

RECEIVED

7:44 am, Jun 11, 2007

Alameda County
Environmental Health

FIRST QUARTER 2007 SITE MONITORING REPORT

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

Prepared for:

**EAST BAY REGIONAL PARK DISTRICT
OAKLAND, CALIFORNIA**

April 2007

**FIRST QUARTER 2007
SITE MONITORING REPORT**

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

Prepared for:

**EAST BAY REGIONAL PARK DISTRICT
P.O. Box 5381
OAKLAND, CALIFORNIA 94605**

Prepared by:

**STELLAR ENVIRONMENTAL SOLUTIONS, INC.
2198 SIXTH STREET
BERKELEY, CALIFORNIA 94710**

April 25 2007

Project No. 2006-17

April 25 2007

Mr. Jerry Wickham, P.G.
Hazardous Materials Specialist, Local Oversight Program
Alameda County Department of Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

Subject: First Quarter 2007 Site Monitoring Report
Redwood Regional Park Service Yard Site – Oakland, California
Alameda County Environmental Health Fuel Leak Case No. RO0000246

Dear Mr. Wickham:

Attached is the referenced Stellar Environmental Solutions, Inc. report for the underground fuel storage tank (UFST) site at the Redwood Regional Park Service Yard, located at 7867 Redwood Road, Oakland, California. This project is being conducted for the East Bay Regional Park District (EBRPD), and follows previous site investigation and remediation activities (conducted since 1993) associated with former leaking UFSTs. The key regulatory agencies for this investigation are the Alameda County Department of Environmental Health, the Regional Water Quality Control Board, and the California Department of Fish and Game.

This report summarizes groundwater and surface monitoring and sampling activities conducted between January 1 and March 31, 2007 (First Quarter 2007). Ongoing bioventing activities are reported in technical submittals that are separate from the ongoing groundwater and surface water monitoring quarterly reports; however, summaries of bioventing activities are included in the quarterly groundwater monitoring reports.

I declare, under penalty of perjury, that the information and/or recommendations contained in the attached document or report is true and correct to the best of my knowledge. If you have any questions regarding this report, please contact Mr. Neal Fujita of the EBRPD, or contact us directly at (510) 644-3123.

Sincerely,



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



cc: Carl Wilcox, California Department of Fish and Game
Neal Fujita, East Bay Regional Park District
State of California GeoTracker system; Alameda County Environmental Health ftp system

TABLE OF CONTENTS

Section	Page
1.0 INTRODUCTION.....	1
Project Background.....	1
Objectives and Scope of Work.....	1
Historical Corrective Actions and Investigations	1
Site Description.....	2
Regulatory Oversight	2
2.0 PHYSICAL SETTING.....	6
Site Lithology.....	6
Hydrogeology.....	10
3.0 Q1 2007 ACTIVITIES	13
Groundwater and Surface Water Monitoring Activities	13
Bioventing-related Activities	15
4.0 REGULATORY CONSIDERATIONS	16
Groundwater Contamination.....	16
Surface Water Contamination	16
5.0 MONITORING EVENT ANALYTICAL RESULTS	18
Current Event Groundwater and Surface Water Results	18
Quality Control Sample Analytical Results	19
6.0 SUMMARY, CONCLUSIONS, AND PROPOSED ACTIONS.....	21
Summary and Conclusions.....	21
Proposed Actions	22

TABLE OF CONTENTS (continued)

Section	Page
7.0 REFERENCES AND BIBLIOGRAPHY	23
8.0 LIMITATIONS	28

Appendices

Appendix A	Historical Groundwater Monitoring Well Water Level Data
Appendix B	Groundwater Monitoring Field Documentation
Appendix C	Analytical Laboratory Report and Chain-of-Custody Record
Appendix D	Historical Groundwater and Surface Water Analytical Results

TABLES AND FIGURES

Tables	Page
Table 1 Groundwater Monitoring Well Construction and Groundwater Elevation Data – March 21, 2007 Monitoring Event Redwood Regional Park Corporation Yard, Oakland, California	14
Table 2 Groundwater and Surface Water Sample Analytical Results – March 21, 2007 Redwood Regional Park Corporation Yard, Oakland, California	19

Figures	Page
Figure 1 Site Location Map	3
Figure 2 Site Plan and Historical Sampling Locations	4
Figure 3 Geologic Cross-Section Locations	7
Figure 4 Geologic Cross-Sections A-A' through C-C'	8
Figure 5 Geologic Cross-Sections D-D' through F-F'	9
Figure 6 Groundwater Elevation Map – March 21, 2007	11
Figure 7 Groundwater Analytical Results and Gasoline Plume – March 2007	20

1.0 INTRODUCTION

PROJECT BACKGROUND

The subject property is the East Bay Regional Park District (EBRPD) Redwood Regional Park Service Yard located at 7867 Redwood Road in Oakland, Alameda County, California. The site has undergone site investigations and remediation since 1993 to address subsurface contamination caused by leakage from one or both of two former underground fuel storage tanks (UFSTs) that contained gasoline and diesel fuel. The Alameda County Department of Environmental Health (Alameda County Environmental Health) has provided regulatory oversight of the investigation since its inception (Alameda County Environmental Health Fuel Leak Case No. RO0000246). Other regulatory agencies with historical involvement in site review include the Regional Water Quality Control Board (Water Board) and the California Department of Fish and Game (CDFG).

OBJECTIVES AND SCOPE OF WORK

This report discusses the following activities conducted/coordinated by Stellar Environmental Solutions, Inc. (SES) between January 1 and March 31, 2007:

- Collecting water levels in site wells to determine shallow groundwater flow direction;
- Sampling site wells for contaminant analysis and natural attenuation indicators; and
- Collecting surface water samples for contaminant analysis.

HISTORICAL CORRECTIVE ACTIONS AND INVESTIGATIONS

Previous SES reports have provided discussions of previous site remediation and investigations; site geology and hydrogeology; residual site contamination; conceptual model for contaminant fate and transport; and hydrochemical trends and plume stability. Section 7.0 (References and Bibliography) of this report provides a listing of all technical reports for the site.

The general phases of site work included:

- An October 2000 Feasibility Study report for the site submitted to Alameda County Environmental Health, which provided detailed analyses of the regulatory implications of the site contamination and an assessment of viable corrective actions (SES, 2000d).

- Two instream bioassessment events conducted in April 1999 and January 2000 to evaluate potential impacts to stream biota associated with the site contamination (no impacts were documented).
- Additional monitoring well installations and corrective action by ORC™ injection proposed by SES and approved by Alameda County Environmental Health in its January 8, 2001 letter to the EBRPD. Two phases of ORC™ injection were conducted—in September 2001 and July 2002.
- A total of 41 groundwater monitoring events, conducted on a quarterly basis since project inception (November 1994); a total of 11 groundwater monitoring wells are currently available for monitoring.
- A bioventing pilot test conducted in September and October 2004 to evaluate the feasibility of this corrective action strategy, and installation of the full-scale bioventing system in November and December 2005. Bioventing activities conducted to date have been, and will continue to be, discussed in bioventing-specific technical reports, and updates will be provided in groundwater monitoring progress reports as they relate to this ongoing program.

SITE DESCRIPTION

Figure 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 (amsl) at the eastern edge of the service yard to approximately 530 feet amsl at Redwood Creek, which defines the approximate western edge of the project site with regard to this investigation. Figure 2 shows the site plan.

REGULATORY OVERSIGHT

The lead regulatory agency for the site investigation and remediation is Alameda County Environmental Health (Case No. RO0000246), with oversight provided by the Water Board (GeoTracker Global ID T0600100489). The CDFG is also involved with regard to water quality impacts to Redwood Creek. All workplans and reports have been submitted to these agencies. Historical Alameda County Environmental Health-approved revisions to the groundwater sampling program have included:

- Discontinuing hydrochemical sampling and analysis in wells MW-1, MW-3, MW-5, and MW-6;
- Discontinuing creek surface water sampling at upstream location SW-1;
- Discontinuing field measurement and laboratory analyses for natural attenuation indicators, to be re-implemented following the bioventing corrective action; and

Figure 1
Site Location Map

Figure 2
Site Plan and Historical Sampling Locations

- Reducing the frequency of creek surface water sampling from quarterly to semi-annually. The latter recommendation has not yet been implemented due to the EBRPD's continued concern over potential impacts to Redwood Creek.

The site is in compliance with State of California GeoTracker requirements for uploading of electronic data and reports. In addition, electronic copies of technical documentation reports published since Q2 2005 have been uploaded to Alameda County Environmental Health's file transfer protocol (ftp) system. Per Alameda County Environmental Health's October 31, 2005 "Miscellaneous Administrative Topics and Procedures" directive, effective January 31, 2007, paper copies of reports will no longer be required by Alameda County Environmental Health.

2.0 PHYSICAL SETTING

This section discusses the site hydrogeologic conditions based on geologic logging and water level measurements collected at the site since September 1993. Previous SES reports have included detailed discussions of site lithologic and hydrogeologic conditions. In May 2004, Alameda County Environmental Health requested, via email, additional evaluation of site lithology—specifically, the preparation of multiple geologic cross-sections parallel to and perpendicular to the contaminant plume's long axis.

SITE LITHOLOGY

Figure 3 shows the location of the geologic cross-sections. Figure 4 shows three sub-parallel geologic cross-sections (A-A' through C-C') along the long axis of the groundwater contaminant plume (i.e., along local groundwater flow direction). Figure 5 shows three sub-parallel geologic cross-sections (D-D' through F-F') roughly perpendicular to groundwater direction. In each figure, the three sub-parallel sections are presented together for ease of comparison. Due to the small scale, these sections show only lithologic conditions (i.e., soil type and bedrock depth). Additional information on water level depths, historical range of water levels, and inferred thickness of soil contamination was presented in a previous report (SES, 2004c) for cross-section B-B'.

Shallow soil stratigraphy consists of a surficial 3- to 10-foot-thick clayey silt unit underlain by a 5- to 15-foot-thick silty clay unit. In the majority of boreholes, a 5- to 10-foot-thick clayey coarse-grained sand and clayey gravel unit that laterally grades to a clay or silty clay was encountered. 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.

A previous SES report (SES, 2004c) presented a bedrock surface isopleth map (elevation contours for the top of the bedrock surface) in the contaminant plume area. The isopleth map from that report, and Figures 4 and 5 from this report, indicate the following: the bedrock surface slopes steeply, approximately 0.3 feet/foot from east to west (toward Redwood Creek) in the upgradient portion of the site (from the service yard to under the entrance road), then shows a gentle east-to-west slope in the downgradient portion of the site (under the gravel parking area) toward Redwood Creek. This general gradient corresponds to the local groundwater flow direction. On the southern side of the

Figure 3
Geologic Cross-Section Locations

Figure 4
Geologic Cross-Sections A-A' through C-C'

Figure 5
Geologic Cross-Sections D-D' through F-F'

plume area, bedrock slopes gently from south to north (the opposite of the general topographic gradient). Bedrock topography on the northern side of the plume cannot be determined from the available data.

In the central and downgradient portions of the groundwater contaminant plume (under the entrance road and the parking area), the bedrock surface has local, fairly steep elevation highs and lows, expressing a hummocky surface. Bedrock elevations vary by up to 10 feet over distances of less than 20 feet in this area. Local bedrock elevation highs are observed at upgradient location BH-13 (see cross-section F-F') and at downgradient location B15/HP-02 (see cross-section B-B'). Intervening elevation lows create troughs that trend north-south in the central portion of the plume and east-west in the downgradient portion of the plume.

The bedrock surface (and overlying unconsolidated sediment lithology) suggests that the bedrock surface may have at one time undergone channel erosion from a paleostream(s) flowing sub-parallel to present-day Redwood Creek. Because groundwater flows in the unconsolidated sediments that directly overlie the bedrock surface, it is likely that the hummocky bedrock surface affects local groundwater depth and flow direction. This is an important hydrogeologic control that should be considered if groundwater-specific corrective action is contemplated.

HYDROGEOLOGY

Groundwater at the site occurs under unconfined and semi-confined conditions, generally within the clayey, silty, sand-gravel zone. The top of this zone varies between approximately 12 and 19 feet below ground surface (bgs), and the bottom of the water-bearing zone (approximately 25 to 28 feet bgs) corresponds to the top of the siltstone bedrock unit. Seasonal fluctuations in groundwater depth create a capillary fringe of several feet that is saturated in the rainy period (late fall through early spring) and unsaturated during the remainder of the year. The thickness of the saturated zone plus the capillary fringe varies between approximately 10 and 15 feet in the area of contamination. Local perched water zones have been observed well above the top of the capillary fringe.

Figure 6 is a groundwater elevation map constructed from the current event monitoring well equilibrated water levels. Table 1 (in Section 3.0) summarizes current event groundwater elevation data. Appendix A contains historical groundwater elevation data. Consistent with the bedrock isopleth map showing an elevation depression in the vicinity of MW-11, historical groundwater elevations in MW-11 are sporadically lower than in the surrounding area. As discussed in the previous sub-section, local groundwater flow direction is likely more variable than expressed by groundwater monitoring well data, due to local variations in bedrock surface topography.

Figure 6
Groundwater Elevation Map – March 21, 2007

During the March 2007 groundwater monitoring event, well MW-1 exhibited an artesian condition, flowing out of the well head. This condition historically has been noted in other monitoring events conducted during/immediately following periods of high precipitation. Because the actual groundwater elevation for MW-1 could not be calculated, Table 1 and Figure 6 express the water elevation as the top of casing elevation (which is a minimum elevation for groundwater in this event, and is some undetermined higher elevation).

In the upgradient portion of the site (between well MW-1 and MW-2, in landslide debris and the former UFST excavation backfill), the groundwater gradient is approximately 0.23 feet per foot. Downgradient from (west of) the UFST source area (between MW-2 and Redwood Creek), the groundwater gradient is approximately 0.12 feet per foot. Groundwater elevations are at or near historical highs, resulting from the high precipitation levels prior to the monitoring event. The direction of shallow groundwater flow during the current event was to the west-southwest (toward Redwood Creek), which is consistent with historical site groundwater flow direction.

We assume a site groundwater velocity of 7 to 10 feet per year, using general look-up tables for permeability characteristics for the site-specific lithologic data obtained from site investigations. This velocity estimate is conservatively low, but does meet minimum-distance-traveled criteria from the date when contamination was first observed in Redwood Creek (1993) relative to the time of the UFST installations (late 1970s). Locally, however, the groundwater velocity could vary significantly. Calculating the specific hydraulic conductivity critical to accurately estimating site-specific groundwater velocity would require direct testing of the water-bearing zone through a slug or pumping test.

Redwood Creek, which borders the site to the west, is a seasonal creek known for the occurrence of rainbow trout. Creek flow in the vicinity of the site shows significant seasonal variation, with little to no flow during the summer and fall dry season, and vigorous flow with depths exceeding 1 foot during the winter and spring wet season. The creek is a gaining stream (i.e., it is recharged by groundwater seeps and springs) in the vicinity of the site, and discharges into Upper San Leandro Reservoir approximately 1 mile southeast of the site. During low-flow conditions, the groundwater table is below the creek bed in most locations (including the area of historical contaminated groundwater discharge); consequently, there is little to no observable creek flow at these times.

3.0 Q1 2007 ACTIVITIES

This section presents the creek surface water and groundwater sampling and analytical methods for the most recent groundwater monitoring event (Q1 2007), conducted in March 2007. A summary of bioventing-related activities is also provided.

GROUNDWATER AND SURFACE WATER MONITORING ACTIVITIES

Groundwater and surface water analytical results are summarized in Section 5.0. Monitoring and sampling protocols were in accordance with the Alameda County Environmental Health-approved SES technical workplan (SES, 1998a). Current event activities included:

- Measuring static water levels in all 11 site wells.
- Collecting post-purge groundwater samples for laboratory analysis of site contaminants from wells located within (or potentially within) the groundwater plume (MW-2, MW-7, MW-8, MW-9, MW-10, MW-11, and MW-12).
- Collecting Redwood Creek surface water samples for laboratory analysis from locations SW-2 and SW-3.

Creek sampling and groundwater monitoring/sampling was conducted on March 21, 2007. The creek sampling was conducted by the SES project manager. The locations of all site monitoring wells and creek water sampling locations are shown on Figure 2 (in Section 1.0). Well construction information and water level data are summarized in Table 1. Appendix B contains the groundwater monitoring field records for the current event.

Because it appears that the previously-injected ORC™ has been depleted, continued monitoring of the natural attenuation parameters—dissolved oxygen, oxidation-reduction potential, nitrate, ferrous iron, and sulfate—is of marginal value until such time as additional corrective actions that would increase oxygen concentrations (e.g., bioventing) are implemented. Thus, monitoring for natural attenuation parameters was discontinued following the Q3 2004 event.

Table 1
Groundwater Monitoring Well Construction and Groundwater Elevation Data –
March 21, 2007 Monitoring Event
Redwood Regional Park Corporation Yard, Oakland, California

Well	Well Depth	Screened Interval	TOC Elevation	Groundwater Elevation (3/21/07)
MW-1	18	7 to 17	565.83	562.51
MW-2	36	20 to 35	566.42	545.22
MW-3	42	7 to 41	560.81	541.71
MW-5	26	10 to 25	547.41	531.39
MW-6	26	10 to 25	545.43	532.42
MW-7	24	9 to 24	547.56	534.93
MW-8	23	8 to 23	549.13	539.30
MW-9	26	11 to 26	549.28	534.64
MW-10	26	11 to 26	547.22	535.60
MW-11	26	11 to 26	547.75	535.65
MW-12	25	10 to 25	544.67	535.12

Notes:

TOC = Top of casing.

Wells MW-1 through MW-6 are 4-inch diameter; all other wells are 2-inch diameter.

All elevations are feet above U.S. Geological Survey mean sea level.

Groundwater Level Monitoring and Sampling

Groundwater monitoring well water level measurements, purging, sampling, and field analyses were conducted by Blaine Tech Services under the supervision of SES personnel. Groundwater sampling 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), and followed the methods and protocols approved by Alameda County Environmental Health in the SES 1998 workplan (SES, 1998a).

As the first task of the monitoring event, static water levels were measured using an electric water level indicator. Pre-purge groundwater samples were then collected for field and laboratory analysis of natural attenuation indicators. The wells to be sampled for contaminant analyses were then purged (by bailing and/or pumping) of three wetted casing volumes. Aquifer stability parameters (temperature, pH, and electrical conductivity) were measured after each purged casing volume to ensure that representative formation water would be sampled. To minimize the potential for cross-contamination, wells were purged and sampled in order of increasing contamination (based on the analytical results of the previous quarter).

The sampling-derived purge water and decontamination rinseate (approximately 70 gallons) from the current event was containerized in the onsite plastic tank. Purge water from future events will continue to be accumulated in the onsite tank until it is full, at which time the water will be transported offsite for proper disposal.

Creek Surface Water Sampling

Surface water sampling was conducted by SES on March 21, 2007. Surface water samples were collected from two Redwood Creek locations: SW-2 (immediately downgradient of the former UFST source area and within the area of documented creek bank soil contamination) and SW-3 (approximately 500 feet downstream of the SW-2 location). In accordance with a previous SES recommendation approved by Alameda County Environmental Health, upstream sample location SW-1 is no longer part of the surface water sampling program.

At the time of sampling, the creek was at a medium to high stage; water depths were approximately 0.5 to 1 foot with a brisk flow. At the SW-2 location, where contaminated groundwater discharge to the creek historically has been observed, an orange algae was noted growing on the saturated portion of the creek bank, and a slight sheen was visible. This algae likely is utilizing the petroleum as a carbon source, and therefore is a good indicator of the presence of petroleum contamination. However, neither petroleum sheen nor odor was evident on the water surface.

BIOVENTING-RELATED ACTIVITIES

The bioventing system was installed and started up in December 2005/January 2006. Weekly system monitoring and air flow optimization events were conducted for 1 month in January and February 2006. Bioventing system operations and maintenance (O&M) events have been conducted monthly since March 2006. Bioventing activities are discussed in detail in separate technical documents.

4.0 REGULATORY CONSIDERATIONS

The following is a summary of regulatory considerations regarding surface water and groundwater contamination. There are no Alameda County Environmental Health or Water Board cleanup orders for the site, although all site work has been conducted under oversight of these agencies.

GROUNDWATER CONTAMINATION

As specified in the Water Board's *San Francisco Bay Region Water Quality Control Plan* (Water Board, 1986), all groundwaters are considered potential sources of drinking water unless otherwise approved by the Water Board, and are also assumed to ultimately discharge to a surface water body and potentially impact aquatic organisms. While it is likely that site groundwater would satisfy geology-related criteria for exclusion as a drinking water source (excessive total dissolved solids and/or insufficient sustained yield), Water Board approval for this exclusion has not been obtained for the site. As summarized in Table 2 (in Section 5.0), site groundwater contaminant levels are compared to two sets of criteria: 1) Water Board Tier 1 Environmental Screening Levels (ESLs) for sites where groundwater is a current or potential drinking water source; and 2) ESLs for sites where groundwater is not a current or potential drinking water source.

As stipulated in the ESL document (Water Board, 2004), the ESLs are not cleanup criteria; rather, they are conservative screening-level criteria designed to be protective of both drinking water resources and aquatic environments in general. The groundwater ESLs are composed of multiple components, including ceiling value, human toxicity, indoor air impacts, and aquatic life protection. Exceedance of ESLs suggests that additional investigation and/or remediation is warranted. While drinking water standards [e.g., Maximum Contaminant Levels (MCLs)] are published for the site contaminants of concern, Alameda County Environmental Health has indicated that impacts to nearby Redwood Creek are of primary importance, and that site target cleanup standards should be evaluated primarily in the context of surface water quality criteria.

SURFACE WATER CONTAMINATION

As summarized in Table 2 (in Section 5.0), site surface water contaminant levels are compared to the most stringent screening level criteria published by the State of California, U.S. Environmental Protection Agency, and U.S. Department of Energy. These screening criteria address chronic and acute exposures to aquatic life. As discussed in the ESL document (Water Board, 2005), benthic

communities at the groundwater/surface water interface (e.g., at site groundwater discharge location SW-2) are assumed to be exposed to the full concentration of groundwater contamination prior to dilution/mixing with the surface water). This was also a fundamental assumption in the instream benthic macroinvertebrate bioassessment events, which documented no measurable impacts.

Historical surface water sampling in the immediate vicinity of contaminated groundwater discharge (SW-2) has sporadically documented petroleum contamination, usually in periods of low stream flow, and generally at concentrations several orders of magnitude less than adjacent (within 20 feet) groundwater monitoring well concentrations. It is likely that mixing/dilution between groundwater and surface water precludes obtaining an “instantaneous discharge” surface water sample that is wholly representative of groundwater contamination at the discharge location. Therefore, the most conservative assumption is that surface water contamination at the groundwater/surface water interface is equivalent to the upgradient groundwater contamination (e.g., site downgradient wells MW-7, MW-9 and MW-12).

While site target cleanup standards for groundwater have not been determined, it is likely that no further action will be required by regulatory agencies when groundwater (and surface water) contaminant concentrations are all below their respective screening level criteria. Residual contaminant concentrations in excess of screening level criteria might be acceptable to regulatory agencies if a more detailed risk assessment (e.g., Tier 2 and/or Tier 3) demonstrates that no significant impacts are likely.

5.0 MONITORING EVENT ANALYTICAL RESULTS

This section presents the field and laboratory analytical results of the most recent monitoring event. Table 2 summarizes the contaminant analytical results, and Figure 7 shows the contaminant analytical results and the inferred limits of the gasoline groundwater plume. Appendix C contains the certified analytical laboratory report and chain-of-custody record for the current event; Appendix D contains a summary of historical groundwater and surface analytical results.

CURRENT EVENT GROUNDWATER AND SURFACE WATER RESULTS

Current quarter site groundwater maximum concentrations in monitoring wells MW-7, MW-8, MW-9, and MW-11 exceeded their respective groundwater ESLs for total extractable hydrocarbons as diesel (TEHd) and total volatile hydrocarbons as gasoline (TVHg) under both the *drinking water resource is threatened* and *drinking water resource is not threatened* criteria. Concentrations of benzene, ethylbenzene and total xylenes exceeded their respective groundwater ESLs under both criteria in wells MW-8, MW-9, and MW-11. The *drinking water resource is not threatened* ESL criterion was exceeded for benzene in wells MW-2, MW-7, and MW-10; for TVHg and TEHd in MW-12; for ethylbenzene in wells MW-7 and MW-12; for MTBE in MW-2. Concentrations of contaminants were detected below their respective ESLs for TVHg in wells MW-2 and MW-10; for TEHd, ethylbenzene, and MTBE in MW-10; for ethylbenzene and total xylenes in MW-12; for toluene in wells MW-8 and MW-9; and for total xylenes in MW-11.

Except for MTBE, maximum groundwater contaminant concentrations were all detected in well MW-8 (located approximately half the distance between the former source area and the creek). Maximum MTBE concentrations were detected in downgradient well MW-2 near the former source area. Elevated contaminant concentrations were also detected in downgradient wells MW-7, MW-9, and MW-11. The northern edge of the plume in the downgradient area of the plume is defined by well MW-12. The southern edge of the plume in the downgradient area is not strictly defined; however, based on historical groundwater data, it appears to be located between well MW-9 and well MW-5. The current event contaminant plume geometry is consistent with recent historical contaminant distribution, showing the center of contaminant mass in groundwater located downgradient of the former source area.

Table 2
Groundwater and Surface Water Sample
Analytical Results – March 21, 2007
Redwood Regional Park Corporation Yard, Oakland, California

Location	Contaminant						
	TVHg	TEHd	Benzene	Toluene	Ethyl-benzene	Total Xylenes	MTBE
GROUNDWATER SAMPLES							
MW-2	59	<50	4	<0.5	<0.5	<0.5	14
MW-7	6,200	2,900	34	<0.5	190	15.2	<2.0
MW-8	15,000	4,500	340	19	1,300	1,275	<20
MW-9	9,600	2,900	120	8.7	780	455	<10.0
MW-10	57	55	3.6	<0.5	2.2	<0.5	3.1
MW-11	4,500	1,900	110	<0.5	170	7.9	<2.0
MW-12	390	110	<0.5	<0.5	1.7	1.7	<2.0
Groundwater ESLs ^(a)	100 / 500	100 / 640	1.0 / 46	40 / 130	30 / 290	13 / 13	5 / 1,800
REDWOOD CREEK SURFACE WATER SAMPLES							
SW-2	<50	<50	<0.5	<0.5	<0.5	<1.0	<2.0
SW-3	<50	<50	<0.5	<0.5	<0.5	<1.0	3.3
Surface Water Screening Levels ^(a, b)	500	100	46	130	290	13	8,000

Notes:

^(a) Water Board Environmental Screening Levels (drinking water resource threatened/not threatened) (Water Board, 2004).

^(b) Lowest of chronic and acute surface water criteria published by the State of California, U.S. Environmental Protection Agency, or U.S. Department of Energy.

MTBE = methyl *tertiary*-butyl ether

TVHg = total volatile hydrocarbons - gasoline range

TEHd = total extractable hydrocarbons - diesel range

All concentrations expressed in micrograms per liter (µg/L), equivalent to parts per billion.

Samples in **bold-face type** exceed the ESL and/or surface water screening levels.

Neither of the two surface water samples collected (SW-2 and SW-3) had detectable concentrations for any of the site contaminants analyzed, with the exception of a low concentration (below surface water ESLs) of MTBE in sample SW-3.

QUALITY CONTROL SAMPLE ANALYTICAL RESULTS

Laboratory quality control samples (e.g., method blanks, matrix spikes, surrogate spikes) 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 (see Appendix C).

Figure 7
Groundwater Analytical Results and Gasoline Plume – March 2007

6.0 SUMMARY, CONCLUSIONS, AND PROPOSED ACTIONS

The following conclusions and proposed actions are based on the findings of the current event activities, as well as on salient historical findings.

SUMMARY AND CONCLUSIONS

- Groundwater sampling has been conducted approximately on a quarterly basis since November 1994 (41 events in the initial site wells). A total of 11 site wells are available for monitoring; 7 of the available wells are currently monitored for contamination.
- Site contaminants of concern include gasoline, diesel, BTEX, and MTBE. Current groundwater concentrations exceed regulatory screening levels for groundwater and surface water.
- The primary environmental risk is discharge of contaminated groundwater to the adjacent Redwood Creek. A stream bioassessment concluded that there were no direct impacts to the surface water benthic community; however, groundwater contamination is sporadically detected in surface water samples, and there is historical visual evidence of plume discharge at the creek/groundwater interface. Surface water samples have sporadically exceeded surface water ESL criteria for gasoline, diesel, and benzene, and generally only under low creek flow conditions. An in-stream bioassessment evaluation in 1999-2000 determined no impacts to the benthic macroinvertebrate community.
- The existing well layout adequately constrains the lateral extent of groundwater contamination, and the vertical limit is very likely the top of the near-surface (25 to 28 feet) siltstone bedrock. The saturated interval extends approximately 12 to 15 feet from top of bedrock through the capillary fringe. Groundwater elevations fluctuate seasonally, creating a capillary fringe that varies seasonally in thickness.
- The groundwater contaminant plume has become disconnected from its original source, but continues to be fed from the residual hydrocarbon concentrations in the soil. The groundwater plume has migrated well beyond the former source area (represented by well MW-2) toward Redwood Creek. The plume of groundwater contamination above screening levels appears to be approximately 120 feet long and approximately 30 to 50 feet wide. The zone of greatest contamination (greater than 10,000 micrograms per liter of total petroleum hydrocarbons) is currently an approximately 10- to 30-foot-wide by 50-foot-long area extending from mid-plume well MW-8 to the most downgradient well MW-7.

- The contaminant plume is neither stable nor reducing, as groundwater contaminant concentrations fluctuate seasonally, and the center of mass of the contaminant plume (represented by maximum concentrations) has alternated between mid-plume and downgradient wells in recent history. However, the bioventing appears to be reducing the residual contaminant mass, which should affect the dissolved hydrocarbon concentrations in the future.
- There is no indication that maximum site groundwater concentrations are increasing, suggesting that “worst case” contaminant concentrations may have been reached. Compared to the same monitoring event a year ago, the contaminant concentrations in well MW-2 near the source area and MW-8 in the central area of the plume have decreased, whereas concentrations in downgradient wells MW-7, MW-9, and MW-11 (which are relatively unaffected by the bioventing system) have increased.
- Soil bioventing was implemented as a remedy in December 2005 to remediate the vadose zone soil contamination that has continued to provide an input source to the groundwater. A 2- to 3-year or longer program of bioventing will likely reduce unsaturated zone contamination such that it will no longer be a long-term source of contamination to groundwater. However, the first year of bioventing, in the 2005-2006 timeframe, was an exceptionally wet year and the unsaturated zone was saturated for a longer period, making the bioventing system less effective.

PROPOSED ACTIONS

The EBRPD proposes to implement the following actions to address regulatory concerns:

- Continue the quarterly program of creek and groundwater sampling and reporting.
- Continue to inform regulators of site progress and seek their concurrence with proposed actions.
- Operate the bioventing system as a corrective action to move the site toward closure, and report those results in bioventing-specific technical reports.
- Continue to evaluate analytical results (and bioventing contaminant removal data) in the context of hydrochemical trends, impacts of groundwater contamination on Redwood Creek, and the effectiveness of the corrective action.
- Continue to make required Electronic Data Format uploads to the GeoTracker database, and upload an electronic copy of technical reports to Alameda County Environmental Health’s ftp system.

7.0 REFERENCES AND BIBLIOGRAPHY

Parsons Engineering Science (Parsons), 1998. Quarterly Progress Report 11, Redwood Regional Park Service Yard, Oakland, California. January 28.

Parsons Engineering Science (Parsons), 1997a. Quarterly Progress Report 7, Redwood Regional Park Service Yard, Oakland, California. January 31.

Parsons Engineering Science (Parsons), 1997b. Quarterly Progress Report 8 and Annual Summary Assessment, Redwood Regional Park Service Yard, Oakland, California. April 4.

Parsons Engineering Science (Parsons), 1997c. Quarterly Progress Report 9, Redwood Regional Park Service Yard, Oakland, California. June 30.

Parsons Engineering Science (Parsons), 1997d. Quarterly Progress Report 10, Redwood Regional Park Service Yard, Oakland, California. September 22.

Parsons Engineering Science (Parsons), 1996a. Quarterly Progress Report 5, Redwood Regional Park Service Yard, Oakland, California. June 6.

Parsons Engineering Science (Parsons), 1996b. Quarterly Progress Report 6, Redwood Regional Park Service Yard, Oakland, California. September 24.

Parsons Engineering Science (Parsons), 1995a. Quarterly Progress Report 2, Redwood Regional Park Service Yard, Oakland, California. March 8.

Parsons Engineering Science (Parsons), 1995b. Quarterly Progress Report 3, Redwood Regional Park Service Yard, Oakland, California. June 23.

Parsons Engineering Science (Parsons), 1995c. Quarterly Progress Report 4 and Annual Summary Assessment (November 1994 - August 1995), Redwood Regional Park Service Yard, Oakland, California. November 13.

Parsons Engineering Science (Parsons), 1994a. Creek and Soil Sampling at Redwood Regional Park, Oakland, California. March 2.

- Parsons Engineering Science (Parsons), 1994b. Creek Surface Water at Redwood Regional Park, Oakland, California. May 13.
- Parsons Engineering Science (Parsons), 1994c. Workplan for Groundwater Characterization Program at East Bay Regional Park Service Yard, Oakland, California. August 17.
- Parsons Engineering Science (Parsons), 1994d. Quarterly Progress Report 1, Redwood Regional Park Service Yard, Oakland, California. December 28.
- Parsons Engineering Science (Parsons), 1993a. Closure of Underground Fuel Storage Tanks and Initial Site Characterization at Redwood Regional Park Service Yard, Oakland, California. December 16.
- Parsons Engineering Science (Parsons), 1993b. Workplan for Site Characterization at East Bay Regional Park District, Redwood Regional Park Corporation Yard, Oakland, Alameda County, California. September 3.
- Regional Water Quality Control Board, San Francisco Bay Region (Water Board), 2005. Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater.
- Regional Water Quality Control Board, San Francisco Bay Region (Water Board), 1995. *San Francisco Bay Region Water Quality Control Plan*.
- 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.
- Stellar Environmental Solutions, Inc. (SES), 2007. Fourth Quarter 2006 Groundwater Monitoring and Annual Summary Report, Redwood Regional Park Service Yard, Oakland, California. January 9.
- Stellar Environmental Solutions, Inc. (SES), 2006a. Fourth Quarter 2005 Groundwater Monitoring and Annual Summary Report, Redwood Regional Park Service Yard, Oakland, California. January 20.
- Stellar Environmental Solutions, Inc. (SES), 2006b. First Quarter 2006 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. April 21.
- Stellar Environmental Solutions, Inc. (SES), 2006c. Second Quarter 2006 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. July 5.

Stellar Environmental Solutions, Inc. (SES), 2006d. Third Quarter 2006 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. November 21.

Stellar Environmental Solutions, Inc. (SES), 2005a. Fourth Quarter 2004 Groundwater Monitoring and Annual Summary Report, Redwood Regional Park Service Yard, Oakland, California. January 24.

Stellar Environmental Solutions, Inc. (SES), 2005b. First Quarter 2005 Groundwater Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. March 31.

Stellar Environmental Solutions, Inc. (SES), 2005c. Second Quarter 2005 Groundwater Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. July 12.

Stellar Environmental Solutions, Inc. (SES), 2005d. Third Quarter 2005 Groundwater Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. October 13.

Stellar Environmental Solutions, Inc. (SES), 2004a. Year 2003 Annual Summary Report, Redwood Regional Park Service Yard, Oakland, California. January 15.

Stellar Environmental Solutions, Inc. (SES), 2004b. First Quarter 2004 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. April 14.

Stellar Environmental Solutions, Inc. (SES), 2004c. Second Quarter 2004 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. July 16.

Stellar Environmental Solutions, Inc. (SES), 2004d. Third Quarter 2004 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. October 12.

Stellar Environmental Solutions, Inc. (SES), 2003a. Year 2002 Annual Summary Report, Redwood Regional Park Service Yard, Oakland, California. January 27.

Stellar Environmental Solutions, Inc. (SES), 2003b. First Quarter 2003 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. May 5.

Stellar Environmental Solutions, Inc. (SES), 2003c. Second Quarter 2003 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. July 29.

Stellar Environmental Solutions, Inc. (SES), 2003d. Third Quarter 2003 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. October 3.

- Stellar Environmental Solutions, Inc. (SES), 2002a. First Quarter 2002 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. April 16.
- Stellar Environmental Solutions, Inc. (SES), 2002b. Second Quarter 2002 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. July 23.
- Stellar Environmental Solutions, Inc. (SES), 2002c. Third Quarter 2002 Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. October 14.
- Stellar Environmental Solutions, Inc. (SES), 2001a. Monitoring Well Installation and Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. February 8.
- Stellar Environmental Solutions, Inc. (SES), 2001b. Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. May 4.
- Stellar Environmental Solutions, Inc. (SES), 2001c. Well Installation, Site Monitoring, and Corrective Action Report, Redwood Regional Park Service Yard, Oakland, California. October 26.
- Stellar Environmental Solutions, Inc. (SES), 2000a. Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. April 21.
- Stellar Environmental Solutions, Inc. (SES), 2000b. Workplan for Groundwater Monitoring Well Installations, Redwood Regional Park Service Yard, Oakland, California. October 19.
- Stellar Environmental Solutions, Inc. (SES), 2000c. Site Monitoring Report, Redwood Regional Park Service Yard, Oakland, California. October 19.
- Stellar Environmental Solutions, Inc. (SES), 2000d. Site Feasibility Study Report, Redwood Regional Park Service Yard, Oakland, California. October 20.
- Stellar Environmental Solutions, Inc. (SES), 1999a. Workplan for Subsurface Investigation, Redwood Regional Park Service Yard, Oakland, California. April 8.
- Stellar Environmental Solutions, Inc. (SES), 1999b. Residual Contamination Investigation and Remedial Action Assessment Report, Redwood Regional Park Service Yard, Oakland, California. June 9.

Stellar Environmental Solutions, Inc. (SES), 1998a. Workplan for Continued Site Investigation and Closure Assessment, Redwood Regional Park Service Yard, Oakland, California. October 9.

Stellar Environmental Solutions, Inc. (SES), 1998b. Site Investigation and Closure Assessment Report, Redwood Regional Park Service Yard, Oakland, California. December 4.

8.0 LIMITATIONS

This report has been prepared for the exclusive use of the East Bay Regional Park District, its authorized representatives, and the regulatory agencies. No reliance on this report shall be made by anyone other than those for whom it was prepared.

The findings and conclusions presented in this report are based on the review of previous investigators' findings at the site, as well as onsite activities conducted by SES since September 1998. This report provides neither a certification nor guarantee that the property is free of hazardous substance contamination. This report has been prepared in accordance with generally accepted methodologies and standards of practice. The SES personnel who performed this work are qualified to perform such investigations and have accurately reported the information available, but cannot attest to the validity of that information. No warranty, expressed or implied, is made as to the findings, conclusions, and recommendations included in the report.

The findings of this report are valid as of the present. Site conditions may change with the passage of time, natural processes, or human intervention, which can invalidate the findings and conclusions presented in this report. As such, this report should be considered a reflection of the current site conditions as based on the investigation and remediation completed.

APPENDIX A

Historical Groundwater Monitoring Well Water Level Data

APPENDIX B

Groundwater Monitoring Field Documentation

APPENDIX C

Analytical Laboratory Report and Chain-of-Custody Record

APPENDIX D

Historical Groundwater and Surface Water Analytical Results