★ **Stellar Environmental Solutions**

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Geoscience & Engineering Consulting

October 9, 1998

Mr. Michael Rugg
California Department of Fish and Game
P.O. Box 47
Yountville, California 94599

Subject: Workplan for Continued Site Investigation and Site Closure Assessment
for Redwood Regional Park Service Yard Site - Oakland, California

Dear Mr. Rugg:

On behalf of the East Bay Regional Park District (District), Stellar Environmental Solutions (SES) is pleased to submit this workplan for the underground fuel storage tank (UFST) site located at the Redwood Regional Park Service Yard Site, 7867 Redwood Road in Oakland, California. SES is the District's new consultant and will be continuing the site investigation activities that have been conducted by the previous consultant (Parsons Engineering Science, Inc.) since 1993. Project continuity will be ensured as the SES project manager, Mr. Bruce Rucker, was the Parsons project manager since the inception of the project.

This workplan is submitted in response to Alameda County Health Care Services Agency's (ACHCSA) July 1, 1998 request to address potential environmental impacts associated with the site's former leaking underground fuel storage tanks (UFSTs). Fuel contaminants (including gasoline, diesel and BTEX constituents) have been documented in site soils and groundwater, and have been periodically detected in the adjacent Redwood Creek. In accordance with a recent verbal request from Mr. Scott Seery (ACHCSA case officer) this workplan is being submitted to you.

This workplan summarizes the objectives, scope of work and methodologies for continued site investigation and assessment activities. The workplan proposes to evaluate the data collected to date, complete an additional groundwater and creek surface monitoring event, and identify a viable site closure strategy. Following the additional sampling event, SES will identify sensitive site receptors and other environmental impacts; model existing hydrochemical and hydrologic data to evaluate groundwater plume stability and potential long-term impacts, and evaluate remedial options to address unacceptable impacts, including the viability of introducing oxygen releasing compounds existing and/or additional site groundwater wells to enhance natural degradation of fuel compounds. The workplan also presents the qualifications of the SES team.

We estimate that the report summarizing the results of the workplan activities will be completed by approximately November 1, 1998. Please contact me directly at 510-644-3123 if you have any questions or require additional information regarding the proposed scope of work.

Sincerely,

Bruce M. Rucker

Bruce M. Rucker, R.G., R.E.A,
Project Manager

Richard S. Makdisi, R.G., R.E.A.
Principal

cc. Warren Gee, East Bay Regional Park District

WORKPLAN FOR CONTINUED SITE INVESTIGATION AND SITE CLOSURE ASSESSMENT

REDWOOD REGIONAL PARK SERVICE YARD
OAKLAND, CALIFORNIA

Prepared For:

EAST BAY REGIONAL PARK DISTRICT
OAKLAND, CALIFORNIA

Prepared By:

STELLAR ENVIRONMENTAL SOLUTIONS
2110 SIXTH STREET
BERKELEY, CALIFORNIA 94710

October 1998

Project No. 98031

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1.0 INTRODUCTION AND BACKGROUND

PROJECT BACKGROUND

The site is an active East Bay Regional Park District (District) service yard that utilized two UFSTs (gasoline and diesel fuel) from the mid-1960s through 1993 when they were removed along with associated hydrocarbon contaminated soil. Soil and groundwater were contaminated by total petroleum hydrocarbons (TPH) associated with releases from the UFSTs. The extent of this contamination has been documented in a series of site characterization activities conducted since 1993. The Alameda County Health Care Services Agency (ACHCSA) is the lead regulatory agency for the site investigation.

In 1998, ACHCSA, with input from the State of California Department of Fish and Game, requested that the District submit a workplan to address continued site activities. Of immediate concern to the regulatory agencies are the potential impacts to Redwood Creek, located approximately 130 feet downgradient of the former UFSTs. Detection of fuel constituents in the creek during the low flow summer months and the presence of a petroleum sheen indicate that the groundwater plume daylights in the creek.

KEY OBJECTIVES AND SCOPE OF WORK SUMMARY

The key objectives of this site investigation are to: critically evaluate site hydrochemical and contaminant migration data, identify site-specific Applicable, Relevant and Appropriate Regulations (ARARs) and regulatory agency site closure criteria; evaluate current and future impacts; assess the need for additional remediation and/or investigation; and evaluate remedial strategies to meet site closure or cleanup objectives.

The tasks that will be conducted to meet these objectives include:

- Conduct an additional groundwater and surface monitoring, sampling and analysis event.
- Conduct trend analyses of the groundwater hydrochemistry.
- Estimate the mass of residual contamination in soil and groundwater.
- Identify potential receptors and other impacts associated with site contamination.

- Discuss the relevant site analytical and geologic data with respect to ARARs.
- Evaluate if additional site remediation and/or investigation is necessary in light of ARARs, potential impacts and regulator site closure criteria.
- If remediation is deemed necessary, evaluate viable remedial strategies, including Monitored Natural Attenuation and active mass removal/reduction techniques.

These activities are described in detail in subsequent Section 2.0 – Proposed Activities.

SITE DESCRIPTION AND PHYSICAL SETTING

The project site is located at 7867 Redwood Road in Oakland, Alameda County, California. Figure 1 shows the location of the project site. Figure 2 shows a site plan with the monitoring wells. Redwood Creek, a creek known for its occurrence of California rainbow trout, runs north to south approximately 130 feet west of the former UFSTs. Creek flow varies seasonally from spring fed flow in the summer, which results in interrupted flow along the creek, and fall dry season to high flow (up to several feet deep) in the spring and winter rainy season. Total topographic relief from the service yard to the creek bed (east to west) is approximately 30 feet. The area of investigation consists of a paved service yard, the paved park road, a dirt parking lot and wooded terrain.

Shallow soil stratigraphy beneath the project site consists of a surficial 3- to 10-foot thick clayey silt unit underlain by a 5- to 15-foot thick silty clay unit. In all monitoring well borings, a 5- to 10-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.

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 UFST excavation. Groundwater seepage into Redwood Creek is indicated by historical observations of fuel-contaminated capillary fringe soils in the eastern bank of Redwood Creek. The direction of local groundwater flow beneath the project site is approximately from northeast to southwest.

HISTORICAL SITE INVESTIGATIONS AND REMEDIAL ACTIVITIES

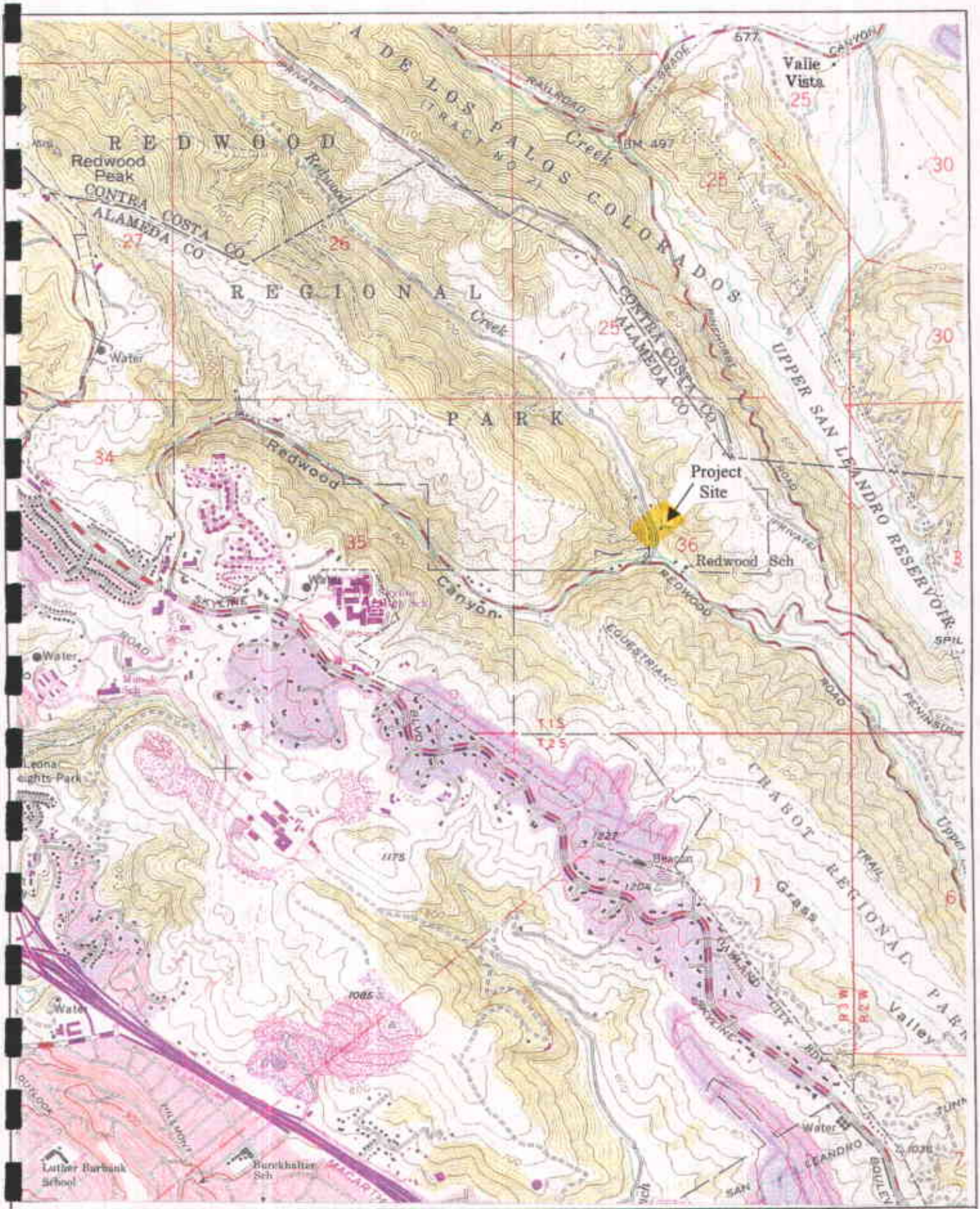
The two UFSTs and approximately 600 cubic yards of contaminated soil were removed in April 1993. Excavation of contaminated soil was halted due to the potential for slope instability, the presence of significant facility constraints, and infiltration of spring water into the excavation. Confirmation soil samples collected in the excavation sidewalls contained up to 12,000 milligrams

per kilogram (mg/kg) TPH-gasoline, 1,300 mg/kg TPH-diesel, 80 mg/kg benzene, 390 mg/kg toluene, 230 mg/kg ethylbenzene and 1,100 mg/kg total xylenes.

An initial site characterization was conducted in September and October 1993 in the vicinity of the former UFST excavation to evaluate the nature, magnitude and extent of soil and groundwater contamination associated with the residual UFST-sourced soil contamination. 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 198 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).

In February 1994, petroleum-contaminated soil in the bed of Redwood Creek where the plume daylights southwest of the former UFSTs was sampled and 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. Fuel analytes have been detected in surface water in four of the ten sampling events. 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.

Fe fixating?



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U.S.G.S. TOPOGRAPHIC MAP SHOWING SITE LOCATION

Redwood Regional Park Service Yard
Oakland, Alameda County, California

By: MJC | NOVEMBER 1997

Figure 1

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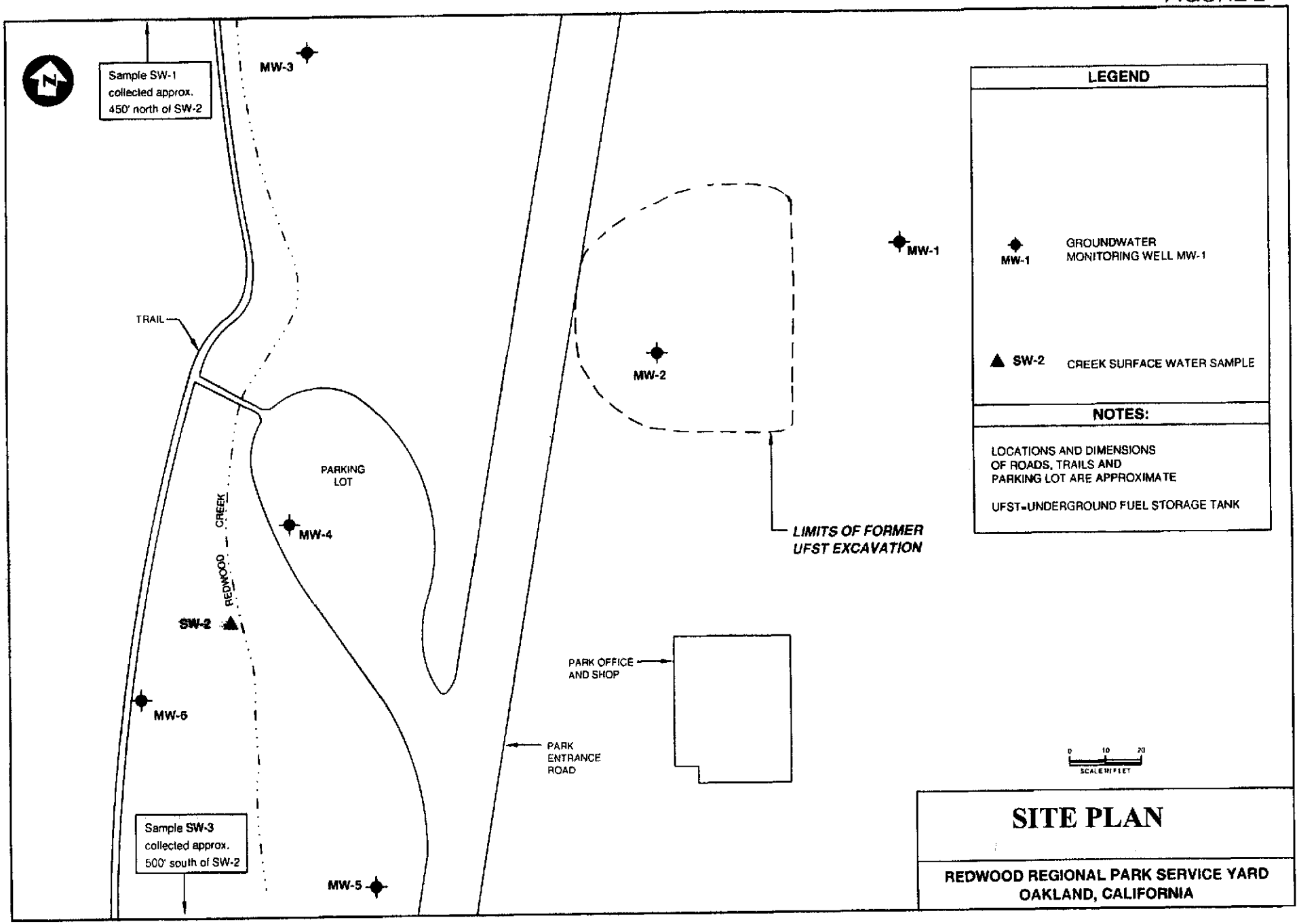
FIGURE 2



SITE PLAN

REDWOOD REGIONAL PARK SERVICE YARD
OAKLAND, CALIFORNIA

2.0 PROPOSED ACTIVITIES

This section discusses the proposed activities for the next phase of the investigation, and are presented in the following subsections: Prepare Site Health and Safety Plan; Groundwater and Surface Water Monitoring, Sampling and Analysis; Evaluate Chemical Trends, Applicable Regulations and Closure Strategy; and Prepare Report of Findings.

PREPARE SITE HEALTH AND SAFETY PLAN

In conformance with the Federal and California Occupational Health and Safety Administration (OSHA) requirements [29 CFR 1910.120(j)] for personnel involved in field activities at sites with any known or suspected contamination, SES will prepare a site-specific health and safety plan (HASP) based on the currently available data, prior to performing the groundwater sampling event. The HASP will be included as an attachment to the workplan and will include a discussion of the following:

- Purpose, applicability and responsibility;
- Site contaminants and monitoring protocols;
- General health and safety emergency procedures;
- Levels of personal protection; and
- Site organization and control.

GROUNDWATER AND SURFACE WATER MONITORING, SAMPLING AND ANALYSIS

Continued groundwater and surface water monitoring, sampling and analysis will be conducted to provide hydrochemical and hydrologic data necessary to evaluate site conditions. In addition to those compounds historically analyzed (TPH-G, TPH-D and BTEX), water samples collected in the proposed additional sampling event will be analyzed for methyl tertiary butyl ether (MTBE), a gasoline oxygenating additive that has been recently identified by regulatory agencies as a compound of concern at gasoline release sites.

The ACHCSA has recommended that a "no purge" groundwater monitoring well sampling protocol be implemented to assess any differences in water quality compared to a post purge sample. The

decision to implement that strategy will be based on whether a "no purge" sample was collected before well purging, and a one "post-purge" sample was collected following the removal of three to five saturated volumes at each monitoring well. SES will evaluate the technical validity of implementing the other recommendations made by Parsons ES in the last site report regarding revising groundwater and surface water program, and will discuss any proposed recommendations in the next report (see subsequent section "Prepare Report of Findings").

EVALUATE CHEMICAL TRENDS, APPLICABLE REGULATIONS AND SITE CLOSURE STRATEGY

SES will critically evaluate historical hydrochemical and hydrogeologic data in the context of hydrochemical trends, potential impacts and applicable regulations. The overall objective of this review will be to estimate the mass of residual contamination and develop a conceptual model of the environmental mobility and fate of site contaminants. Based on the evaluation, a literature review will be conducted to identify published data and regulatory agency criteria regarding potentially viable remedial strategies. These data will be used to qualitatively evaluate the viability of remedial options that would decrease potential impacts to Redwood Creek and other potential receptors and expedite site closure. One of the remedial options that will be evaluated will be Monitored Natural Attenuation (MNA) coupled with the addition of oxygen releasing compounds to existing and/or additional site groundwater wells for the purpose of enhancing natural degradation of fuel compounds. Concurrently, SES will identify any data gaps that may need to be addressed to evaluate remedial options and advance site closure. We anticipate that this may include: exploratory borehole sampling and analysis to determine the current lateral extent and maximum concentrations of fuel compounds in site groundwater and soil; and, analyzing groundwater samples for indicators of natural attenuation and to evaluate the need for adding oxygen releasing compounds to enhance biodegradation of fuel compounds.

SES will also review the Applicable, Relevant and Appropriate Regulations (ARARs), guidance, specifications and any policy that relates to the site and the District's goal of achieving site closure. The regulatory assessment will entail reviewing the regulatory communication on the site from ACHCSA and/or CF&G, any site orders, recent changes in regulatory closure criteria, citation of published literature on fuel site closure criteria assessment, reviewing the cleanup goal objectives and determining rationale for changes in the cleanup goals that would still be consistent with overall regulatory considerations. SES will also identify sensitive receptors, including available information on the Redwood Creek rainbow trout population, and qualitatively assess the current and future potential impacts to these receptors associated with site contamination.

PREPARE REPORT OF FINDINGS

SES will prepare a concise and comprehensive draft report documenting the results of the scope of work activities and discussing the implications of findings with respect to applicable regulations and regulatory concerns to achieve the objective of site closure. The report will contain:

- Executive summary of findings;
- Investigation scope and objectives;
- Environmental background and history of the site, including a database of all pertinent site data;
- Regional and local geologic and hydrogeologic conditions;
- Site maps delineating site features, investigation/remediation and locations, and other pertinent information;
- Description of fieldwork and groundwater sampling protocols;
- Historical and the current monitoring analytical results tabulated along with applicable regulatory limits of concern;
- Evaluation of the extent of residual soil and groundwater contamination based on the data collected;
- Hydrologic and hydrochemical trend analyses;
- Discussion of the fate and transport mechanisms of the constituents of concern in the groundwater and their potential migrational pathways;
- Qualitative evaluation of potentially viable remedial options;
- Summary and conclusions;
- Recommended revisions to the current sampling and analysis program as necessary to support the selected remedial option
- Recommended protocols for addressing data gaps as necessary to support the selected remedial option;
- Technical and regulatory references; and
- Technical appendices including chain-of-custody records and laboratory results.

The report will be submitted to both ACHCSA and California Fish & Game.

3.0 SCHEDULE

We estimate that the report summarizing the investigation will be submitted to ACHCSA and California Fish & Game by approximately November 1, 1998.

The schedule for subsequent site activities will necessarily depend on the scope of those activities. The District and/or SES will keep ACHCSA and California Fish & Game apprised of the schedule for follow-on activities.

4.0 SES TEAM QUALIFICATIONS

STELLAR ENVIRONMENTAL SOLUTIONS

Stellar Environmental Solutions was established in 1995 and provides a full range of environmental and engineering services needed for environmental and hazardous waste management projects throughout California. Our clients include both private sector (commercial, industrial, developers and utilities) and public sector (special districts, utilities city and municipal agencies). Services provided range from hazardous waste management planning, to identifying and assessing hazardous materials and soil and groundwater contamination, to designing, managing construction, and providing short-term operations and maintenance for remedial actions. Our geotechnical and environmental engineering capabilities have been used to solve problems related to third party reviews, environmental compliance audits, RCRA assessments, hazardous waste planning characterization of hazardous waste in air, soil and water, remediation design and implementation services, industrial facility closures, and site regulatory closures.

Stellar Environmental Solutions is a small and locally-focused (Bay Area) focused consulting firm with four senior principal/associates and a cadre of specialty subcontractors. Every SES project has a principal providing technical oversight and/or project management, bringing up to 20 years of experience to the project. The following are brief resumes of key personnel that will implement this project. The corporate qualifications of the sampling and analytical laboratory subcontractors are presented at the end of this section.

Richard Makdisi, R.E.A., R.G. – Principal

Education: MS, Geochemistry, California State University, 1980
BA, Geology, University of London, England, 1974

Registrations: Registered Geologist, California #4652, 1988
California Registered Environmental Assessor #00282, 1987

Mr. Makdisi, a California Registered Geologist (R.G.) and Registered Environmental Assessor (R.E.A.), is Principal of Stellar Environmental Solutions (SES). He has more than 20 years of experience in hazardous management, geoscience engineering, geochemistry, and geohydrology. Mr. Makdisi has hands-on experience managing U.S. EPA, and Cal EPA, RCRA and CERCLA remediation sites for commercial and government clients. He has conducted Remedial

Investigation/Feasibility Studies (RI/FS), Remedial Action Plans (RAPs), Remedial Design, and remediation. Mr. Makdisi has extensive knowledge of California hazardous waste, solid waste, water code regulations, and ARAR development, and has provided client-regulatory agency liaison services on major remediation projects. He has implemented soil gas, geophysical, geotechnical, and hydropunch sampling investigations, and has extensive experience in evaluating remedial technologies and overseeing their implementation. Mr. Makdisi has achieved site closures for numerous contaminated sites and completed facility closures (RCRA, PBR and non-RCRA sites) for manufacturing sites. He has also prepared Solid Waste Assessment Test and hazardous waste planning documents, including HWMDs, RMPPs and SPCCs. In addition to his hazardous waste investigations, Mr. Makdisi has provided geology, soils, seismicity, hazardous materials and risk assessment analyses for over 25 major Environmental Impact Reports/ Environmental Impact Statements (EIR/EIS).

Bruce Rucker, R.E.A., R.G. – Project Manager

Education:	MS, Geology, California State University, Hayward, 1996 BA, Environmental Sciences, University of Virginia, 1984
Registrations	Registered Geologist, California #6814, 1998 California Registered Environmental Assessor #2465, 1990 Professional Certificate in Hazardous Materials Management, University of California, 1990

Mr. Rucker, a California R.G. and R.E.A., has over 10 years of experience in providing a broad range of environmental services to commercial and public sector clients. Mr. Rucker has been Project Manager for the Redwood Regional Park Service Yard project since its inception in 1993. His expertise includes: conducting Phase I environmental site assessments and hazardous materials sections of EIRs/EISs for transportation and water conveyance corridors and for individual properties; designing and implementing contaminant investigations; evaluating remedial options and implementing soil and groundwater remedial actions associated with a multitude of contaminant source types; post-remediation surface water and groundwater monitoring; risk-based evaluation of impacts from residual contamination; conducting facility regulatory compliance audits including asbestos surveys; air and noise monitoring; peer review of technical documents; NPDES Permit wastestream compliance monitoring and reporting; on-call, rapid-response construction-phase contaminant assessment; managing waste soil and water including landfarming and profiling for off-site treatment/disposal; and regulatory liaison including permitting, data reporting, and negotiating work scopes and cleanup standards. Mr. Rucker has demonstrated proficiency in designing and implementing investigations to both meet the needs of the client and to satisfy regulatory agency requirements in a cost-effective and technically excellent manner.

BLAINE TECH SERVICES, INC. – GROUNDWATER AND SURFACE WATER SAMPLING SERVICES

BTS (San Jose, California) is a technical sampling and reporting firm established in 1985 to provide quality third-party field sampling and documentation services. BTS has been performing groundwater sampling at EPA superfund sites and RCRA sites in Alameda and Santa Clara counties continuously since 1987. BTS has 15 innovatively-designed sampling trucks with all the necessary specialized tools to perform efficient sampling of drummed material wastes, soil, groundwater and surface water. BTS has successfully completed over 20 projects since 1995 under SES's direction.

CURTIS & TOMPKINS, LTD. – ANALYTICAL LABORATORY SERVICES

C&T (Berkeley, California) is a State of California Department of Health Services-certified hazardous waste analytical laboratory (Environmental Laboratory Accreditation Program [ELAP] No. 1459) that maintains current certifications for all the analytical methods proposed for this investigation. Founded in 1878, C&T is the oldest continuously-operating consulting laboratory in the United States, providing environmental/toxics laboratory analyses and data management services from their Berkeley facility since 1980. C&T has been conducting soil and water analyses for the Redwood Regional Park Service Yard project since its inception in 1993, and has provided similar services to SES on dozens of projects since 1995.

APPENDIX A: SAMPLING AND MONITORING PROTOCOLS

SAMPLING AND ANALYSIS PERSONNEL

Sampling and analysis will be conducted by trained personnel. Sampling and analysis personnel will be trained in the performance of the specific task to which they are assigned.

SUMMARY OF SAMPLING PROCEDURES

Activities which will occur during groundwater sampling are summarized as follows:

- Pre-arrangement with testing laboratory
- Assembly and preparation of equipment and supplies
- Groundwater sampling
  - water-level measurements
  - immiscible material measurements (with an interface probe)
  - visual inspection of borehole water
  - well bore evacuation
  - sampling
- Sample preservation and shipment
  - sample preparation
  - onsite measurement of parameters
  - sample labeling
- Completion of sample records
- Completion of chain-of-custody records
- Sample shipment

Detailed sampling and analysis procedures are presented in following sections.

ARRANGEMENTS WITH ANALYTICAL LABORATORY

Prior to sampling, arrangements will be made with an analytical laboratory to conduct the sample analyses. The laboratory will provide a sufficient number of sample containers for the wells to be sampled and the blanks to be included. The laboratory will determine the proper type and size for the containers based upon the analyses requested. For samples requiring chemical preservation, preservatives will be added to containers by the laboratory prior to shipping containers to the site. Shipping containers, ice chests with adequate container padding, will be sent to the site with the containers.

PREPARATION FOR SAMPLING

Prior to the sampling episode, equipment to be used will be assembled and its operating condition verified, calibrated (if required), and properly cleaned (if required). In addition, all record-keeping materials will be prepared.

Equipment Check-Out

This activity includes the verification that equipment is in proper operating condition. Also, arrangements for repair or replacement of any equipment which is inoperative are made.

Equipment Calibration

Where appropriate, equipment will be calibrated according to the manufacturer's specifications prior to field use. This applies to the equipment for making onsite chemical measurements of pH, conductivity, and temperature of water.

Equipment Cleaning

Portions of sampling and test equipment which will contact the sample will be thoroughly cleaned before use for sampling. This will include the water-level probe, bailers, lifting line, and other equipment or portions thereof which may be immersed. The procedure for cleaning non-dedicated equipment is given below.

- Clean with potable water and phosphate-free detergent
- Rinse with potable water
- Rinse with distilled or deionized water
- Air dry the equipment prior to use

Any deviations from these procedures will be documented in the permanent record of the sampling event.

Laboratory-supplied sample containers will be cleaned and sealed by the laboratory before shipping. The type of container provided and the method of container cleaning should be in the laboratory's permanent record of the sampling event.

Sampling equipment to be disposed of after use will be cleaned with potable water and phosphate-free detergent before disposal as solid waste. Rinse water will be stored on-site in the plastic storage tank for subsequent proper disposal.

GROUNDWATER SAMPLING PROCEDURES

Special care will be exercised to prevent contamination of the groundwater and extracted samples during the sampling activities. The two primary ways in which such contamination can occur are:

- Contamination of a sample through contact with improperly cleaned equipment.
- Cross-contamination of the groundwater through insufficient cleaning of equipment between wells. Pre-cleaned disposable sampling equipment will be rinsed with distilled water prior to use.

To prevent such contamination, sampling equipment and sample containers will be thoroughly cleaned before and after field use and between uses at different sampling locations according to the procedures in Section 4.3. In addition to the use of properly cleaned equipment, two further precautions will be taken:

- A clean pair of new, disposable latex (or similar) gloves will be worn each time a different well is sampled.
- Sample collection activities will progress from the least affected (upgradient) area to the most affected (downgradient) area. Wells described as "background" or "upgradient" wells will be sampled first.

The following paragraphs present procedures for the several activities which comprise groundwater sample acquisition. These activities will be performed in the same order as presented below. Exceptions to this procedure will be noted in the permanent sampling record.

Preparation of Location

Prior to starting the sampling procedure, the area around the well will be cleared of foreign materials, such as brush, rocks, debris, etc. A clean (new), disposable plastic sheet will be placed around the well casing so that the sheet is flat on the ground. The sheet will be placed such that the flush-mount

well projects through the center of the sheet. This preparation will prevent sampling equipment from inadvertently contacting the ground or exterior parts of the well.

Water-Level Measurement

The first sampling operation will be water-level measurement. An electrical probe or a weighted tape will be used to measure the depth to groundwater below the datum to the nearest ⅛-inch (0.01 foot). The datum, usually the top of the inner casing (inside and below the protective steel cover), will be described in the monitoring well records. A permanent mark or scribe will be marked on the inner casing.

If the wells to be sampled are closely spaced, the water levels at all of the closely spaced wells will be measured before any of the wells are evacuated. The water-level probe or weighted tape will be cleaned with phosphate-free detergent in distilled water and with a distilled water rinse between usage at different wells.

Immiscible Material Measurement

After the water level is measured, an interface probe will be lowered into the well to measure the thickness of any immiscible materials floating on the water surface. The thickness of any immiscible material will be noted on the sampling records.

Total Depth Measurement

Once the water level and immiscible material thickness is measured and recorded, the water-level probe or weighted tape will be slowly lowered to the bottom of the well. The depth to the bottom will be measured and recorded. The probe or tape will then be slowly withdrawn from the well. The bottom of the probe or tape will be observed after withdrawal to determine if evidence of any viscous, heavy contaminants are apparent. Descriptions, and measurements if possible, of such materials will be made from observation of the probe or tape.

Visual Inspection of Well Water

Prior to well evacuation, a small quantity of water will be removed with a bailer, in a manner which does not totally immerse the bailer. The recovered sample is representative of the top of the water column in the well casing. If immiscible materials were present as measured by the interface probe at the top of the water column, this technique can allow their detection. The water will be observed for the presence of any floating films or other indications of immiscible materials. Any sample odors will be noted. These observations regarding odor or visual evidence of immiscible materials will be recorded in the sampling record.

The sample taken in this manner will be discarded unless the site-specific protocol calls for retention of this sample. The sample will be placed in a labeled container for proper disposal.

Non-Purge Sampling

If applicable, non-purge samples will be collected immediately following water level measurement by lowering a pre-cleaned bailer until it is fully immersed, then retrieving the bailer. Care will be taken to minimize disturbance of the well water during sampling.

Well Bore Evacuation

If post-purge samples are to be collected, observations of purged water will be recorded during removal and prior to it being discarded. Onsite parameter measurements of the purged water, as described in this section, will indicate when water-quality parameters have stabilized, and also will be recorded.

The volume of water contained within the well bore at the time of sampling will be calculated, and four times the calculated volume will be removed from the well and discarded. A bailer will be used for well evacuation. Calculation of the volume of water to be evacuated will be done as follows:

Number of Bailers:

$$\text{Number of bailers} = 4 \times \frac{\text{Volume of water in well (Vw)}}{\text{Volume of bailer (Vb)}}$$

Volume of Water in Well:

$$Vw = \frac{3.142 \times dw^2 \times Lw}{4}$$

where: Vw = water volume in well (ft^3)

dw = inside diameter of well (ft)

Volume of Water in Full Bailer:

$$Vb = \frac{3.142 \times db2 \times Lb}{4}$$

where: Vb = water volume in bailer (ft^3)

db = inside diameter of bailer (ft)

Lb = length of bailer (ft)

For wells which can be evacuated to a dry state, the well will be evacuated completely, and the sample taken as soon as sufficient water for sampling is present in the well. Sample compositing, or sampling over a lengthy period by accumulating small volumes of water at different times to eventually obtain a sample of sufficient volume, will not be done.

Water produced during well evacuation will be contained in a suitable container and temporarily stored onsite pending proper disposal.

Certain chemical and physical parameters in water can change significantly within a short time of sample acquisition. These parameters cannot be accurately measured in a laboratory located more than a few hours from the facility, and so will be measured onsite with portable equipment. These parameters are:

- pH
- Specific conductance
- Temperature

These parameters will be measured in unfiltered, unpreserved, "fresh" water taken by the same technique as the samples taken for laboratory analyses. The measurements will be made in a clean glass container separate from those intended for laboratory analyses. The tested sample will be discarded after use. The measured values will be recorded in the sampling record.

Sample Extraction

A disposable polyethylene bailer will be used to extract water samples from the well. Care will be taken during insertion of sampling equipment to prevent undue disturbance of water in the well. The bailer will be lowered into the water gently to prevent splashing and extracted gently to prevent creation of an excessive vacuum in the well. The sample will be transferred directly into the appropriate container. While pouring water from a bailer, the water will be carefully poured down the inside of the sample bottle to prevent significant aeration of the sample. Unless other instructions are given by the analytical laboratory, the sample containers will be completely filled so that no air space remains in the container. Excess water taken during sampling will be placed in a container for proper disposal.

CREEK SURFACE WATER SAMPLING

Surface water samples will be collected at previously marked locations along the creek bed. Samples will be collected in a sequence from downstream to upstream to minimize disturbance of creek sediments, and the sampler will take care at each location to not stir up creek sediments or otherwise cause the disturbance of creek water before or during sampling.

Samples will be collected by lowering a new, clean sampling container (unpreserved) so that the container lip is just below the water surface. Care will be taken to not allow floating or suspended materials to enter the sampling container. For samples to be analyzed for extractable hydrocarbons (diesel range), the samples will be collected directly in the container to be transported to the laboratory. For volatile hydrocarbons samples (gasoline and BTEX), samples will be collected in a new, clean, unpreserved container then transferred to the pre-preserved glass VOA vials in a manner that minimizes sample agitation and does not allow overflow of the sample preservative.

Quality Control Samples

For the sampling event, a trip blank sample (distilled water) will be shipped from the laboratory to the facility and will be returned to the laboratory for analysis. The trip blank will not be opened in the field. A field duplicate groundwater sample also will be included for analysis to evaluate the precision of laboratory analytical testing. Generally, the field duplicate sample will be collected from the well that contained the lowest detectable concentrations of volatile compounds (TPH-g and BTEX) in the previous sampling event. The field duplicate sample will be given a "blind" designation that will not be recognized as a duplicate and that will not be confused with other samples analyzed.

SAMPLE HANDLING

Sample Preservation

Water samples will be properly prepared for transportation to the laboratory by refrigeration and chemical preservation, as necessary. The laboratory providing sample containers will add any necessary chemical preservatives to the sealed containers provided prior to shipment.

Container and Labels

Glass containers and appropriate container lids will be provided by the laboratory. The containers will be filled and container lids tightly closed. Sample container lids will be sealed so that it will be obvious if the seal has been tampered with or broken. The label will be firmly attached to the container side (not lid). The following information will be legibly and indelibly written on the label:

- Facility name
- Sample identification
- Sample type (groundwater, surface water, etc.)
- Sampling date
- Sampling time
- Preservatives added, and, sample collectors initials

Sample Shipment

In most instances, the concentration and type of compounds present in the groundwater are considered by the U.S. Department of Transportation to be non-hazardous. Thus, the following packaging and labeling requirements for the sample materials are appropriate for shipping the sample to the testing laboratory:

- Package sample so that is does not leak, spill, or vaporize from its packaging
- Label package with:
  - sample collector's name, address, and telephone number
  - laboratory's name, address, and telephone number
  - description of sample
  - quantity of sample
  - date of shipment

To comply with packaging regulations and to take practical measures to prevent damage to expensive groundwater samples, SES will follow packaging and shipping instructions supplied by the certified testing laboratory.

Chain-of-Custody Control

After samples are obtained, chain-of-custody procedures will be followed to establish a written record concerning sample movement between the sampling site and the testing laboratory. Each shipping container will contain a chain-of-custody form to be completed by the sampling personnel packing the samples. The chain-of-custody form for each container will be completed in triplicate. One copy of this form will be maintained at the site, and the other two copies at the laboratory. One of the laboratory copies will become a part of the permanent record for the sample and will be returned with the sample analyses.

The record will contain the following minimum information:

- Collector's sample number
- Signature of collector
- Date and time of collection
- Place and address of collection
- Material type
- Preservatives added
- Analyses requested
- Signatures involved in the chain of possession
- Inclusive dates of possession

The shipping container will be sealed so that it will be obvious if the seal has been tampered with or broken. The Chain-of-Custody documentation will be placed inside the container so that it is immediately apparent to the laboratory personnel receiving the container, but could not be damaged or lost during shipping.

SAMPLING RECORDS

To provide complete documentation of sampling, detailed records will be maintained during sampling. These records will include the information listed below:

- Sample location (facility name)
- Sample identification (name and sample number)

- Sample location map or detailed sketch
- Date and time of sampling
- Sampling method
- Field observations of sample appearance and odor
- Weather conditions
- Samples identification
- Any other information which is significant