993 with previously excavated clean overburden (estimated 270 cubic yards) and imported fill (estimated 330 cubic yards) and the surface was repaved with asphalt.

The approximately 600 cubic yards of contaminated soil were stockpiled on plastic sheeting at an open area behind the Redwood Park Fire Station #2 located on Redwood Road approximately 500 feet east of the project site. Confirmation soil samples were collected from the stockpiled soil in July 1993, and aeration of the stockpiled, contaminated soil began in August 1993 (Parsons 1993a). Following Alameda County Health Care Services Agency, Environmental Health Department, Hazardous Materials Division (ACHCSA) approval, **the soil was relocated to Sibley Regional Preserve in Contra Costa County, California for further aeration and final disposition at that site (EBRPD 1995).**

### 1.2.2 Initial Site Characterization

Following a request by ACHCSA, Parsons submitted a technical workplan (Parsons 1993b) and conducted an initial site characterization in September and October 1993 in the vicinity of the former UFST excavation. The objective of the program was to evaluate the nature, magnitude and extent of soil and groundwater contamination associated with the residual UFST-sourced soil contamination. Tasks conducted included: advancing 17 exploratory borings and converting five to temporary well points; collecting 27 soil and five "grab" groundwater samples for laboratory analysis; and measurement of static water levels (Parsons 1993c). **No significant soil contamination was detected in soil borings immediately**

north, south or east of the former UFST remedial excavation. Fuels in soil were detected in soil borings up to 90 feet southwest of the former UFST excavation. Maximum soil concentrations detected included 1,900 mg/Kg TPH-G, 1,300 mg/Kg TPH-K and 125 mg/Kg BTEX constituents. Maximum fuel concentrations detected in groundwater collected from temporary well points included 810,000 µg/L TPH-G, 2,300,000 µg/L TPH-K, 570 µg/L TPH-D and 125,000 µg/L BTEX (including 12,000 µg/L benzene) (ES 1993c).

### 1.2.3 Creek Soil and Surface Water Sampling

Following observation of an area of discolored soil in the bed of Redwood Creek southwest of the former UFSTs, soil and surface water samples were collected for laboratory analysis in February and March 1994 (Parsons 1994a and 1994b). One soil sample was collected in February 1994 for laboratory analysis from the discolored soil. That sample contained 3 mg/Kg of TPH-D; neither TPH-G nor BTEX constituents were detected. Field observations have indicated the presence of both a petroleum sheen and an orange algae on the creek water surface in the area of the discolored soil suggesting that the fuel is acting as a carbon source for the algae. Surface water samples have been collected from Redwood Creek at locations upstream, downstream, and in the immediate vicinity of the area of discolored soil, when surface water is available, since February 1994. Figure 2.3 shows these sampling locations and Section 4 provides a detailed discussion of analytical results.

### 1.2.4 Revisions to Sampling Program

Approval was granted for discontinuing hydrochemical monitoring of wells MW-1, MW-3 and MW-6 following the August 1995 monitoring event due to lack of detectable fuel analytes in groundwater in those wells, and for reducing the frequency of creek surface water sampling from quarterly to semi-annually (ACHCSA 1996a).

The following conclusions regarding the extent of fuels in soil, groundwater, and surface water are based on the data collected by Parsons prior to February 1998:

- Soil excavation activities were effective in reducing the majority of fuels in soil on the immediate vicinity of the former UFSTs to concentrations less than regulatory agency action levels.
- Capillary fringe soils in the bank of Redwood Creek and groundwater impacted by TPH and BTEX above regulatory agency action levels were detected up to 130 feet southwest (downgradient) of the UFST source area.
- Surface water in Redwood Creek has been historically impacted by TPH-G and BTEX, generally in periods of low creek flow.

## SECTION 2

### SITE HYDROGEOLOGY

The following evaluation of the hydrogeologic conditions at the project site is based on geologic logging and water level measurements collected at the site by Parsons beginning in September 1993. This section summarizes site geology and groundwater and surface water hydrology.

#### 2.1 GEOLOGY

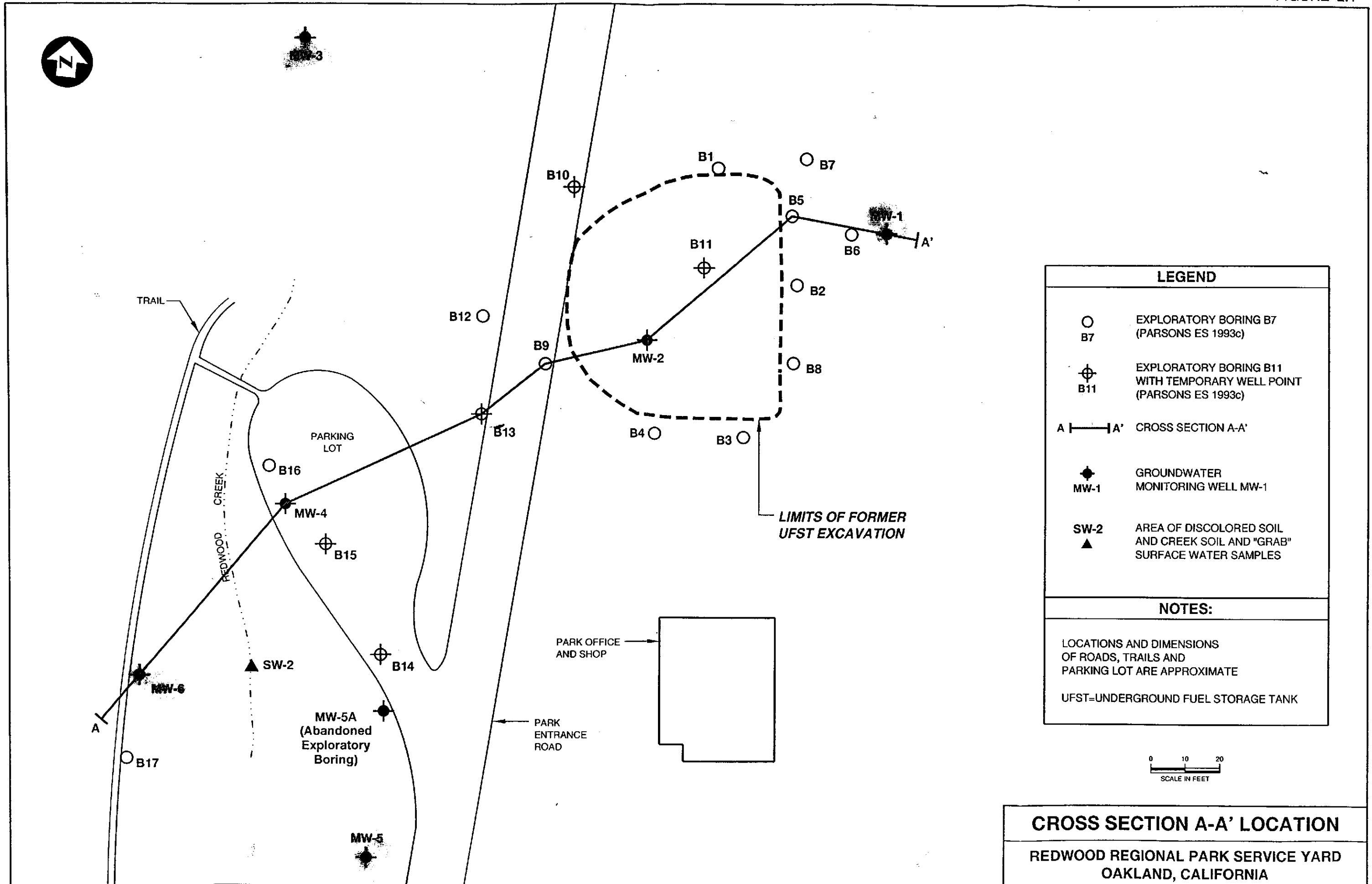
The site is located approximately seven miles east of the southeastern shoreline of San Francisco Bay, within the Coast Ranges physiographic province of California. The San Francisco Bay Area is an elongate structural depression bounded by the Santa Cruz Mountains on the west and the Diablo Range on the east. The Berkeley Hills are encompassed by the Diablo Range.

The San Francisco Bay Area is a seismically active region. The area's main geologic structures are associated with two major faults: the San Andreas Fault in the Santa Cruz Mountains and the Hayward Fault which forms the western boundary of the Diablo Range. The Diablo Range has been uplifted and the bay has gradually subsided over the last three million years. The site is located approximately 2.5 miles east of the Hayward Fault (Norris and Webb 1990, Nilsen et. al. 1979).

The bedrock in these mountain ranges is composed of sedimentary, metamorphic and volcanic rocks of Jurassic through Tertiary age (Borchardt et. al. 1975). Overlying the bedrock in Redwood Creek canyon is Quaternary alluvium consisting of silt, sand and gravel. Subsurface stratigraphy at the site is illustrated in cross section A-A' (Figures 2.1 and 2.2) based on soil boring data acquired during the 1993 initial site characterization and the November 1994 well installation program. Shallow soil stratigraphy consists of a surficial three to ten foot-thick clayey silt unit underlain by a five- to fifteen- foot thick silty clay unit. In all monitoring well borings, a five- to ten-foot thick clayey coarse-grained sand and clayey gravel unit was encountered that laterally grades to a clay or silty clay. This unit overlies a weathered siltstone at the base of the observed soil profile. Soils in the vicinity of MW-1 are inferred to be landslide debris.

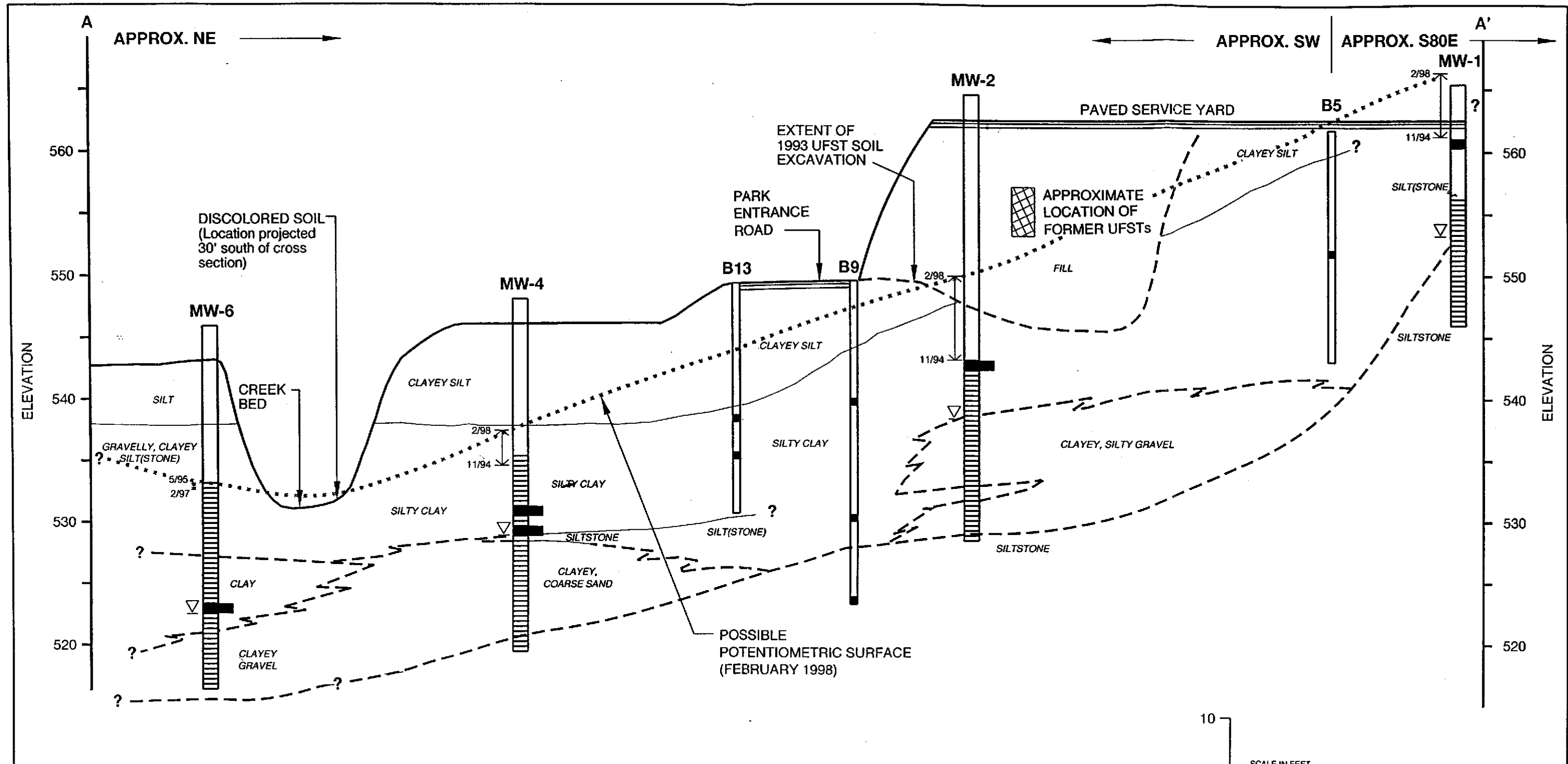
#### 2.2 HYDROLOGY

Redwood Creek borders the site to the west and is a seasonal creek known for the occurrence of Rainbow Trout. The site lies approximately one mile upstream (northwest) of Upper San Leandro Reservoir.



**CROSS SECTION A-A' LOCATION**  
**REDWOOD REGIONAL PARK SERVICE YARD**  
**OAKLAND, CALIFORNIA**

FIGURE 2.2



LEGEND		NOTES:
	B1 EXPLORATORY BORING B1	LOCATIONS AND DIMENSIONS OF ROADS, TRAILS AND PARKING LOT ARE APPROXIMATE UFST=UNDERGROUND FUEL STORAGE TANK UFSTs NOT DRAWN TO SCALE ALL ELEVATIONS SURVEYED BY EBRPD RELATIVE TO UNITED STATES GEOLOGICAL SURVEY (USGS) SURVEY BENCHMARK NO. JHF-49 AND ARE EXPRESSED AS FEET ABOVE MEAN SEA LEVEL (MSL) WELL CASING AND BORING WIDTHS NOT TO SCALE
	LOCATION OF SOIL SAMPLE COLLECTED FOR LABORATORY ANALYSIS	
	FIRST ENCOUNTERED GROUNDWATER DURING DRILLING (10/94)	
	MW-1 MONITORING WELL MW-1	
	WELL SCREEN INTERVAL	
	2/98 11/94 RANGE OF STATIC WATER LEVELS MEASURED BETWEEN NOVEMBER 1994 AND FEBRUARY 1998 SHOWING DATES OF MEASURED MAXIMA AND MINIMA	

**CROSS SECTION A-A'**  
**REDWOOD REGIONAL PARK SERVICE YARD**  
**OAKLAND, CALIFORNIA**

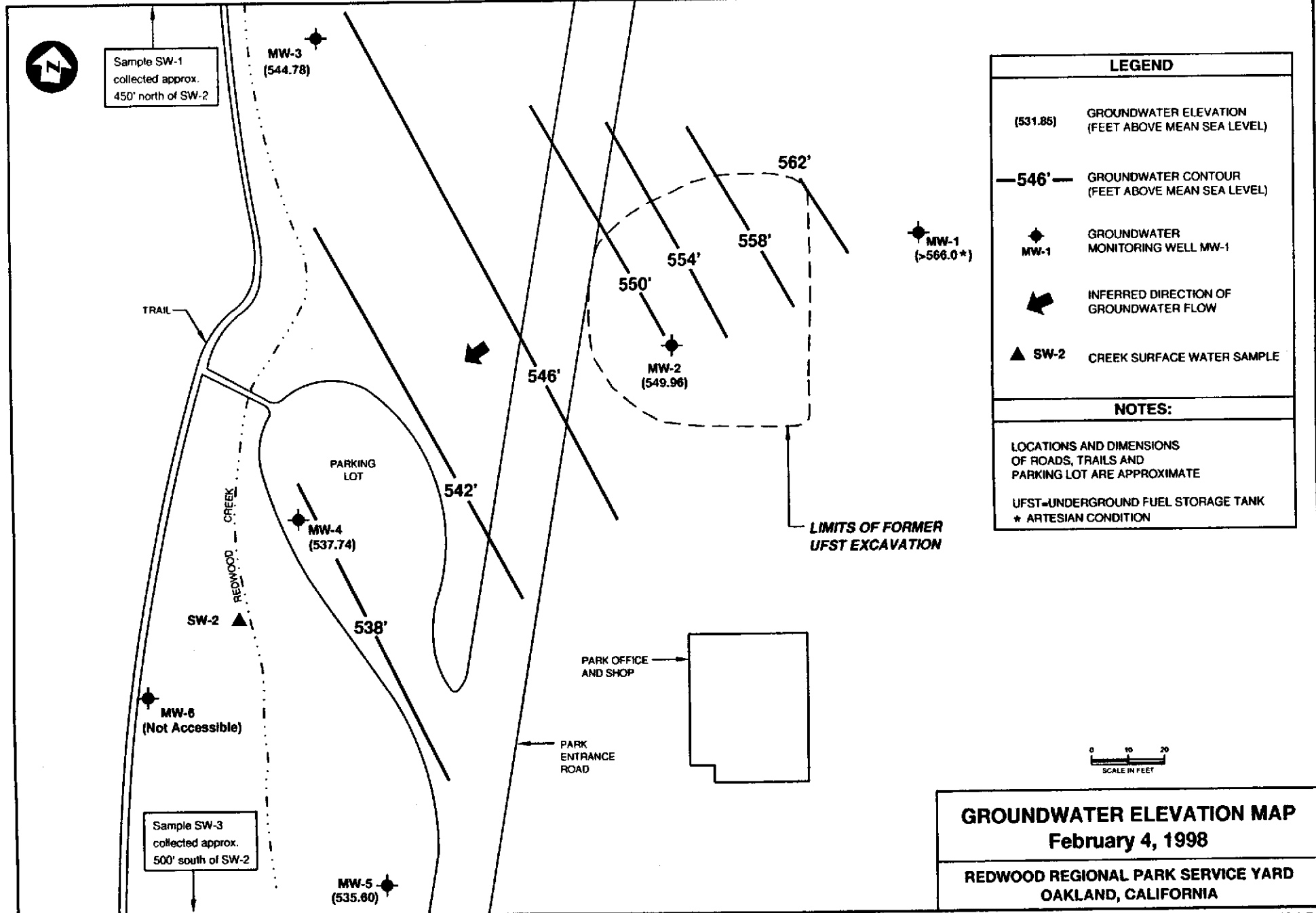


Groundwater at the site occurs under predominantly unconfined conditions, as evidenced by the equilibrated static water levels relative to the water level in Redwood Creek and the level of water seepage out of the north face of the former excavation. Groundwater seepage into Redwood Creek is indicated by historical observations of fuel-contaminated capillary fringe soils in the eastern bank of Redwood Creek (Parsons 1994d). Groundwater was first observed at the top of the clayey, silty sand-gravel zone in all monitoring well borings except MW-1. First occurrence of groundwater during drilling was encountered from approximately 3 to 25 feet bgs, and equilibrated water levels ranged from 2 to 18 feet bgs (Parsons 1993c and Appendices B and C). The difference between first occurrence of groundwater and equilibrated water level ranged from 0 to 13 feet. These differences were the greatest in areas east of the road and were much less west of the road. Figure 2.2 shows the range of static water levels measured in site wells between November 1994 and February 1998.

Figure 2.3 is a groundwater elevation map constructed from the February 1998 monitoring well static water levels. The direction of local groundwater flow in the portion of the study area east of Redwood Creek is from northeast to southwest. This groundwater flow direction is consistent with previously recorded measurements made in site wells and boreholes since September 1993. For comparison, historical groundwater elevation maps are presented in Appendix A. It is inferred that local groundwater flow direction west of Redwood Creek is toward the east (toward the creek). The groundwater gradient is approximately 0.1 feet per foot between wells MW-2 and Redwood Creek, and is approximately 2 feet per foot between well MW-1 and the former UFST source area. The increased groundwater gradient in that area is inferred to result from the topography and the highly disturbed nature of sediments in the landslide debris. A static groundwater level above the ground surface was noted in well MW-1 in the February 1998 event.

As discussed above, the materials encountered at the water table in borings in the vicinity of the former UFSTs are predominantly clayey silt and silty clay. A hydraulic conductivity value of approximately 0.003 ft/day and an effective porosity value of 30 percent are representative values of these parameters for this soil type (Fetter 1988). Given a groundwater gradient of 0.1 feet per foot as estimated from static water level measurements west of the UFST source area, the average linear groundwater velocity would be approximately 0.4 feet per year. Materials encountered a few feet below the water table in five of the six monitoring wells include a five- to ten-foot thick clayey coarse-grained sand/clayey gravel unit. This is probably the major water-transmitting unit in the observed soil profile. A hydraulic conductivity value of approximately 0.05 ft/day and an effective porosity of 35 percent are representative of these parameters for this soil type (Fetter 1988), yielding an average linear groundwater velocity of approximately five feet per year (approximately ten times the value for the upper silty clay, clayey silt unit). These values are approximations only, and actual groundwater velocities could vary substantially. There is no comprehensive data on groundwater hydrology in the area of the project site (ACFCWCD 1988).

FIGURE 2.3



provides access to that well. All water level measurements were made using an electric water level indicator.

Groundwater sampling of MW-2, MW-4, and MW-5 was conducted in accordance with state of California guidelines for sampling dissolved analytes in groundwater associated with leaking UFSTs (State Water Resources Control Board 1989). Prior to collection of groundwater samples, a pre-cleaned Teflon™ bailer or submersible pump was used to purge a minimum of three casing volumes from each well. Electrical conductivity (EC), hydrogen ion index (pH), and temperature (T) of purge water were measured during well purging, to document the stabilization of formation-water in the wells. Appendix B includes water level data and groundwater monitoring field notes from the groundwater monitoring event.

Glass sample containers were filled with sample water from a pre-cleaned Teflon™ bailer. The water samples collected from wells MW-2 and MW-4 had a petroleum odor. Purge water from well MW-4 contained what appeared to be the same orange-colored algae that has been previously observed on the surface of Redwood Creek in the vicinity of the groundwater seep in the creek bank immediately downgradient of well MW-4.

To prevent cross-contamination, groundwater sampling equipment was decontaminated prior to use and between each monitoring well with an Alconox™ wash followed by three deionized water rinses. Following sample collection, sample containers were labeled, placed in a cooler packed with "blue ice," and transported under chain-of-custody the same day to a laboratory accredited by the California Environmental Protection Agency (Cal EPA) Department of Health Services (DHS) Environmental Laboratory Accreditation Program (ELAP). Chain-of-custody records for the groundwater samples are included in Appendix C. A total of approximately 75 gallons of purge water and decontamination rinsate from the current groundwater sampling event was containerized in the on-site plastic tank. It is anticipated that site purge water will continue to be accumulated in this on-site tank until it is full, at which time it will be transported by a licensed waste hauler to a permitted wastewater facility.

### 3.2 CREEK SURFACE WATER SAMPLING

Surface water samples were collected on February 4, 1998 from locations SW-1, SW-2, and SW-3 in Redwood Creek (Figure 2.3). Surface water samples were collected in a new glass sampling container by immersing the container just under the water surface, transferring the sample to the appropriate container, and immediately capping the containers, which were then labeled, chilled and transported under chain-of-custody the same day to the analytical laboratory. **No petroleum sheen or odor was noted in any of the surface water samples.** At the time of sampling, the creek was flowing extremely vigorously and had a water depth of several feet at the sampling locations.

## SECTION 4

### EVALUATION OF RESULTS

This section describes the results of the 12th (February 1998) groundwater and surface water sampling event. Also presented is a summary of the groundwater and surface water results from the previous 11 sampling events (November 1994 through December 1997).

#### 4.1 FEBRUARY 1998 GROUNDWATER AND SURFACE WATER ANALYTICAL RESULTS

The current groundwater and surface water monitoring and sampling program is consistent with the Parsons workplan for groundwater characterization at the site (Parsons 1994c). Groundwater and surface water samples collected in February 1998 were analyzed for the following constituents:

- TPH-G by the California DTSC Leaking Underground Fuel Tank (LUFT) Manual Method (equivalent to modified EPA Method 8015, and equivalent to Total Volatile Hydrocarbons -gasoline range [TVH] as reported on the analytical laboratory report)
- TPH-D by the California DTSC LUFT Manual Method (equivalent to modified EPA Method 8015, and equivalent to Total Extractable Hydrocarbons - diesel range [TEH] as reported on the analytical laboratory report)
- BTEX by EPA Method 8020

##### 4.1.1 Groundwater Samples

Table 4.1 summarizes groundwater sample analytical results from the February 1998 groundwater sampling event. The maximum concentrations of fuel analytes in groundwater were detected in downgradient well MW-4, including TPH-G (5,500 µg/L) and TPH-D (340 µg/L). The maximum concentration of total BTEX constituents (1,112 µg/L) was detected in well MW-2. The maximum concentration of benzene detected in the current event was 270 µg/L in well MW-2. No analytes of concern were detected in well MW-5.

##### 4.1.2 Creek Surface Water

Surface water samples collected from Redwood Creek (Figure 2.3) were analyzed for TPH-G, TPH-D and BTEX. None of these constituents were detected in any of the surface water samples.

**TABLE 4.1**  
**GROUND WATER AND CREEK SURFACE WATER SAMPLE ANALYTICAL**  
**RESULTS**  
**February 4, 1998**  
**Redwood Regional Park Service Yard, Oakland, California**

Compound:	Concentration ( $\mu\text{g/L}$ )					
	TPH-G	TPH-D	Benzene	Toluene	Ethylbenzene	Total Xylenes
<b>Groundwater Samples</b>						
MW-2	2,000	200 <sup>(c)</sup>	270	92	150	600
MW-4	5,300	340 <sup>(c)</sup>	110	24 <sup>(b)</sup>	320	402
MW-4 <sup>(a)</sup>	5,500	NA	110	24 <sup>(b)</sup>	340	434
MW-5	< 50	< 50	< 0.5	< 0.5	< 0.5	< 0.5
<b>Creek Surface Water Samples</b>						
SW-1	< 50	< 50	< 0.5	< 0.5	< 0.5	< 0.5
SW-2	< 50	< 50	< 0.5	< 0.5	< 0.5	< 0.5
SW-3	< 50	< 50	< 0.5	< 0.5	< 0.5	< 0.5

**Notes:**

- (a) = Quality control field duplicate sample designated MW-0A on the chain-of-custody and analytical laboratory report
- (b) = Presence of this compound confirmed by second column, however the confirmation concentration differed from the reported concentration by more than a factor of two.
- (c) = Sample exhibits lighter hydrocarbon fuel pattern than the indicated standard.
- TPH-G = Total petroleum hydrocarbons - gasoline range (equivalent to total volatile hydrocarbons - gasoline range)
- TPH-D = Total petroleum hydrocarbons - diesel ranges (equivalent to total extractable hydrocarbons - diesel range)
- NA = Not Analyzed
- $\mu\text{g/L}$  = Micrograms per liter, equivalent to parts per billion (ppb)

**4.1.3 Quality Control Sample Analytical Results**

Two types of field quality control (QC) samples were used to assess whether field or laboratory procedures affected analytical results of the current groundwater sampling event. One equipment rinse blank (MW-0B) was collected following sampling and equipment decontamination activities at well MW-4 to monitor potential cross-contamination in the field due in the event of inadequate decontamination of sampling equipment. That sample was analyzed for TPH-G and BTEX; none of these constituents were detected, verifying the integrity of field decontamination procedures and sample containers.

One field duplicate sample (MW-0A) was collected from well MW-4 and analyzed for TPH-G and BTEX to assess whether field procedures produced reproducible results. For detected compounds, relative percent differences (RPDs) (aka, variance from the mean) in concentration between the field and duplicate samples included: 3.7% (TPH-G); 0.0% (benzene); 0.0% (toluene); 6.1% (ethylbenzene); and 7.7% (total xylenes). These data suggest very good reproducibility of laboratory analyses.

Laboratory QC samples (e.g. method blanks, matrix spikes, surrogate spikes, etc.) were analyzed by the laboratory in accordance with requirements of each analytical method. All laboratory QC sample results and sample holding times were within the acceptance limits of the methods (Appendix C).

## 4.2 SUMMARY OF GROUND WATER AND SURFACE WATER CHEMISTRY

The following summarizes available data regarding detected groundwater and surface water chemistry at the project site, collected by Parsons since September 1993. Documentation of specific analytical methods and individual analyses may be found in the referenced documents.

### 4.2.1 Groundwater

Maximum fuel concentrations in groundwater detected in temporary well points installed in September 1993 included 810,000  $\mu\text{g/L}$  TPH-G, 2,300,000  $\mu\text{g/L}$  TPH-K, 570  $\mu\text{g/L}$  TPH-D and 125,000  $\mu\text{g/L}$  BTEX (including 12,000  $\mu\text{g/L}$  benzene) (ES 1993c).

Table 4.2 summarizes groundwater analytical results collected during quarterly monitoring of the six site groundwater monitoring wells since November 1994.

Analytes of concern were not detected in wells MW-1 (upgradient), MW-3 (transgradient) and MW-6 (downgradient) over the four quarters of monitoring prior to their removal from the hydrochemical monitoring program, except for a detection of BTEX (0.8  $\mu\text{g/L}$ ) attributable to cross-contamination from field equipment. These data indicate that the lateral extent of the fuel plume in groundwater is confined to the area bounded by these perimeter wells.

In transgradient well MW-5, TPH-G has been detected only three times in 12 events, and only once (80  $\mu\text{g/L}$ ) since August 1996. TPH-D has never been detected in MW-5 and the only BTEX constituent detected was benzene (0.6  $\mu\text{g/L}$ ) in February 1995.

Well MW-2 was installed immediately downgradient from the source area. Prior to February 1998, TPH-D was not detected in well MW-4, and concentrations of TPH-G and total BTEX constituents were detected in the range of tens of micrograms per liter. In February 1998, TPH-D was detected for the first time in this well, and TPH-G and BTEX were detected at this well's historical maximum concentrations.

Site-wide maximum concentrations of groundwater analytes were detected in well MW-4 until February 1995, and decreased significantly until February 1998, when concentrations comparable to the historical site-wide maxima were detected. Figure 4.1 shows historical groundwater analytical results from well MW-4, expressed as a four quarter moving average. Each data point in this figure is the average concentration over the previous four quarters. This data presentation is useful for evaluating long-term hydrochemical trends without emphasizing seasonal perturbations. Figure 4.1 confirms the generally decreasing trend of fuel concentrations, prior to the current event.

Figure 4.1  
 Historical Ground Water Analytical Results: Well MW-4  
 Four Quarter Moving Average  
 Redwood Regional Park Service Yard, Oakland, California

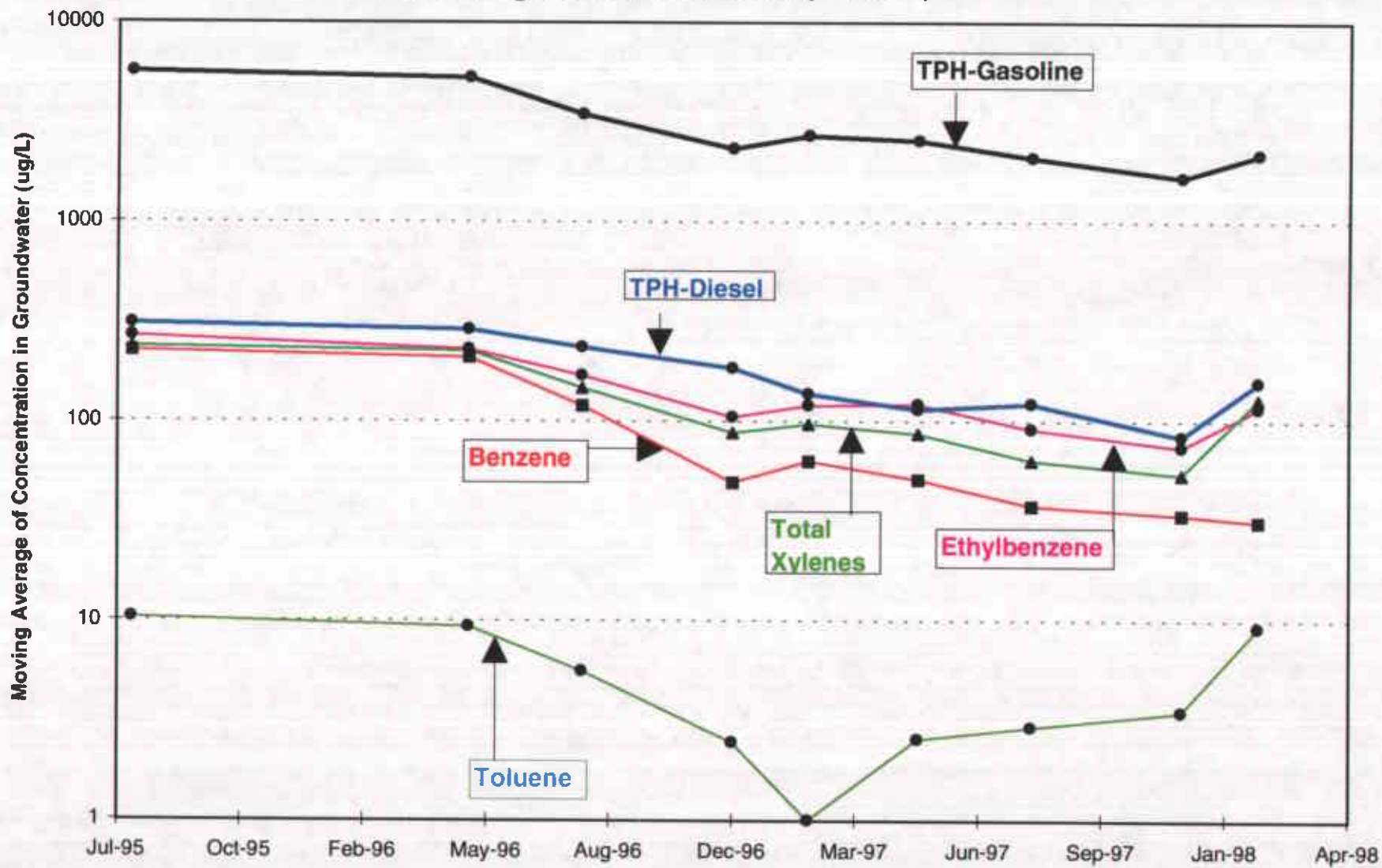


TABLE 4.2

GROUNDWATER ANALYTICAL SUMMARY  
 November 1994 - February 1998  
 Redwood Regional Park Service Yard, Oakland, California

Sample ID	Analyte	MRL (µg/L)	Nov. 1994	Feb. 1995	May 1995	August 1995	May 1996	August 1996	Dec. 1996	Feb. 1997	May 1997	August 1997	Dec. 1997	Feb. 1998
MW-1	TPH-G	50	ND	ND	ND	ND	*	*	*	*	*	*	*	*
	TPH-D/K	50	ND	ND	ND	ND	*	*	*	*	*	*	*	*
	BTEX	0.5	ND	ND	ND	ND	*	*	*	*	*	*	*	*
MW-2	TPH-G	50	66	89	ND	ND	ND	ND	ND	ND	67	ND	61	2,000
	TPH-D/K	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	200
	BTEX	0.5	4.3	29.6	8.0	5.7	ND	ND	7.9	1.2	14.0	5.6	31.4	1,112
MW-3	TPH-G	50	ND	ND	ND	ND	*	*	*	*	*	*	*	*
	TPH-D/K	50	ND	ND	ND	ND	*	*	*	*	*	*	*	*
	BTEX	0.5	ND	0.8	ND	ND	*	*	*	*	*	*	*	*
MW-4 <sup>(a)</sup>	TPH-G	50	2,600	11,000	7,200	1,800	1,100	3,700	2,700	3,300	490	1,900	1,000	5,300
	TPH-D/K	50	230	330	440	240	140	120	240	ND	ND	150	84	340
	BTEX	0.5	362.8	1,337	1,033	227.3	98	409	242	372.5	13.4	142.7	122.5	908
MW-5	TPH-G	50	50	70	ND	ND	ND	80	ND	ND	ND	ND	ND	ND
	TPH-D/K	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	BTEX	0.5	ND	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-6	TPH-G	50	ND	ND	ND	ND	*	*	*	*	*	*	*	*
	TPH-D/K	50	ND	ND	ND	ND	*	*	*	*	*	*	*	*
	BTEX	0.5	ND	ND	ND	ND	*	*	*	*	*	*	*	*

↑↑

AA

Notes:

- TPH-G = Total petroleum hydrocarbons, gasoline range (California Department of Toxic Substances Control [DTSC] Leaking Underground Fuel Tank [LUFT] Field Manual Method).
- TPH-D/K = Total petroleum hydrocarbons, diesel and kerosene range (California Department of Toxic Substances Control [DTSC] Leaking Underground Fuel Tank [LUFT] Field Manual Method).
- BTEX = Benzene, toluene, ethylbenzene and total xylenes (EPA Method 8020).
- ND = Not detected above MRL.
- MRL = Method reporting limit.
- \* = Well not sampled.
- (a) = Concentration is for the field sample as opposed to the field duplicate sample.
- µg/L = micrograms per liter (equivalent to parts per billion).



The following conclusions regarding groundwater chemistry are supported by the available data:

- The magnitude of groundwater contamination is well defined by the three site wells currently sampled, and the lateral extent was well characterized by the six site wells, three of which no longer require sampling.
- Fuel analytes have not been detected in well MW-5 for six events, since August 1996. Previously detected concentrations (TPH-G and benzene were the only detected analytes) were just above the method reporting limits.
- The highest concentrations of fuel contaminants in groundwater have been detected in downgradient well MW-4, indicating that the fuel plume in groundwater has migrated at least 100 feet downgradient of the source area (monitored by well MW-2). Algal blooms or an associated bacterial population in the vicinity of well MW-4 may be utilizing the petroleum as a carbon source.
- The maximum concentrations of fuel contaminants in groundwater occur generally during the February sampling events, which generally correlate with higher groundwater elevations, presumably due to increased precipitation. This suggests that rising groundwater may desorb fuel contaminants from soil in the previously unsaturated zone, thereby increasing fuel concentrations in groundwater during the rainy season.

#### **4.2.2 Creek Surface Water**

Table 4.3 summarizes analytical results of surface water samples collected from Redwood Creek (downgradient of the former UFSTs) since February 1994. Fuel analytes have been detected in surface water in four of the ten sampling events conducted since February 1994. Maximum concentrations (all in August 1997) include: 350 µg/L TPH-G; 130 µg/L TPH-D; 13 µg/L benzene; 0.89 µg/L toluene; 19 µg/L ethylbenzene; and 10.7 µg/L total xylenes. All of these maxima were found at location SW-2, directly downgradient of the former UFSTs. No fuel analytes have been detected at any of the locations since August 1997.

Fuel analytes have been detected at downstream location SW-3 in only two events: 74 µg/L TPH-D in May 1996 and 69 µg/L TPH-G in August 1996. BTEX constituents have never been detected at the downstream sampling location.

Fuel analytes were detected only once (50 µg/L TPH-G in February 1994, at a concentration equal to the method reporting limit) at upstream location SW-1, presumably resulting from runoff of vehicle-sourced fuels from nearby parking lots or roadways.

Areas of fuel-discolored soil have been observed in the east creek bed directly downgradient of the former UFSTs sporadically since February 1994, indicating that the leading edge of the UFST-sourced groundwater contaminant plume has reached the creek. Blooms of what are inferred to be orange algae on the water surface have been observed coincident with the areas of discolored soil, suggesting that the fuel may be serving as a carbon source for a bacterial population, whose waste byproducts are a food source for the algae.

TABLE 4.3

**CREEK SURFACE WATER ANALYTICAL SUMMARY**  
**February 1994 - February 1998**  
**Redwood Regional Park Service Yard, Oakland, California**

Sample ID	Analyte	MRL (µg/L)	February/March 1994	May 1995	August 1995	May 1996	August 1996	December 1996	February 1997	August 1997	December 1997	February 1998
SW-1 <sup>(a)</sup>	TPH-G	50	50	ND	*	ND	ND	ND	ND	ND	ND	ND
	TPH-D/K	50	ND	ND	*	ND	ND	ND	ND	ND	ND	ND
	BTEX	0.5	ND	ND	*	ND	ND	ND	ND	ND	ND	ND
SW-2 <sup>(b)</sup>	TPH-G	50	130/80	ND	ND	ND	200	ND	ND	130	ND	ND
	TPH-D/K	50	ND/ND	ND	ND	ND	ND	ND	ND	130	ND	ND
	BTEX	0.5	9.5/4.6	ND	ND	ND	12.9	ND	ND	43.6	ND	ND
SW-3	TPH-G	50	*	ND	ND	ND	69	ND	ND	ND	ND	ND
	TPH-D/K	50	*	ND	ND	74	ND	ND	ND	ND	ND	ND
	BTEX	0.5	*	ND	ND	ND	ND	ND	ND	ND	ND	ND

## Notes:

(a) Sample name is CW-2 for February 1994 sampling event.

(b) Sample name is CW-1 for February 1994 and CW-3 for March 1994 sampling event.

TPH-G = Total petroleum hydrocarbons, gasoline range (California Department of Toxic Substances Control [DTSC] Leaking Underground Fuel Tank [LUFT] Field Manual Method).

TPH-D/K = Total petroleum hydrocarbons, diesel and kerosene range (California Department of Toxic Substances Control [DTSC] Leaking Underground Fuel Tank [LUFT] Field Manual Method).

BTEX = Benzene, toluene, ethylbenzene and total xylenes (EPA Method 8020).

ND = Not detected above MRL.

\* = Location not sampled.

MRL = Method reporting limit.

All concentrations are µg/L (equivalent to parts per billion).

The following conclusions regarding surface water chemistry are supported by the available data:

- The leading edge of the fuel plume in groundwater has reached the east bank of Redwood Creek.
- Fuel analytes are detected sporadically, generally during periods of low surface water flow (May through August).
- A bacterial population in the vicinity of SW-2 may be utilizing the petroleum as a carbon source.
- Fuel analytes (TPH-G and TPH-D only) have been detected at downstream creek location SW-3 only once each in nine events (since May 1995) at concentrations just above the method reporting limit, indicating that these contaminants are generally attenuated to non-detectable concentrations within 500 feet of the point of discharge into the creek.

## SECTION 5

### REGULATORY CONSIDERATIONS

The ACHCSA is the designated lead agency for oversight of environmental investigations at the project site, and is therefore the principal contact regarding interpretation of applicable regulations. The California Regional Water Quality Control Board - San Francisco Bay Region (RWQCB) provides oversight of ACHCSA decisions.

#### 5.1 RELEVANT CRITERIA FOR GROUNDWATER AND SURFACE WATER CHEMISTRY

##### 5.1.1 Drinking Water Standards

Measured electrical conductivity values of groundwater at the site range from approximately 200 to 500  $\mu\text{mhos/cm}$  (Appendix D) and rarely exceed the maximum value of 5,000  $\mu\text{mhos/cm}$  (equivalent to  $\mu\text{S/cm}$ ) established by the SWRCB for potential public water supplies. Additionally, sustained yield of site wells is likely to be greater than the 200 gallons per day [gpd] criterion for potentially suitable drinking water (State Water Resources Control Board 1991). Based on these data, groundwater at the site may be considered as a potential drinking water source, and therefore drinking water standards (i.e. Maximum Contaminant Levels [MCLs]) may be applicable to contaminated groundwater at the site.

Numerical drinking water quality standards are published for several contaminants detected in groundwater and surface water at the site. Relevant standards include:

Benzene	1 $\mu\text{g/L}$	(California Primary MCL)
Toluene	1,000 $\mu\text{g/L}$	(Proposed Federal Primary MCL)
	40 $\mu\text{g/L}$	(Proposed Federal Secondary MCL)
Ethylbenzene	680 $\mu\text{g/L}$	(California Primary MCL)
	30 $\mu\text{g/L}$	(Proposed Federal Secondary MCL)
Xylenes	1,750 $\mu\text{g/L}$	(California Primary MCL)
	20 $\mu\text{g/L}$	(Proposed Federal Secondary MCL)

However, it should be noted that specific MCLs for drinking water are not published for total petroleum hydrocarbons in groundwater. This contaminant would therefore be regulated under the RWQCB general "nondegradation of beneficial use" policy (RWQCB 1992).

##### 5.1.2 Beneficial Uses and Water Quality Objectives

Beneficial uses of surface water quality in California are used to establish water quality standards and discharge prohibitions (RWQCB 1992). There are no listed beneficial uses for

Redwood Creek. However, there are listed beneficial uses for Upper San Leandro Reservoir (located approximately 4,000 feet south [downstream] of the project site), into which Redwood Creek flows. Existing beneficial uses for Upper San Leandro Reservoir include: water contact recreation; municipal and domestic supply; warm and cold fresh water habitats; wildlife habitat; and fish spawning. Potential beneficial uses include non-contact water recreation.

Groundwater seepage occurs along the eastern boundary of Redwood Creek approximately 130 feet west (downgradient) of the UFST source area. During periods of sufficient creek flow, surface water originating at the seeps would be expected to flow into Upper San Leandro Reservoir approximately 4,000 feet south (downstream).

## **5.2 GROUNDWATER AND SURFACE WATER REGULATORY EVALUATION**

### **5.2.1 Groundwater**

Maximum fuel concentrations detected in site groundwater samples during the previous year of groundwater monitoring (all in well MW-4) that are in excess of published regulatory agency ARARs include:

- Benzene (110 µg/L; exceeds the 1 µg/l California Primary MCL and the 0.34 µg/L and 21 µg/L WQOs for inland surface waters)
- Ethylbenzene (320 µg/L; exceeds the proposed Federal Secondary MCL)
- Total xylenes (402 µg/L; exceeds the proposed Federal Secondary MCL)

Benzene, detected only twice since May 1995, is the only creek water contaminant that has been detected in excess of published regulatory agency ARARs, and has never been detected at the downstream SW-3 location. Benzene concentrations in August 1996 (7.5 µg/L) and August 1997 (13 µg/L) exceed the 0.34 µg/L WQO for inland surface waters that are potential drinking water sources. However, the samples analyzed do not represent an average concentration over a 30-day period, upon which the WQO is based, and therefore are not directly comparable to the WQO.

Benzene has never been detected at downstream sampling location SW-3; hence, it is very unlikely that any site-sourced benzene would be present above the WQO at the point of discharge into Upper San Leandro Reservoir.

## SECTION 6

### RECOMMENDATIONS

Parsons recommends continuing the current program of groundwater and surface water monitoring, with the following revisions:

- **Discontinue hydrochemical monitoring in transgradient well MW-5**, based on the absence of detectable contamination in that well over the previous six events (since December 1996). Static water level elevations should continue to be measured in all site wells to evaluate groundwater flow direction.
- **Reduce the frequency of groundwater sampling and water level monitoring from quarterly to annually.** This revision is warranted as the seasonal fluctuations of groundwater chemistry is well established. We recommend that the groundwater annual sampling be conducted in February, the monitoring event with the historical maximum concentrations of fuel constituents in groundwater.
- **Evaluate the discontinuation of purging wells MW-2 and MW-4 prior to collecting groundwater samples.** This recommendation is based on Alameda County's September 16, 1997 letter to EBRPD stating that purging before well sampling is not required. Parsons recommends that for the next sampling event, both no-purge and post-purge samples be collected and analyzed, to allow comparison of analytical results. If warranted, purging would be discontinued in subsequent events. In the event that the no-purge technique is implemented, all purge water currently containerized at the site should be disposed of in accordance with local, state and federal regulations. One composite equipment decontamination rinsate sample will be collected in the next sampling event and analyzed to determine fuel analyte concentration and to evaluate disposal options for rinsate generated in future events (estimated to be less than 5 gallons per event). These options may include: surface discharge (waiver from National Pollutant Discharge Elimination System [NPDES] permit may be required from the RWQCB); discharge to the sanitary sewer system (permit or waiver from permit may be required from East Bay Municipal Utility District); or, continue to containerize for eventual off-site disposal.
- **Discontinue hydrochemical sampling at the Redwood Creek surface water upstream sampling location SW-1**, based on the absence of detectable contamination at that location over the previous eight events (since March 1994). This revision is warranted as historical analytical data indicate no significant contribution of fuel contamination upstream of the SW-2 sampling location.

- **Reduce the frequency of surface water sampling at the remaining two locations from semi-annually to annually.** This revision is warranted as seasonal fluctuations of surface water chemistry are well established, and fuel analytes have historically been detected only during periods of low creek flow (May through August). Therefore we recommend that the surface water annual sampling be conducted between May and August.

**REFERENCES**

- Alameda County Flood Control and Water Conservation District (ACFCWCD) 1988. Geohydrology and Groundwater Quality Overview of the East Bay Plain Area, Report 205 (j).
- ACHCSA 1996a, Letter to Mr. Ken Burger of EBRPD. January 9
- Borcherdt, R. D., Gibbs, J.F. and Lajoie, K.R. 1975. Maps Showing Maximum Earthquake Intensity Predicted in the Southern San Francisco Bay Region, California, For Large Earthquakes on the San Andreas and Hayward Faults, Sheet 3: Generalized Geologic Map.
- East Bay Regional Parks District (EBRPD) 1995. Letter from Mr. Warren Gee (EBRPD) to Mr. Paul Andrews (Contra Costa County Health Services Department). June 1
- Fetter 1988. Applied Hydrogeology, MacMillan Publishing Company, New York.
- Nilsen, T.H., Wright, R.H., Vlastic, T.C. and Spangle, W.E. 1979. Relative Slope Stability and Land-Use Planning in the San Francisco Bay Region, California, USGS Professional Paper 944, 96 pp.
- Norris and Webb 1990. Geology of California, 2nd Edition, John Wiley and Sons, Inc., New York, 541 p.
- Parsons 1993a. Closure of Underground Fuel Storage Tanks and Initial Site Characterization at Redwood Regional Park Service Yard, Oakland, California. December 16
- Parsons 1993b. Workplan for Site Characterization at East Bay Regional Park District, Redwood Regional Park Corporation Yard, Oakland, Alameda County, California. September 3
- Parsons 1994a. Creek and Soil Sampling at Redwood Regional Park, Oakland, California. March 2
- Parsons 1994b. Creek Surface Water at Redwood Regional Park, Oakland, California. May 13
- Parsons 1994c. Workplan for Groundwater Characterization Program at East Bay Regional Park Service Yard, Oakland, California. August 17
- Parsons 1994d. Quarterly Progress Report 1, Redwood Regional Park Service Yard, Oakland, California. December 28

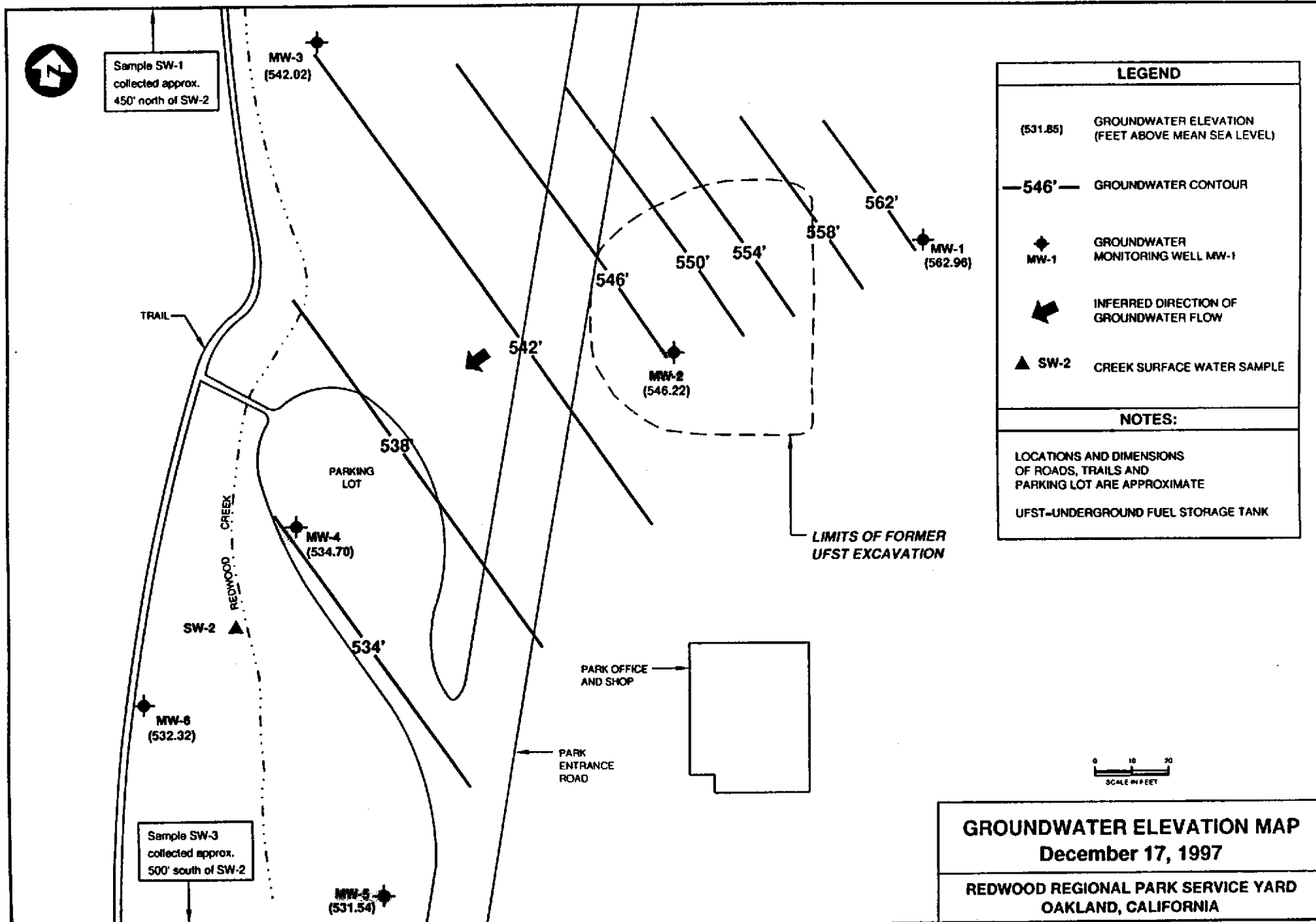


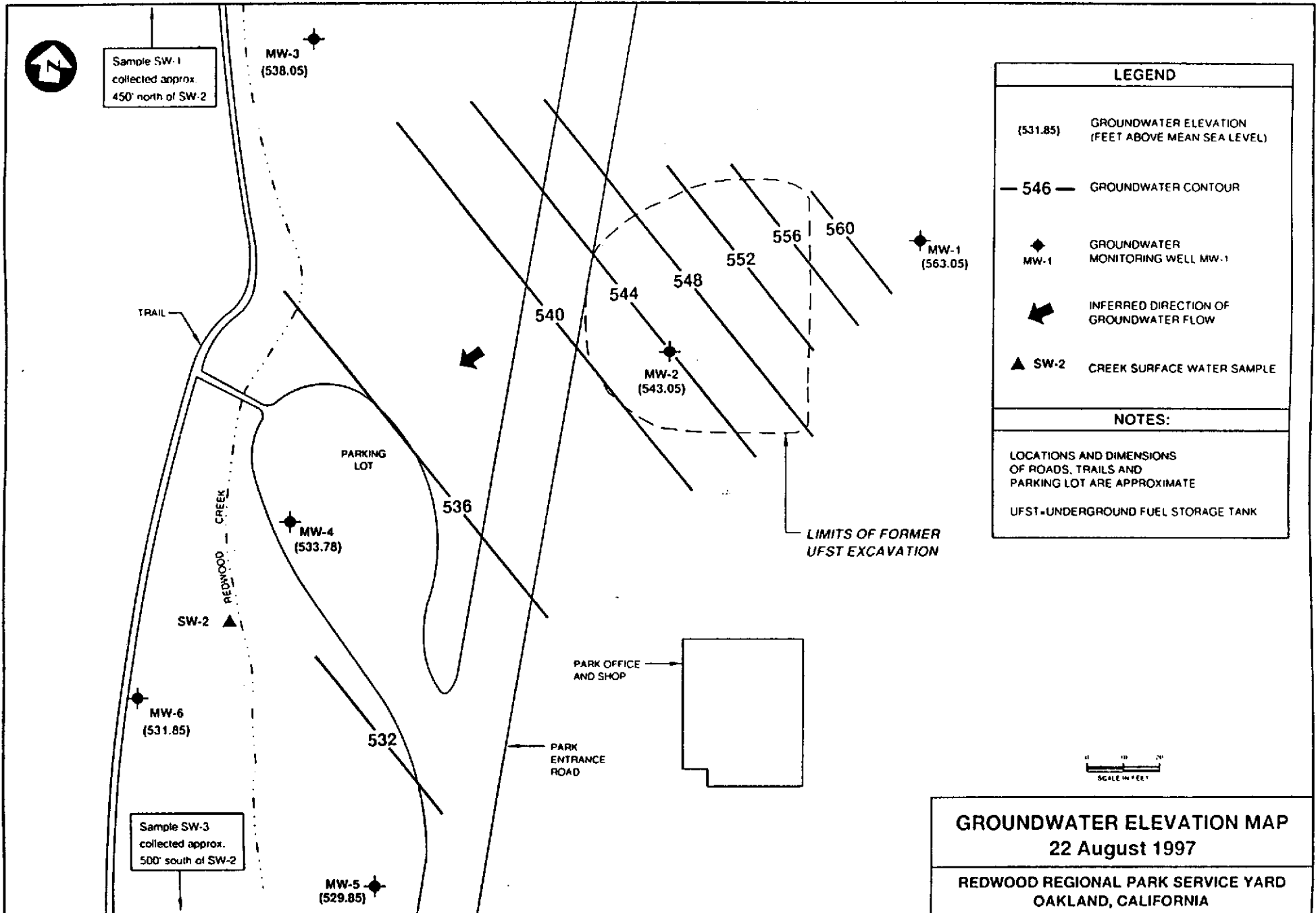
- Parsons 1995a. Quarterly Progress Report 2, Redwood Regional Park Service Yard, Oakland, California. March 8
- Parsons 1995b. Quarterly Progress Report 3, Redwood Regional Park Service Yard, Oakland, California. June 23
- Parsons 1995c. Quarterly Progress Report 4 and Annual Summary Assessment (November 1994 - August 1995), Redwood Regional Park Service Yard, Oakland, California. November 13
- Parsons 1996a. Quarterly Progress Report 5, Redwood Regional Park Service Yard, Oakland, California. June 6
- Parsons 1996b. Quarterly Progress Report 6, Redwood Regional Park Service Yard, Oakland, California. September 24
- Parsons 1997a. Quarterly Progress Report 7, Redwood Regional Park Service Yard, Oakland, California. January 31
- Parsons 1997b. Quarterly Progress Report 8 and Annual Summary Assessment, Redwood Regional Park Service Yard, Oakland, California. April 4
- Parsons 1997c. Quarterly Progress Report 9, Redwood Regional Park Service Yard, Oakland, California. June 30
- Parsons 1997d. Quarterly Progress Report 10, Redwood Regional Park Service Yard, Oakland, California. September 22
- Parsons 1998. Quarterly Progress Report 11, Redwood Regional Park Service Yard, Oakland, California. January 28
- Regional Water Quality Control Board - San Francisco Bay Region (RWQCB) 1992. Water Quality Control Plan for the San Francisco Basin. 17 January
- State Water Resources Control Board 1989. Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure: State of California Leaking Underground Fuel Tank Task Force, October
- 1991. California Inland Surface Waters Plan, Water Quality Control Plan for Inland Surface Waters of California, Resolution No. 91-33 (including as an appendix Resolution No. 88-63). April

**APPENDIX A**

**HISTORICAL GROUNDWATER  
ELEVATION MAPS**

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Sample SW-1  
collected approx.  
450' north of SW-2

MW-3  
(538.05)

MW-1  
(563.05)

MW-2  
(543.05)

MW-4  
(533.78)

MW-6  
(531.85)

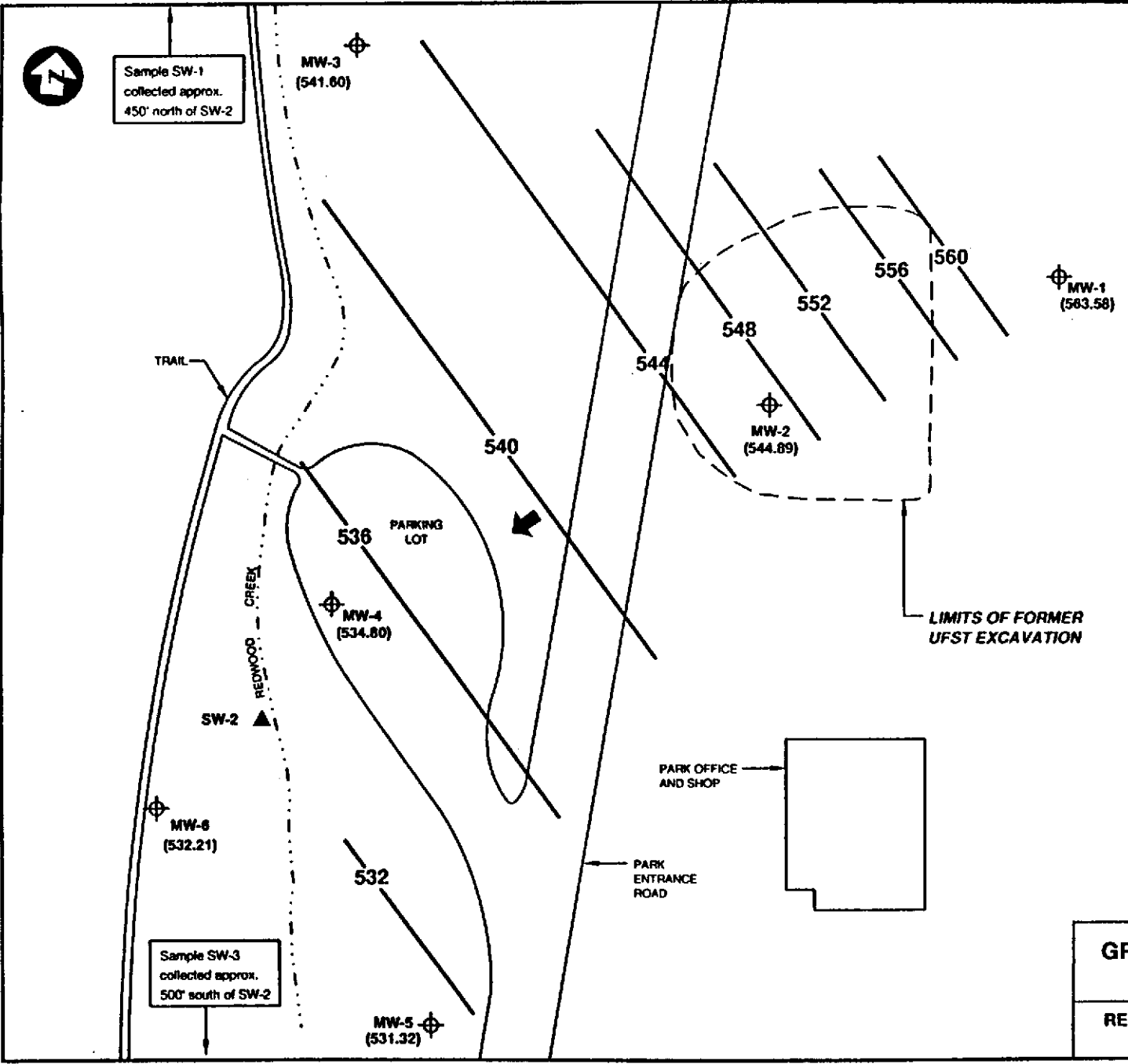
Sample SW-3  
collected approx.  
500' south of SW-2

MW-5  
(529.85)

LEGEND	
(531.85)	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
— 546 —	GROUNDWATER CONTOUR
◆ MW-1	GROUNDWATER MONITORING WELL MW-1
←	INFERRED DIRECTION OF GROUNDWATER FLOW
▲ SW-2	CREEK SURFACE WATER SAMPLE
NOTES:	
LOCATIONS AND DIMENSIONS OF ROADS, TRAILS AND PARKING LOT ARE APPROXIMATE	
UFST-UNDERGROUND FUEL STORAGE TANK	



**GROUNDWATER ELEVATION MAP**  
**22 August 1997**  
**REDWOOD REGIONAL PARK SERVICE YARD**  
**OAKLAND, CALIFORNIA**



LEGEND	
(563.58)	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
— 546 —	GROUNDWATER CONTOUR
⊕ MW-1	GROUNDWATER MONITORING WELL MW-1
↙	INFERRED DIRECTION OF GROUNDWATER FLOW
▲ SW-2	CREEK SURFACE WATER SAMPLE
NOTES:	
LOCATIONS AND DIMENSIONS OF ROADS, TRAILS AND PARKING LOT ARE APPROXIMATE	
UFST—UNDERGROUND FUEL STORAGE TANK	



**GROUNDWATER ELEVATION MAP**  
**15 May 1997**  
**REDWOOD REGIONAL PARK SERVICE YARD**  
**OAKLAND, CALIFORNIA**



Sample SW-1  
collected approx.  
450' north of SW-2

MW-3  
(542.0)

MW-1  
(563.0)

MW-2  
(546.0)

MW-4  
(534.8)

MW-6  
(532.3)

Sample SW-3  
collected approx.  
500' south of SW-2

MW-5  
(531.7)

TRAIL

REDWOOD CREEK

PARKING LOT

SW-2

PARK OFFICE AND SHOP

PARK ENTRANCE ROAD

LIMITS OF FORMER UFST EXCAVATION

**LEGEND**

- (548.0) GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- 546 - GROUNDWATER CONTOUR
- ◆ MW-1 GROUNDWATER MONITORING WELL MW-1
- ➔ INFERRED DIRECTION OF GROUNDWATER FLOW
- ▲ SW-2 CREEK SURFACE WATER SAMPLE

**NOTES:**

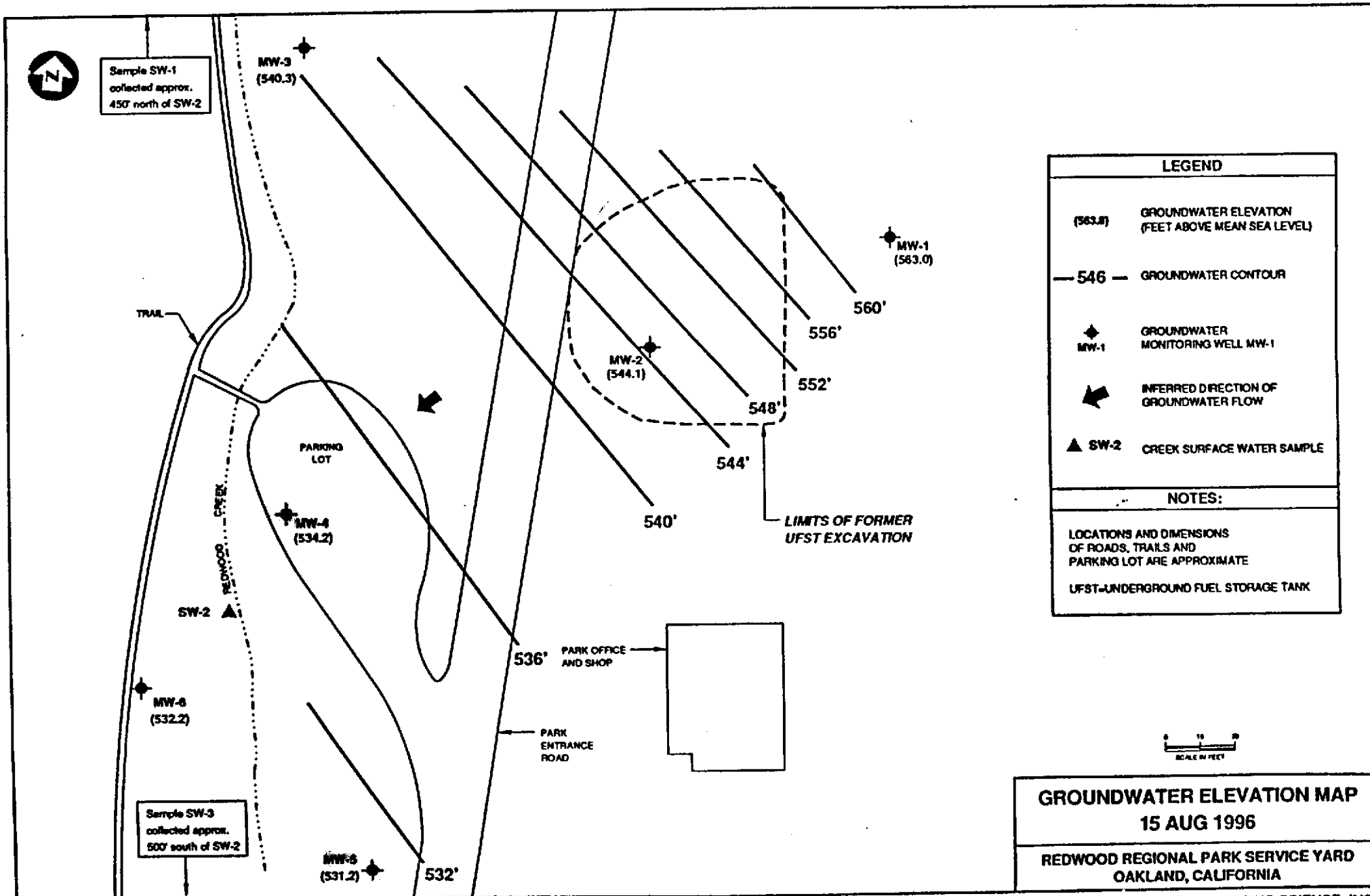
LOCATIONS AND DIMENSIONS OF ROADS, TRAILS AND PARKING LOT ARE APPROXIMATE  
UFST-UNDERGROUND FUEL STORAGE TANK

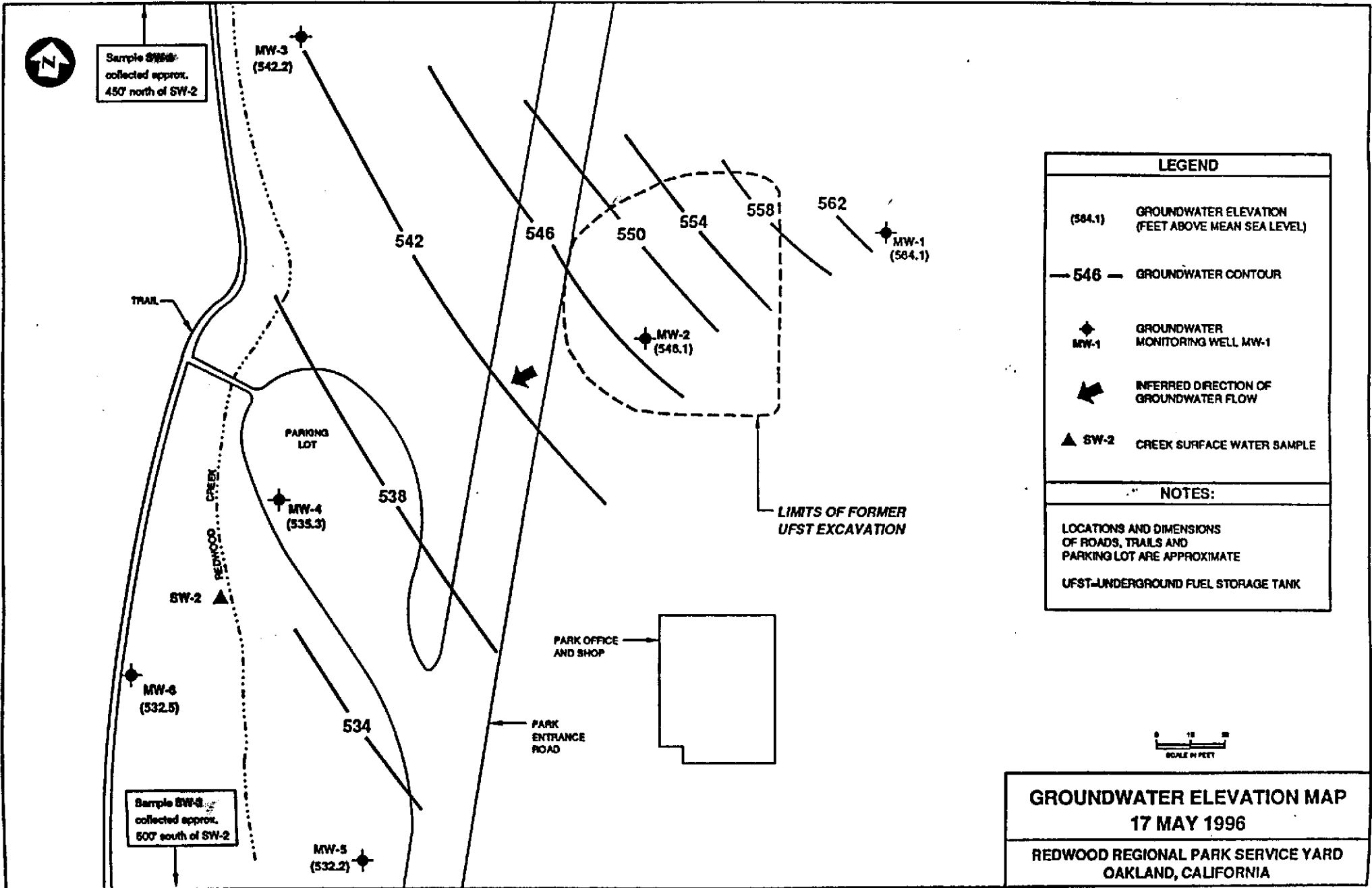


**GROUNDWATER ELEVATION MAP**  
9 December 1996

REDWOOD REGIONAL PARK SERVICE YARD  
OAKLAND, CALIFORNIA

PARSONS ENGINEERING SCIENCE, INC.





**LEGEND**

(584.1)	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
— 546 —	GROUNDWATER CONTOUR
◆ MW-1	GROUNDWATER MONITORING WELL MW-1
↙	INFERRED DIRECTION OF GROUNDWATER FLOW
▲ SW-2	CREEK SURFACE WATER SAMPLE

**NOTES:**

LOCATIONS AND DIMENSIONS OF ROADS, TRAILS AND PARKING LOT ARE APPROXIMATE  
 UFST-UNDERGROUND FUEL STORAGE TANK

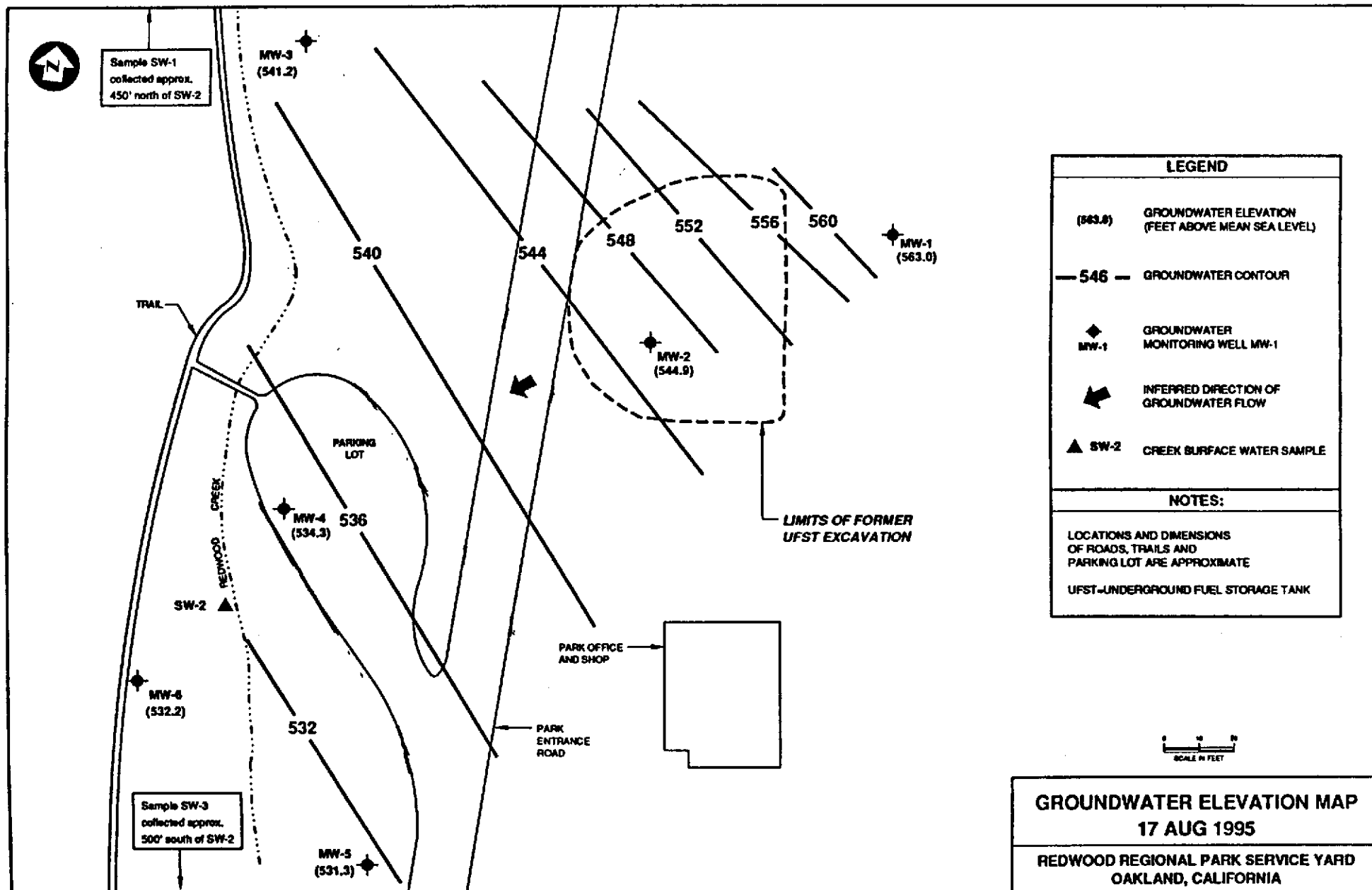


**GROUNDWATER ELEVATION MAP  
 17 MAY 1996**

**REDWOOD REGIONAL PARK SERVICE YARD  
 OAKLAND, CALIFORNIA**



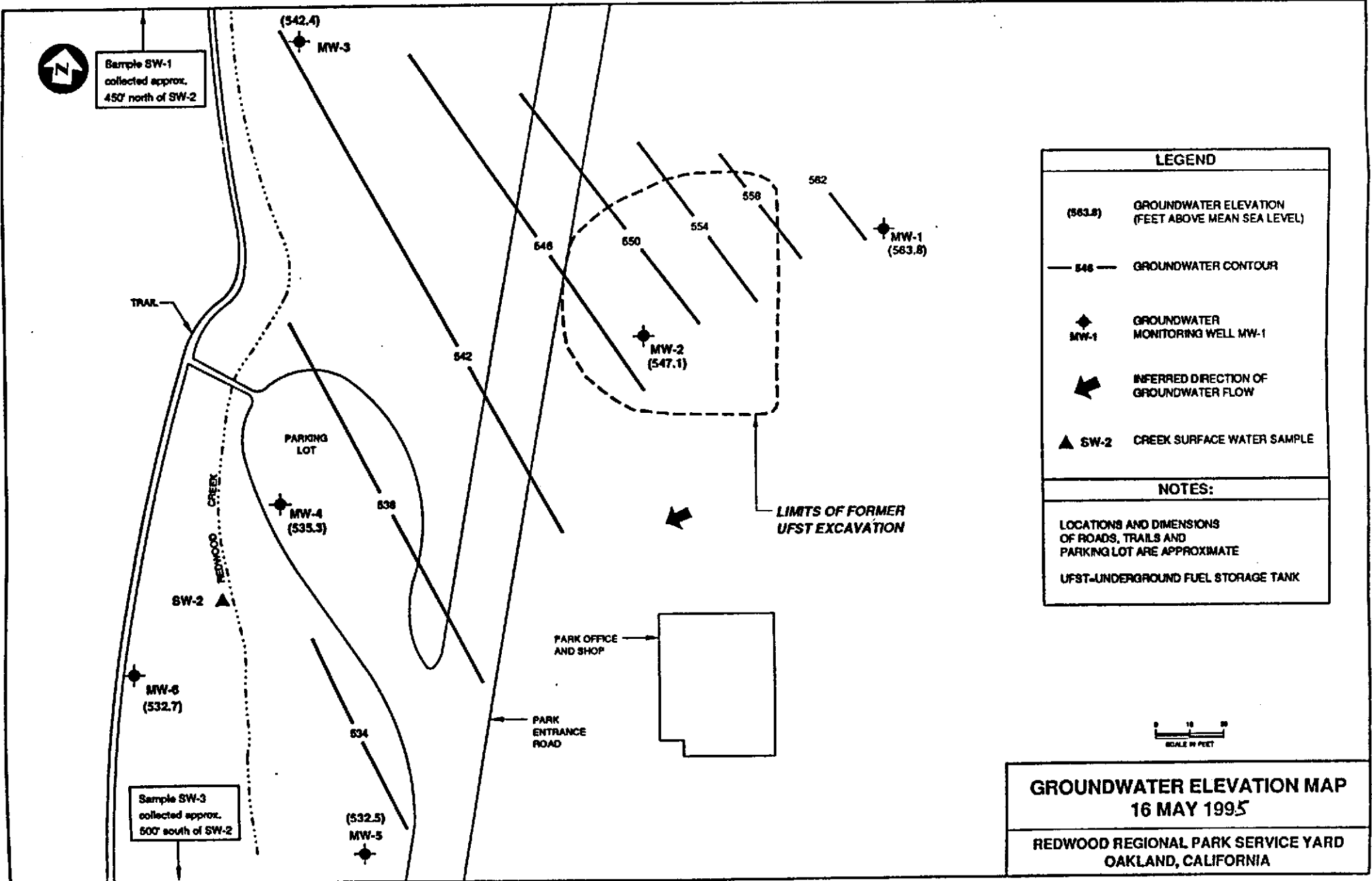
FIGURE



LEGEND	
(563.0)	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
— 546 —	GROUNDWATER CONTOUR
◆ MW-1	GROUNDWATER MONITORING WELL MW-1
↖	INFERRED DIRECTION OF GROUNDWATER FLOW
▲ SW-2	CREEK SURFACE WATER SAMPLE
NOTES:	
LOCATIONS AND DIMENSIONS OF ROADS, TRAILS AND PARKING LOT ARE APPROXIMATE	
UFST—UNDERGROUND FUEL STORAGE TANK	



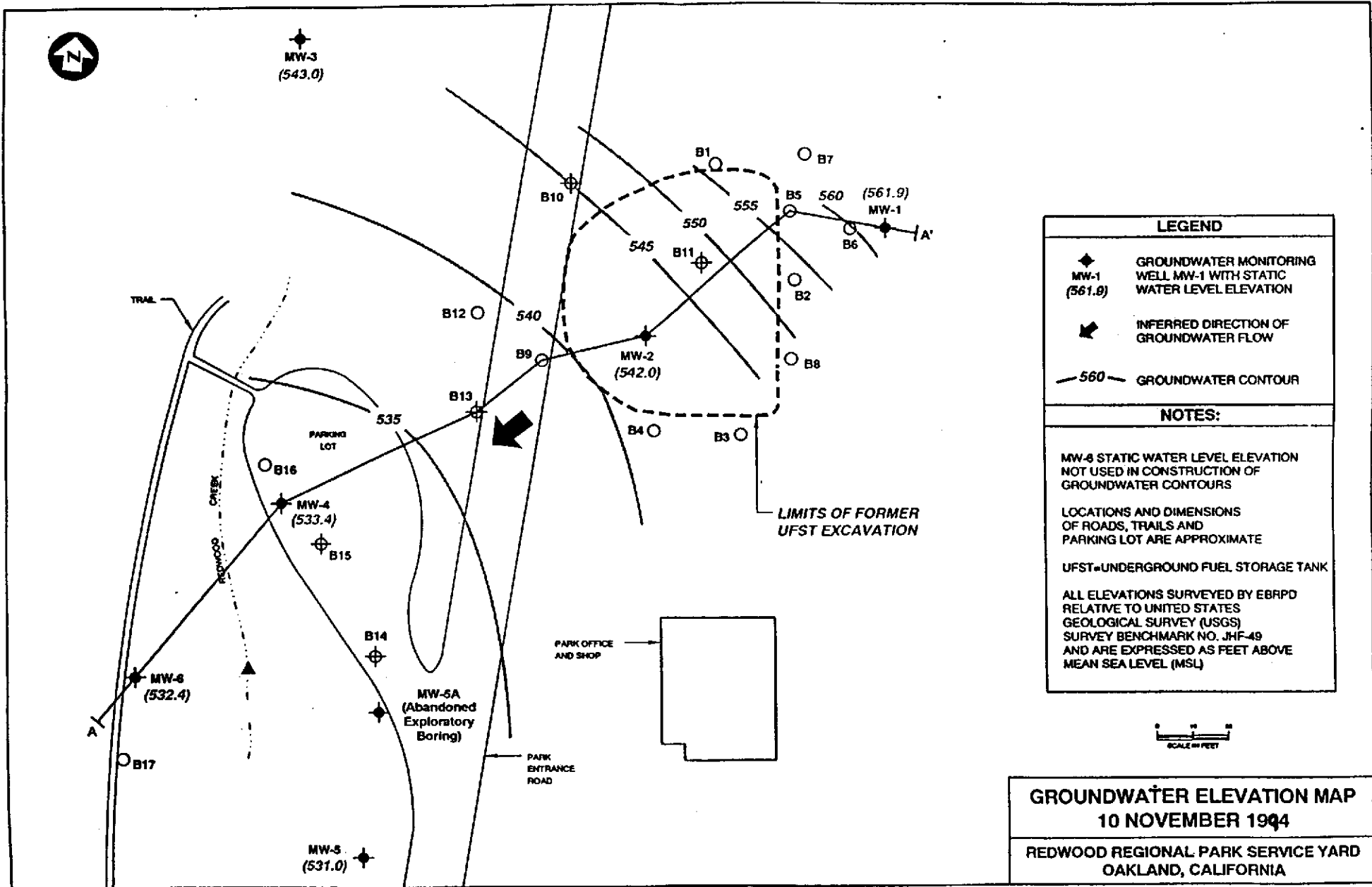
**GROUNDWATER ELEVATION MAP**  
**17 AUG 1995**  
**REDWOOD REGIONAL PARK SERVICE YARD**  
**OAKLAND, CALIFORNIA**



LEGEND	
(563.8)	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
— 546 —	GROUNDWATER CONTOUR
◆ MW-1	GROUNDWATER MONITORING WELL MW-1
←	INFERRED DIRECTION OF GROUNDWATER FLOW
▲ SW-2	CREEK SURFACE WATER SAMPLE
NOTES:	
LOCATIONS AND DIMENSIONS OF ROADS, TRAILS AND PARKING LOT ARE APPROXIMATE	
UFST-UNDERGROUND FUEL STORAGE TANK	



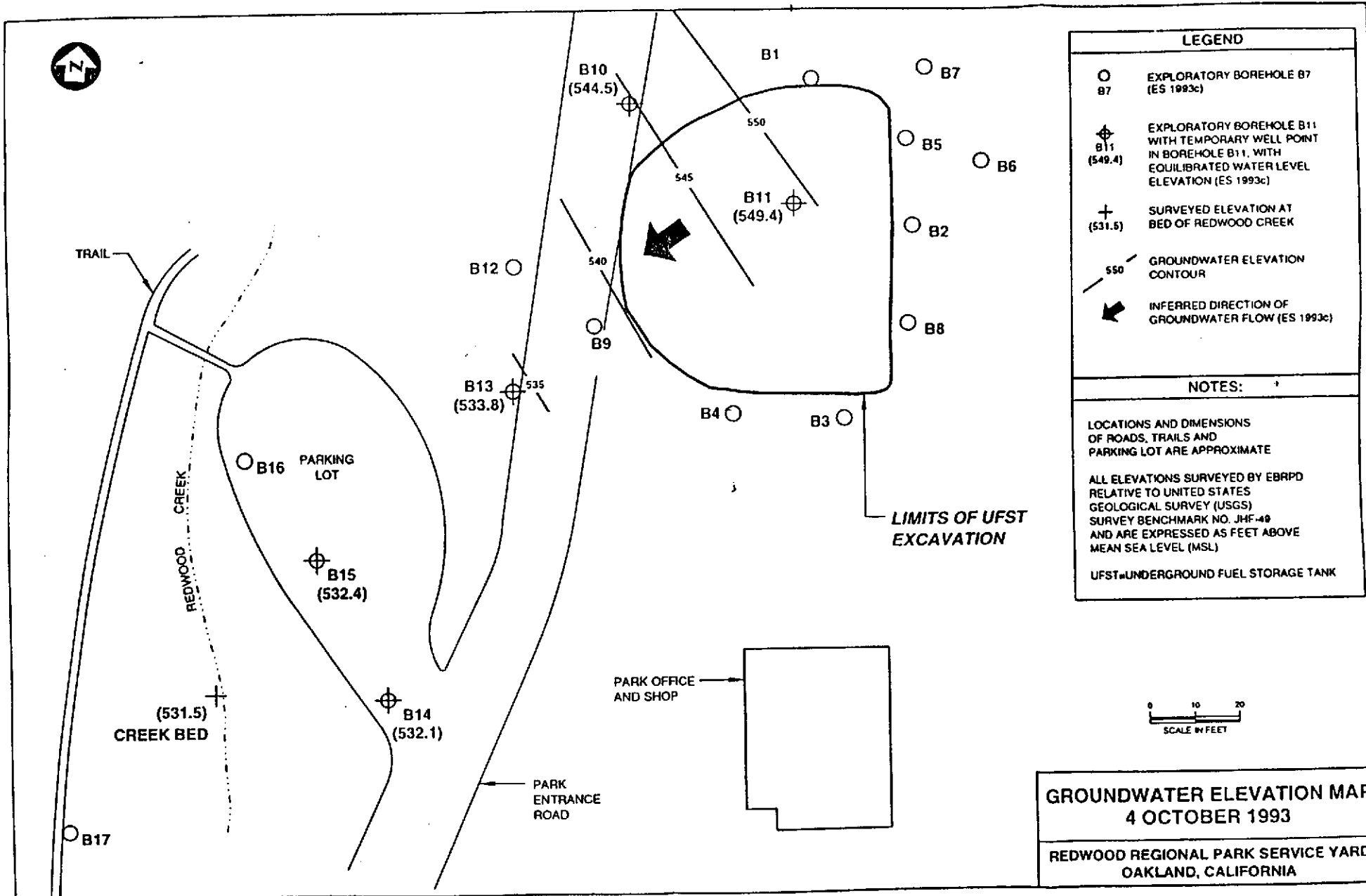
**GROUNDWATER ELEVATION MAP**  
**16 MAY 1995**  
 REDWOOD REGIONAL PARK SERVICE YARD  
 OAKLAND, CALIFORNIA



LEGEND	
	GROUNDWATER MONITORING WELL MW-1 WITH STATIC WATER LEVEL ELEVATION
	INFERRED DIRECTION OF GROUNDWATER FLOW
	560 GROUNDWATER CONTOUR
NOTES:	
MW-6 STATIC WATER LEVEL ELEVATION NOT USED IN CONSTRUCTION OF GROUNDWATER CONTOURS	
LOCATIONS AND DIMENSIONS OF ROADS, TRAILS AND PARKING LOT ARE APPROXIMATE	
UFS=UNDERGROUND FUEL STORAGE TANK	
ALL ELEVATIONS SURVEYED BY EBRPD RELATIVE TO UNITED STATES GEOLOGICAL SURVEY (USGS) SURVEY BENCHMARK NO. JHF-49 AND ARE EXPRESSED AS FEET ABOVE MEAN SEA LEVEL (MSL)	



**GROUNDWATER ELEVATION MAP**  
**10 NOVEMBER 1994**  
 REDWOOD REGIONAL PARK SERVICE YARD  
 OAKLAND, CALIFORNIA



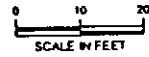
LEGEND	
○ B7	EXPLORATORY BOREHOLE B7 (ES 1993c)
⊕ B11 (549.4)	EXPLORATORY BOREHOLE B11 WITH TEMPORARY WELL POINT IN BOREHOLE B11, WITH EQUILIBRATED WATER LEVEL ELEVATION (ES 1993c)
+ (531.5)	SURVEYED ELEVATION AT BED OF REDWOOD CREEK
- - - 550	GROUNDWATER ELEVATION CONTOUR
↘	INFERRED DIRECTION OF GROUNDWATER FLOW (ES 1993c)

**NOTES:**

LOCATIONS AND DIMENSIONS OF ROADS, TRAILS AND PARKING LOT ARE APPROXIMATE

ALL ELEVATIONS SURVEYED BY EBRPD RELATIVE TO UNITED STATES GEOLOGICAL SURVEY (USGS) SURVEY BENCHMARK NO. JHF-49 AND ARE EXPRESSED AS FEET ABOVE MEAN SEA LEVEL (MSL)

UFST=UNDERGROUND FUEL STORAGE TANK



**GROUNDWATER ELEVATION MAP**  
4 OCTOBER 1993

REDWOOD REGIONAL PARK SERVICE YARD  
OAKLAND, CALIFORNIA

**APPENDIX B**

**FEBRUARY 1998 WATER LEVEL DATA AND  
GROUNDWATER MONITORING NOTES**

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## WATER LEVEL DATA

PARSONS ENGINEERING SCIENCE

DATE: February 4, 1998

PROJECT/LOCATION: Redwood Regional Park Service Yard,  
Oakland, California

PROJECT No.: 729457

PERSONNEL: Bruce Rucker

Well No	Water Level from T.O.C.	Well Depth From T.O.C	Depth to T.O.C	Water Level from G.S.	Well Casing Dia.	Gallons/ Casing Vol.	T.O.C. Elev. USGS	Water Level USGS
MW-1	(a)	18.0	-2.3	> - 2.3 (a)	4	NS	565.9	> 565.9 (a)
MW-2	16.54	36.5	-2.4	14.1	4	13.0	566.5	549.96
MW-3	16.12	45.0	-2.8	13.3	4	NS	560.9	544.78
MW-4	10.36	26.0	-2.1	8.3	4	10.2	548.1	537.74
MW-5	11.90	26.0	-2.3	9.6	4	9.2	547.5	535.60
MW-6	NA	27.0	NA	NA	4	NS	NA	NA

**NOTES:**

T.O.C.: Top of Casing

Gallons/casing volume for 4" inner diameter casing = 0.65 gallons per linear foot

Negative value for "Depth to T.O.C." indicates that T.O.C. is above ground surface

G.S.: Ground Surface

USGS: U.S. Geological Survey feet above mean sea level (MSL)

NS: Not Sampled                      NA: Not Accessible

All elevations surveyed by East Bay Regional Parks District relative to USGS Survey Benchmark No. JHF-49

(a) Equilibrated water level above ground surface.

# GROUNDWATER SAMPLING FIELD NOTES

PARSONS ENGINEERING SCIENCE

PROJECT/LOCATION    REDWOOD REGIONAL PARK SERVICE YARD, OAKLAND, CA

PERSONNEL:    Bruce Rucker

PROJECT NUMBER:    729457

DATE:    February 4, 1998

Well ID	Sampler Date Time	Water Level Before, Well Diameter and Depth*	Water Level After*	Gallons per Casing Volume	Well Purging Method**	Pump On	Pump Off	Temp. (o C)	Specific Cond (umhos/cm)	pH	Total Water Purged (gals)	Sample Coll. Method	Analysis & Number/type of Containers	Comments
MW-1	NS	artesian 4" 18.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NS	NS	
MW-2	BMR 2/4/98 1115	16.40 4" 36.5	26.60	13.1	B	NA	NA	13.5 14.1 14.5 14.5	680 670 670 660	7.35 7.22 7.21 7.19	1 13 26 39	B	(a) (b) & (c)	Sample semi-turbid; no sheen; slight petroleum odor
MW-3	NS	16.12 4" 45.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NS	NS	
MW-4	BMR 2/4/98 1210	10.36 4" 26.0	17.20	10.2	B	NA	NA	13.6 13.4 14.1 13.6	510 520 510 510	7.08 6.94 6.89 6.81	1 10 20 30	B	(a) (b) & (c)	Sample semi-turbid; petroleum odor; orange-colored algae in purge water

**NOTES**

- \* Measured from top of casing in feet
- \*\* G - Grundfos Pump; B - Bailer
- NA Not Applicable
- NR Not Recorded

- (a) Total Extractable Hydrocarbons - diesel range (TPH-D), unpreserved (1: 1L amber bottles).
- (b) BTEX, EPA Method 8020, HCl preserved (2: 40ml VOAs).
- (c) Total Volatile Hydrocarbons-gasoline range (TPH-G), HCl preserved (2: 40ml VOAs).
- NS Not sampled

# GROUNDWATER SAMPLING FIELD NOTES

PARSONS ENGINEERING SCIENCE

PROJECT/LOCATION    REDWOOD REGIONAL PARK SERVICE YARD, OAKLAND, CA

PERSONNEL:    Bruce Rucker

PROJECT NUMBER:    729457

DATE:    February 4, 1998

Well ID	Sampler Date Time	Water Level Before, Well Diameter and Depth*	Water Level After *	Gallons per Casing Volume	Well Purging Method **	Pump On	Pump Off	Temp. (o C)	Specific Cond (umhos/cm)	pH	Total Water Purged (gals)	Sample Coll. Method	Analysis & Number/type of Containers	Comments
MW-5	BMR	11.90												Sample clear; no petroleum sheen.
	2/4/98	4"	13.20	9.2	B	NA	NA	12.1	500	7.46	1	B	(a) (b) & (c)	
								12.9	500	7.40	9			
	1005	26.0						12.8	490	7.14	19			
							12.9	490	7.19	28				
MW-6	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NS	NS	
		4"												
MW-0A	BMR													Field duplicate collected at well MW-4
	2/4/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	B	(b) & (c)	
MW-0B	BMR													Equipment rinsate blank, collected after decon. at well MW-4
	2/4/98	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	(b) & (c)	
	1215													

**NOTES**

- \* Measured from top of casing in feet
- \*\* G -- Grundfos Pump; B - Bailor
- NA Not Applicable
- NR Not Recorded

- (a) Total Extractable Hydrocarbons - diesel range (TPH-D), unpreserved (1: 1L amber bottles).
- (b) BTEX, EPA Method 8020, HCl preserved (2: 40ml VOAs).
- (c) Total Volatile Hydrocarbons-gasoline range (TPH-G), HCl preserved (2: 40ml VOAs).
- NS Not sampled



**APPENDIX C**

**FEBRUARY 1998 CHAIN-OF-CUSTODY RECORD AND  
ANALYTICAL LABORATORY REPORT**

---



Curtis & Tompkins, Ltd., Analytical Laboratories, Since 1878

2323 Fifth Street, Berkeley, CA 94710, Phone (510) 486-0900

A N A L Y T I C A L   R E P O R T

Prepared for:

Parsons Engineering Science, Inc.  
2101 Webster Street  
Suite 700  
Oakland, CA 94612

Date: 12-FEB-98  
Lab Job Number: 132237  
Project ID: 729457  
Location: Redwood G. Water & Surface

Reviewed by:

Reviewed by:

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## TVH-Total Volatile Hydrocarbons

Client: Parsons Engineering Science, Inc.	Analysis Method: TVH
Project#: 729457	Prep Method: EPA 5030
Location: Redwood G.Water & Surface	

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
132237-001	MW-5	38993	02/04/98	02/08/98	02/08/98	
132237-002	MW-2	39013	02/04/98	02/11/98	02/11/98	
132237-003	MW-4	39013	02/04/98	02/11/98	02/11/98	
132237-004	MW-0A	39013	02/04/98	02/11/98	02/11/98	

Matrix: Water

Analyte	Units	132237-001	132237-002	132237-003	132237-004
Diln Fac:		1	5	5	5
Gasoline C7-C12	ug/L	<50	2000	5300	5500
Surrogate					
Bromofluorobenzene	%REC	86	92	81	80

BTXE

Client: Parsons Engineering Science, Inc.	Analysis Method: EPA 8020A
Project#: 729457	Prep Method: EPA 5030
Location: Redwood G. Water & Surface	

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
132237-001	MW-5	38993	02/04/98	02/08/98	02/08/98	
132237-002	MW-2	39013	02/04/98	02/11/98	02/11/98	
132237-003	MW-4	39013	02/04/98	02/11/98	02/11/98	
132237-004	MW-0A	39013	02/04/98	02/11/98	02/11/98	

Matrix: Water

Analyte	Units	132237-001	132237-002	132237-003	132237-004
Diln Fac:		1	5	5	5
Benzene	ug/L	<0.5	270	110	110
Toluene	ug/L	<0.5	92	24 C	24 C
Ethylbenzene	ug/L	<0.5	150	320	340
m,p-Xylenes	ug/L	<0.5	480	370	400
o-Xylene	ug/L	<0.5	120	32 C	34 C
Surrogate					
Trifluorotoluene	%REC	90	96	96	96
Bromofluorobenzene	%REC	77	86	74	77

C: Presence of this compound confirmed by second column, however, the confirmation concentration differed from the reported result by more than a factor of two

## TVH-Total Volatile Hydrocarbons

Client: Parsons Engineering Science, Inc.	Analysis Method: TVH
Project#: 729457	Prep Method: EPA 5030
Location: Redwood G. Water & Surface	

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
132237-005	MW-0B	39013	02/04/98	02/11/98	02/11/98	
132237-006	SW-1	38993	02/04/98	02/08/98	02/08/98	
132237-007	SW-2	38993	02/04/98	02/08/98	02/08/98	
132237-008	SW-3	38993	02/04/98	02/08/98	02/08/98	

Matrix: Water

Analyte	Units	132237-005	132237-006	132237-007	132237-008
Diln Fac:		1	1	1	1
Gasoline C7-C12	ug/L	<50	<50	<50	<50
Surrogate					
Bromofluorobenzene	%REC	74	78	76	77

## BTXE

Client: Parsons Engineering Science, Inc.	Analysis Method: EPA 8020A
Project#: 729457	Prep Method: EPA 5030
Location: Redwood G. Water & Surface	

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
132237-005	MW-0B	39013	02/04/98	02/11/98	02/11/98	
132237-006	SW-1	38993	02/04/98	02/08/98	02/08/98	
132237-007	SW-2	38993	02/04/98	02/08/98	02/08/98	
132237-008	SW-3	38993	02/04/98	02/08/98	02/08/98	

Matrix: Water

Analyte	Units	132237-005	132237-006	132237-007	132237-008
Diln Fac:		1	1	1	1
Benzene	ug/L	<0.5	<0.5	<0.5	<0.5
Toluene	ug/L	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	ug/L	<0.5	<0.5	<0.5	<0.5
m,p-Xylenes	ug/L	<0.5	<0.5	<0.5	<0.5
o-Xylene	ug/L	<0.5	<0.5	<0.5	<0.5
Surrogate					
Trifluorotoluene	%REC	99	89	90	88
Bromofluorobenzene	%REC	80	76	74	77

Lab #: 132237

BATCH QC REPORT



Curtis & Tompkins, Ltd.  
Page 1 of 1

TVH-Total Volatile Hydrocarbons

Client: Parsons Engineering Science, Inc.  
Project#: 729457  
Location: Redwood G. Water & Surface

Analysis Method: TVH  
Prep Method: EPA 5030

METHOD BLANK

Matrix: Water  
Batch#: 38993  
Units: ug/L  
Diln Fac: 1

Prep Date: 02/08/98  
Analysis Date: 02/08/98

MB Lab ID: QC63856

Analyte	Result		
Gasoline C7-C12	<50		
Surrogate	%Rec	Recovery Limits	
Bromofluorobenzene	75	59-162	

Lab #: 132237

BATCH QC REPORT

BTXE

Client: Parsons Engineering Science, Inc.      Analysis Method: EPA 8020A  
Project#: 729457      Prep Method: EPA 5030  
Location: Redwood G.Water & Surface

METHOD BLANK

Matrix: Water      Prep Date: 02/08/98  
Batch#: 38993      Analysis Date: 02/08/98  
Units: ug/L  
Diln Fac: 1

MB Lab ID: QC63856

Analyte	Result	
Benzene	<0.5	
Toluene	<0.5	
Ethylbenzene	<0.5	
m, p-Xylenes	<0.5	
o-Xylene	<0.5	
Surrogate	%Rec	Recovery Limits
Trifluorotoluene	84	53-124
Bromofluorobenzene	74	41-142



Lab #: 132237

BATCH QC REPORT



Curtis & Tompkins, Ltd.  
Page 1 of 1

TVH-Total Volatile Hydrocarbons

Client: Parsons Engineering Science, Inc.  
Project#: 729457  
Location: Redwood G.Water & Surface

Analysis Method: TVH  
Prep Method: EPA 5030

METHOD BLANK

Matrix: Water  
Batch#: 39013  
Units: ug/L  
Diln Fac: 1

Prep Date: 02/11/98  
Analysis Date: 02/11/98

MB Lab ID: QC63925

Analyte	Result		
Gasoline C7-C12	<50		
Surrogate	%Rec	Recovery Limits	
Bromofluorobenzene	76	59-162	

Lab #: 132237

BATCH QC REPORT

BTXE

Client: Parsons Engineering Science, Inc.  
Project#: 729457  
Location: Redwood G. Water & Surface

Analysis Method: EPA 8020A  
Prep Method: EPA 5030

METHOD BLANK

Matrix: Water  
Batch#: 39013  
Units: ug/L  
Diln Fac: 1

Prep Date: 02/11/98  
Analysis Date: 02/11/98

MB Lab ID: QC63925

Analyte	Result		
Benzene	<0.5		
Toluene	<0.5		
Ethylbenzene	<0.5		
m,p-Xylenes	<0.5		
o-Xylene	<0.5		
Surrogate	%Rec		Recovery Limits
Trifluorotoluene	82		53-124
Bromofluorobenzene	76		41-142

Lab #: 132237

BATCH QC REPORT



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Page 1 of 1

TVH-Total Volatile Hydrocarbons

Client: Parsons Engineering Science, Inc.      Analysis Method: TVH  
Project#: 729457      Prep Method: EPA 5030  
Location: Redwood G.Water & Surface

LABORATORY CONTROL SAMPLE

Matrix: Water      Prep Date: 02/08/98  
Batch#: 38993      Analysis Date: 02/08/98  
Units: ug/L  
Diln Fac: 1

LCS Lab ID: QC63854

Analyte	Result	Spike Added	%Rec #	Limits
Gasoline C7-C12	1979	2000	99	80-119
Surrogate	%Rec	Limits		
Bromofluorobenzene	94	59-162		

# Column to be used to flag recovery and RPD values with an asterisk

\* Values outside of QC limits

Spike Recovery: 0 out of 1 outside limits

Lab #: 132237

BATCH QC REPORT



BTXE

Client: Parsons Engineering Science, Inc.	Analysis Method: EPA 8020A
Project#: 729457	Prep Method: EPA 5030
Location: Redwood G. Water & Surface	

LABORATORY CONTROL SAMPLE

Matrix: Water	Prep Date: 02/08/98
Batch#: 38993	Analysis Date: 02/08/98
Units: ug/L	
Diln Fac: 1	

LCS Lab ID: QC63855

Analyte	Result	Spike Added	%Rec #	Limits
Benzene	20.59	20	103	69-109
Toluene	21.34	20	107	72-116
Ethylbenzene	21.01	20	105	67-120
m,p-Xylenes	45.19	40	113	69-117
o-Xylene	22.41	20	112	75-122
Surrogate	%Rec	Limits		
Trifluorotoluene	88	53-124		
Bromofluorobenzene	71	41-142		

# Column to be used to flag recovery and RPD values with an asterisk

\* Values outside of QC limits

Spike Recovery: 0 out of 5 outside limits

Lab #: 132237

BATCH QC REPORT



BTXE

Client: Parsons Engineering Science, Inc.	Analysis Method: EPA 8020A
Project#: 729457	Prep Method: EPA 5030
Location: Redwood G. Water & Surface	

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Field ID: ZZZZZZ	Sample Date: 01/28/98
Lab ID: 132184-012	Received Date: 01/29/98
Matrix: Water	Prep Date: 02/09/98
Batch#: 38993	Analysis Date: 02/09/98
Units: ug/L	
Diln Fac: 1	

MS Lab ID: QC63857

Analyte	Spike Added	Sample	MS	%Rec #	Limits
Benzene	20	1.54	21.85	102	55-125
Toluene	20	1.73	21.74	100	65-126
Ethylbenzene	20	2.04	23.46	107	60-129
m,p-Xylenes	40	2.38	47.86	114	68-116
o-Xylene	20	1.39	24.3	115	69-129
<b>Surrogate</b>					
	%Rec	Limits			
Trifluorotoluene	90	53-124			
Bromofluorobenzene	79	41-142			

MSD Lab ID: QC63858

Analyte	Spike Added	MSD	%Rec #	Limits	RPD #	Limit
Benzene	20	21.86	102	55-125	0	11
Toluene	20	21.51	99	65-126	1	11
Ethylbenzene	20	23.39	107	60-129	0	12
m,p-Xylenes	40	47.43	113	68-116	1	11
o-Xylene	20	24.1	114	69-129	1	12
<b>Surrogate</b>						
	%Rec	Limits				
Trifluorotoluene	89	53-124				
Bromofluorobenzene	77	41-142				

# Column to be used to flag recovery and RPD values with an asterisk  
 \* Values outside of QC limits  
 RPD: 0 out of 5 outside limits  
 Spike Recovery: 0 out of 10 outside limits

Lab #: 132237

BATCH QC REPORT



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Page 1 of 1

BTXE

Client: Parsons Engineering Science, Inc.	Analysis Method: EPA 8020A
Project#: 729457	Prep Method: EPA 5030
Location: Redwood G. Water & Surface	

BLANK SPIKE/BLANK SPIKE DUPLICATE

Matrix: Water	Prep Date: 02/11/98
Batch#: 39013	Analysis Date: 02/11/98
Units: ug/L	
Diln Fac: 1	

BS Lab ID: QC63926

Analyte	Spike Added	BS	%Rec #	Limits
Benzene	20	18.31	92	69-109
Toluene	20	20.33	102	72-116
Ethylbenzene	20	19.4	97	67-120
m,p-Xylenes	40	41.84	105	69-117
o-Xylene	20	22.33	112	75-122
<hr/>				
Surrogate	%Rec	Limits		
Trifluorotoluene	96	53-124		
Bromofluorobenzene	78	41-142		

BSD Lab ID: QC63927

Analyte	Spike Added	BSD	%Rec #	Limits	RPD #	Limit
Benzene	20	18.29	91	69-109	0	11
Toluene	20	18.96	95	72-116	7	11
Ethylbenzene	20	18.54	93	67-120	5	12
m,p-Xylenes	40	40.23	101	69-117	4	11
o-Xylene	20	21.59	108	75-122	3	12
<hr/>						
Surrogate	%Rec	Limits				
Trifluorotoluene	91	53-124				
Bromofluorobenzene	76	41-142				

# Column to be used to flag recovery and RPD values with an asterisk

\* Values outside of QC limits

RPD: 0 out of 5 outside limits

Spike Recovery: 0 out of 10 outside limits



## TEH-Tot Ext Hydrocarbons

Client: Parsons Engineering Science, Inc.	Analysis Method: EPA 8015M
Project#: 729457	Prep Method: EPA 3520
Location: Redwood G. Water & Surface	

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
132237-001	MW-5	38991	02/04/98	02/06/98	02/09/98	
132237-006	SW-1	38991	02/04/98	02/06/98	02/09/98	
132237-007	SW-2	38991	02/04/98	02/06/98	02/09/98	
132237-008	SW-3	38991	02/04/98	02/06/98	02/09/98	

Matrix: Water

Analyte	Units	132237-001	132237-006	132237-007	132237-008
Diln Fac:		1	1	1	1
Diesel C12-C22	ug/L	<50	<50	<50	<50
Surrogate					
Hexacosane	%REC	87	85	81	90

Lab #: 132237

BATCH QC REPORT

TEH-Tot Ext Hydrocarbons

Client: Parsons Engineering Science, Inc.      Analysis Method: EPA 8015M  
Project#: 729457      Prep Method: EPA 3520  
Location: Redwood G.Water & Surface

METHOD BLANK

Matrix: Water      Prep Date: 02/06/98  
Batch#: 38991      Analysis Date: 02/09/98  
Units: ug/L  
Diln Fac: 1

MB Lab ID: QC63847

Analyte	Result	
Diesel C12-C22	<50	
Surrogate	%Rec	Recovery Limits
Hexacosane	98	53-136



Lab #: 132237

BATCH QC REPORT

TEH-Tot Ext Hydrocarbons

Client: Parsons Engineering Science, Inc.	Analysis Method: EPA 8015M
Project#: 729457	Prep Method: EPA 3520
Location: Redwood G.Water & Surface	

BLANK SPIKE/BLANK SPIKE DUPLICATE

Matrix: Water	Prep Date: 02/06/98
Batch#: 38991	Analysis Date: 02/09/98
Units: ug/L	
Diln Fac: 1	

BS Lab ID: QC63848

Analyte	Spike Added	BS	%Rec #	Limits
Diesel C12-C22	2475	1843	74	58-110
Surrogate	%Rec	Limits		
Hexacosane	98	53-136		

BSD Lab ID: QC63849

Analyte	Spike Added	BSD	%Rec #	Limits	RPD #	Limit
Diesel C12-C22	2475	1852	75	58-110	1	21
Surrogate	%Rec	Limits				
Hexacosane	97	53-136				

# Column to be used to flag recovery and RPD values with an asterisk

\* Values outside of QC limits

RPD: 0 out of 1 outside limits

Spike Recovery: 0 out of 2 outside limits



Curtis & Tompkins, Ltd., Analytical Laboratories, Since 1878

2323 Fifth Street, Berkeley, CA 94710. Phone (510) 486-0900

A N A L Y T I C A L   R E P O R T

Prepared for:

Parsons Engineering Science, Inc.  
2101 Webster Street  
Suite 700  
Oakland, CA 94612

Date: 19-FEB-98  
Lab Job Number: 132338  
Project ID: 729457  
Location: Redwood G.Water & Surface

Reviewed by:

Reviewed by:

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## TEH-Tot Ext Hydrocarbons

Client: Parsons Engineering Science, Inc.	Analysis Method: EPA 8015M
Project#: 729457	Prep Method: EPA 3520
Location: Redwood G. Water & Surface	

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
132338-001	MW-2	39079	02/04/98	02/13/98	02/18/98	
132338-002	MW-4	39079	02/04/98	02/13/98	02/18/98	

Matrix: Water

Analyte	Units	132338-001	132338-002
Diln Fac:		1	1
Diesel C12-C22	ug/L	200 YL	340 YL
Surrogate			
Hexacosane	%REC	94	87

Y: Sample exhibits fuel pattern which does not resemble standard  
 L: Lighter hydrocarbons than indicated standard

Lab #: 132338

BATCH QC REPORT

TEH-Tot Ext Hydrocarbons

Client: Parsons Engineering Science, Inc.      Analysis Method: EPA 8015M  
Project#: 729457      Prep Method: EPA 3520  
Location: Redwood G.Water & Surface

METHOD BLANK

Matrix: Water      Prep Date: 02/13/98  
Batch#: 39079      Analysis Date: 02/17/98  
Units: ug/L  
Diln Fac: 1

MB Lab ID: QC64178

Analyte	Result		
Diesel C12-C22	<50		
Surrogate	%Rec	Recovery Limits	
Hexacosane	94	53-136	

TEH-Tot Ext Hydrocarbons

Client: Parsons Engineering Science, Inc.	Analysis Method: EPA 8015M
Project#: 729457	Prep Method: EPA 3520
Location: Redwood G.Water & Surface	

BLANK SPIKE/BLANK SPIKE DUPLICATE

Matrix: Water	Prep Date: 02/13/98
Batch#: 39079	Analysis Date: 02/17/98
Units: ug/L	
Diln Fac: 1	

BS Lab ID: QC64179

Analyte	Spike Added	BS	%Rec #	Limits
Diesel C12-C22	2475	1875	76	58-110
Surrogate	%Rec	Limits		
Hexacosane	90	53-136		

BSD Lab ID: QC64180

Analyte	Spike Added	BSD	%Rec #	Limits	RPD #	Limit
Diesel C12-C22	2475	2070	84	58-110	10	21
Surrogate	%Rec	Limits				
Hexacosane	99	53-136				

# Column to be used to flag recovery and RPD values with an asterisk

\* Values outside of QC limits

RPD: 0 out of 1 outside limits

Spike Recovery: 0 out of 2 outside limits



132237

# CHAIN OF CUSTODY RECORD

Project No.: 729457-06000					NO. OF CONTAINERS	ANALYSIS REQUIRED / PRESERVATIVE										Remarks							
Project Name/Location: Redwood Regional Park / Oakland						<div style="display: flex; justify-content: space-around;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">TVH + BTEX (PTSC LUFT)</div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">TEH (PTSC LUFT)</div> </div>																	
Project Manager: Bruce Rucker																							
Sampler(s): (Printed Name and Signature) Bruce Rucker B.M. Rucker																							
Sample ID	Sample Location	Date	Time	Matrix																			
1 MW-5	Well MW-5	2/4/98	1005	H2O	3	✓	✓														TVH samples are HCl-preserved.		
2 MW-2	" MW-2	↓	1115	↓	3	✓																	
3 MW-4	" MW-4		1210		3	✓																	
4 MW-BA	" MW-BA		blind		2	✓																	
5 MW-BB	" MW-BB		1215		2	✓																	
-6 SW-1	upstream surface water				1225		3	✓	✓														
-7 SW-2	mid-pt. "				1230		3	✓	✓														
-8 SW-3	downstream "				1235		3	✓	✓														
RELINQUISHED BY: (SIGNATURE) B.M. Rucker			DATE 2/4/98		TIME 1350	RECEIVED BY: (SIGNATURE) J. GUERRERO		DATE 2-4-98		TIME 1:50pm		NOTES:											
RELINQUISHED BY: (SIGNATURE)		DATE	TIME	RECEIVED FOR LAB BY: (SIGNATURE)		DATE	TIME	REMARKS/COMMENTS:															