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June 9, 1999

Mr. Scott Seery
Alameda County Health Care Services Agency
Department of Environmental Health, Hazardous Materials Division
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

Subject: Site Investigation Report for Redwood Regional Park Service Yard Site, Oakland, California

Dear Mr. Seery:

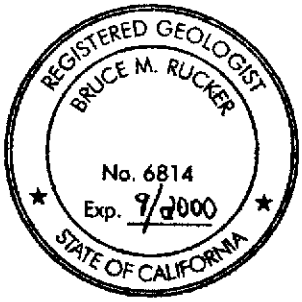
Enclosed is the Stellar Environmental Solutions (SES) Site Investigation Report for the underground fuel storage tank (UFST) site located at the Redwood Regional Park Service Yard Site, 7867 Redwood Road, Oakland, California. This project is being conducted for the East Bay Regional Park District (District) and follows previous site investigation and remediation activities conducted since 1993 associated with former leaking underground fuel storage tanks. The key regulatory agencies for this investigation are Alameda County Health Care Services Agency (ACDEH) and California Department of Fish and Game (CDFG).

This report summarizes activities conducted between April and June 1999 that we recommended in our December 1998 Site Closure Assessment Report, and that were delineated in the SES workplan approved by your agency and CDFG. The scope of work included one stream bioassessment event (conducted by CDFG); one groundwater and creek surface water monitoring event; and an exploratory borehole drilling, sampling and analysis program. If you have any questions regarding this report, please contact Mr. Ken Burger of the District or contact us directly at (510) 644-3123.

Sincerely,

Bruce M. Rucker

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



cc: Michael Rugg, California Department of Fish and Game
Warren Gee and Ken Burger, East Bay Regional Park District

RESIDUAL CONTAMINATION INVESTIGATION AND REMEDIAL ACTION ASSESSMENT REPORT

REDWOOD REGIONAL PARK SERVICE YARD
OAKLAND, CALIFORNIA

Prepared For:

EAST BAY REGIONAL PARK DISTRICT
OAKLAND, CALIFORNIA

Prepared By:

STELLAR ENVIRONMENTAL SOLUTIONS
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June 9, 1999

Project No. 99012

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EXECUTIVE SUMMARY

Stellar Environmental Solutions (SES) was retained by East Bay Regional Park District (District) to conduct additional residual contamination site investigations at the Redwood Regional Park Service Yard fuel leak site at 7867 Redwood Road, Oakland, Alameda County. **Tasks conducted since the previous SES report included:** an instream bioassessment event per California Department of Fish and Game protocols; an exploratory borehole sampling and analysis investigation; and one groundwater and surface water monitoring event. This scope was designed to fill data gaps about the extent of residual hydrocarbon contamination downgradient of the former underground fuel storage tank area, and to evaluate impacts from the groundwater plume on aquatic organisms in Redwood Creek.

The site has undergone site investigations and remediation since 1993 to address the subsurface contamination caused by leakage from one or more of the two former underground fuel storage tanks (UFSTs) that contained gasoline and diesel fuel. The UFSTs and the majority of source area contaminated soil were removed in 1993. **An estimated volume of 850 CY of petroleum-contaminated soil with concentrations above 1,000 mg/Kg is estimated to be left in place in the area of the original excavation and downgradient of it along the pathway of the plume. Most of the residual contaminated soil exists in the capillary fringe up to 150 feet downgradient of the former UFSTs, resulting from the sorption of fuel constituents from contaminated groundwater onto capillary fringe soils during periods of high groundwater elevation. This soil contamination will be a long-term source of groundwater contamination as it desorbs and contributes to the groundwater over time.**

Groundwater sampling conducted on an approximately quarterly frequency since November 1994 (14 events) has shown an overall decreasing concentration trend in groundwater contaminants, which include gasoline, diesel and BTEX. MTBE was detected in both the source area and the downgradient monitoring wells when it was analyzed for the first time in September 1998. **Near-maximum historical groundwater contaminant concentrations were detected in February 1998, coinciding with unusually heavy rains and correspondingly high groundwater elevations, which likely desorbed capillary fringe soil contamination into groundwater.**

The recent (April 1999) groundwater analytical data, which included hydropunch samples as well as monitoring at the existing monitoring wells, better delineated the plume configuration and area of maximum concentrations within the plume. Maximum groundwater contaminant concentrations in site wells have historically been detected in downgradient well MW-4, suggesting that the center of mass of the contaminant groundwater plume has moved from the UFST source area, beyond well MW-2. The new hydropunch data collected in April 1999 shows that MW-4 is located off the center line of the plume, and thus does not represent the highest contamination concentrations within the plume. The recent data, which included a grab-groundwater sample collected from within the Redwood Creek bank area where the plume daylights into the Creek, also indicate a substantial mass of groundwater contamination upgradient of the parking lot's downgradient edge that will continue to migrate toward Redwood Creek. This suggests that future impacts to Redwood Creek from contaminated groundwater discharge may be worse than at present.

The limits of the groundwater contaminant plume and area of plume emission to Redwood Creek have been better defined by the April-May 1999 subsurface investigation. Based on the new data, the plume extends from the source area to Redwood Creek, a distance of approximately 150 feet, and daylights along the creek banks across a width of approximately 30 feet. The area of the plume with TPH concentrations of > 10,000 µg/L is estimated to be 55 feet wide by 100 feet long and begins approximately 30 feet downgradient of the source area; this suggests that the plume is becoming "disconnected" from the former UFST source area. The April 1999 hydropunch groundwater data indicate that the centerline of the contaminant plume—the line of maximum groundwater contamination—is located coincident with borehole location HP-02, approximately 20 feet south of well MW-4. Redwood Creek is a hydraulic barrier preventing contaminated groundwater migration beyond the creek. The flowpath of groundwater in the immediate vicinity of the creek is likely to follow topography, and would be expected to flow in the downstream direction (south) beneath the creek.

Natural attenuation—the natural processes by which the hydrocarbon contamination is reduced by indigenous microorganisms utilizing the contamination as a carbon food source—is undoubtedly occurring within the area of the plume as evidenced by the dissolved oxygen, nitrogen, and redox potential measured at the site. However, the distance of 150 feet from the original source to Redwood Creek is not sufficient to allow full attenuation before it discharges to the creek. The natural attenuation is more effective in reducing the margins of the plume where there is more available oxygen than within the center of the plume where the high hydrocarbon concentrations inhibit oxygen penetration necessary to microbial degradation of the TPH.

Discharge of petroleum-contaminated groundwater into Redwood Creek is evidenced by:

- Historical observation of petroleum-discolored soil particularly pronounced in one area of the bank of Redwood Creek downgradient of the former UFSTs;
- Elevated levels of petroleum constituents in a grab groundwater sample collected within three feet upgradient of Redwood Creek and at an elevation above the surface of Redwood Creek
- Sporadic detection of fuel constituents in creek surface water samples collected at that location; and
- The growth of an algae on the surface water surface at that location (suggesting that the petroleum is serving as a carbon source; that algae has also been observed in the downgradient monitoring well MW-4).

A site reconnaissance of the Creek bank was performed on May 22, 1999. By digging into the bank material above and below the creek surface, an approximately 30-foot wide by approximately 2-foot thick zone of discharge to Redwood Creek was identified. A grab-groundwater sampling point, located in the creek bank just above the area of detected historical fuel concentrations in surface water samples, showed concentrations far higher than the concentrations detected in the surface water, but also significantly lower than concentrations detected in upgradient hydropunch samples. The trace concentrations in the surface water compared to the groundwater plume is attributed to the dilution effect in the stream. The recent hydropunch data also indicate that the "slug" of high groundwater contamination has not yet reached the creek and/or that only the upper portion of the approximately 10-foot thick groundwater plume is discharging into the creek.

The CDFG code stipulates a policy of zero discharge of petroleum to surface waters, unless it can be demonstrated that complete removal of the petroleum is infeasible and that instream biota are not affected. The results of the initial stream bioassessment event (April 1999) indicate no impacts to the benthic macroinvertebrate community in Redwood Creek. A minimum of one additional bioassessment event before this year's rains is recommended by CDFG to complete the evaluation of the full life cycle of potentially impacted macroinvertebrates.

There are no established cleanup criteria for residual soil contamination by TPH. The RWQCB has a to-be-considered ARAR of 1 mg/kg total BTEX in soil. However, the need for remedial action in the soil media and the remedy selection for corrective action should be based on potential impacts to groundwater and surface water quality resulting from desorption of soil contamination.

Site groundwater contaminants that have been historically (and recently) detected in excess of drinking water standards include benzene, ethylbenzene, total xylenes, and MTBE; there are no drinking water standards for TPH compounds. While it is unlikely that site groundwater would be used as a drinking water source, drinking water standards could be applied by regulators as cleanup standards.

Benzene is the only site-sourced contaminant detected in creek surface water samples in excess of published water quality objectives (WQOs) for surface waters that are a potential drinking water source. Ethylbenzene has been detected once in excess of the USEPA water quality guidance criterion. **Based on the absence of detectable contamination immediately downstream of the site, it is very unlikely that site contamination has the potential to impact the nearest municipal drinking water source (Upper San Leandro Reservoir).**

Based on site access constraints and the current distribution of site contamination, an approximately 30- to 60-foot wide by 10-foot thick zone of soil and groundwater contamination exists immediately upgradient (east) of Redwood Creek, which cannot be reasonably mitigated. Contamination upgradient of that zone, near the location of MW-4 near the boundary of the parking area before the break in slope to the Creek, could be curtailed to prevent further migration by installing a reactive wall or oxygen releasing compound curtain as a remedial measure.

PROPOSED ACTIONS

Following the District's review of the draft of this report, the District has elected to implement the following actions to address regulatory concerns:

- Meet with ACDEH and CDFG to discuss the results, conclusions, and recommendations of this investigation, especially as regards the need to mitigate any unacceptable impacts associated with residual site contamination.
- Continue the established program of quarterly groundwater elevation monitoring (all site wells) and sampling (wells MW-2 and MW-4 only). Based on a previous comparative site study, we recommend that all groundwater samples collected for laboratory analysis be collected following well purging.
- Continue the established program of quarterly surface water sampling, with one revision. Discontinuing sampling at the upstream location SW-1 is warranted, given that no significant surface water contamination has historically been detected at that location. The previous ACDEH-approved recommendation to decrease the frequency of surface water sampling from quarterly to semi-annually is not technically appropriate at this time, given the documented impacts to Redwood Creek from discharge of contaminated groundwater.

- Per the recommendation of CDFG, complete a follow-on instream bioassessment of macroinvertebrates prior to the onset of winter rains (fall 1999) to assess potential impacts at the end of the macroinvertebrate life cycle.
- Complete and submit to ACDEH and CDFG a letter-format report following the next quarterly groundwater and surface water monitoring and sampling event (summer 1999), and a comprehensive report following the subsequent sampling and bioassessment event (fall 1999), including conclusions regarding the findings and proposed actions to address remaining regulatory issues.
- Evaluate the cost impacts and technical merits of implementing some active remediation near the downgradient centerline of theplume to minimize future discharge and associated impacts to Redwood Creek.

1.0 INTRODUCTION

PROJECT BACKGROUND

The subject property is the East Bay Regional Park District (District) 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 the subsurface contamination caused by leakage from one or more of two former underground fuel storage tanks (UFSTs) containing gasoline and diesel fuel. The Alameda County Health Care Services Agency, Department of Environmental Health, Hazardous Materials Division (ACDEH) has provided regulatory oversight of the investigation since its inception.

KEY OBJECTIVES AND SCOPE OF WORK

The principal program objectives have been substantively met by the April-May data collection program. The key objectives of this investigation and remedial action evaluation are to:

- Determine if benthic invertebrates in the creek, as indicators of the creek system ecological stability, have been impacted by the site contamination;
- Provide a more refined evaluation of the current magnitude and extent of residual soil and groundwater contamination as regards the potential for contamination discharge to the creek to increase over time; and
- Evaluate on a preliminary basis if site conditions are favorable for natural attenuation of fuel contamination or more aggressive remediation is indicated to be necessary to mitigate contaminated groundwater discharge to the creek.

The tasks that were conducted to meet these objectives include:

- Conduct one groundwater and surface monitoring, sampling and analysis event;
- Conduct one instream bioassessment event;
- Drill and geologically log 10 exploratory boreholes, and collect soil and grab-groundwater samples for laboratory analysis;

- Conduct a survey of the Redwood Creek banks to delineate the area of plume discharge and collect a grab-groundwater sample from within the bank sediments at just above the surface water sampling point; and
- 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 (MNA) and active mass removal/reduction techniques.

SITE DESCRIPTION

The project site is located at 7867 Redwood Road in Oakland, Alameda County, California. 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 (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 as regards this investigation. Figure 2 is a site plan.

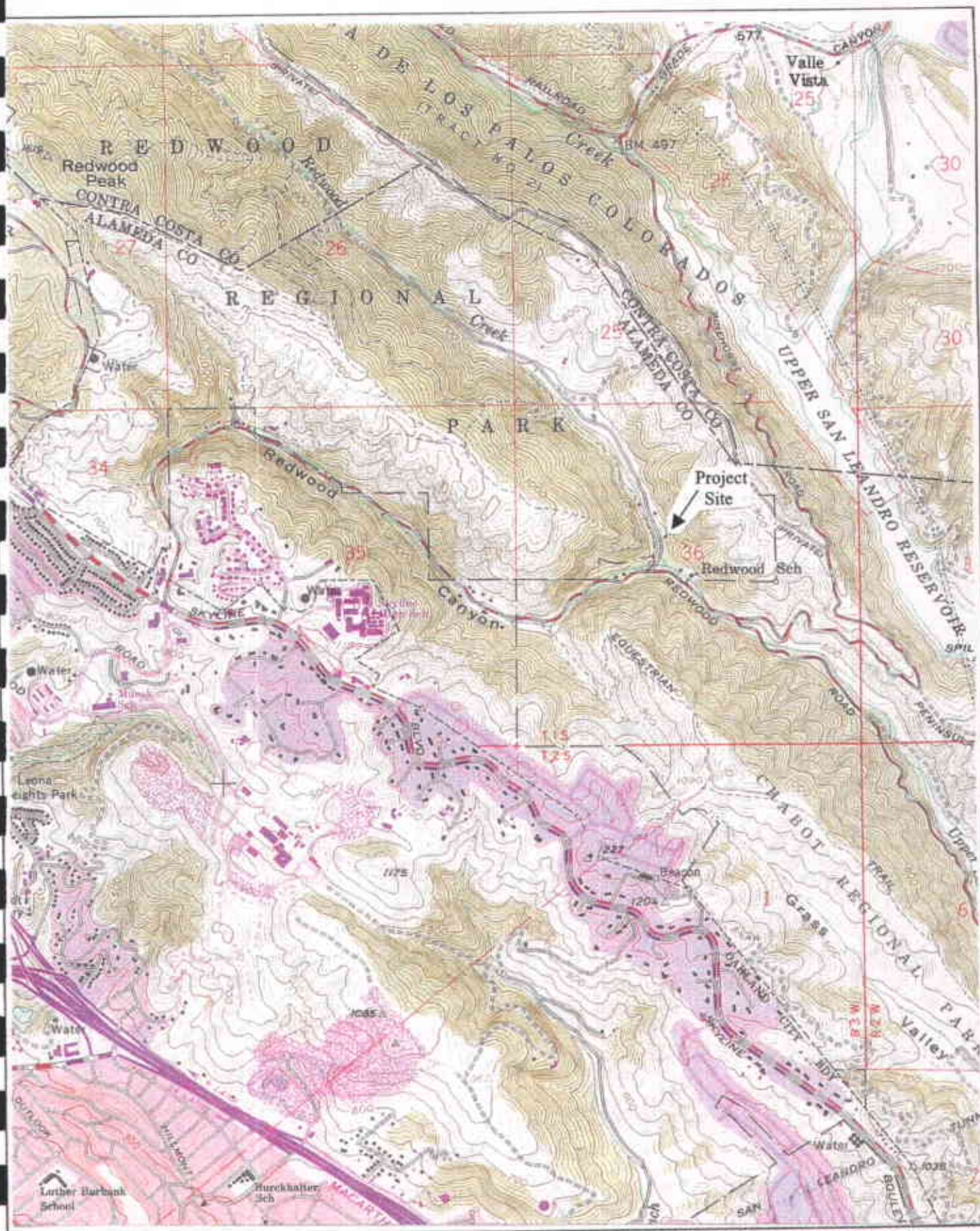
The project site is a service yard for Redwood Regional Park, which utilized two UFSTs (one 2,000-gallon diesel fuel and one 5,000-gallon unleaded gasoline) from the mid-1960s to 1993. Figure 2 shows the location of the former UFSTs. Both UFSTs were reportedly installed between 1965 and 1968 (Parsons, 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).

SITE INVESTIGATION AND REMEDIATION HISTORY

The following summarizes historical site remediation and characterization activities that have been conducted since 1993, beginning with removal of the UFSTs. Appendix A contains tabular summaries of historical soil, groundwater and surface water analytical results. Sampling locations are shown on figures presented later in this report. A complete listing of previous site investigation and remediation reports is included in the References section (Section 9.0).

UFST Removals and Soil Remediation Activities

The two project site UFSTs were excavated and transported offsite 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 range (TPHg) and aromatic hydrocarbons [benzene, toluene,



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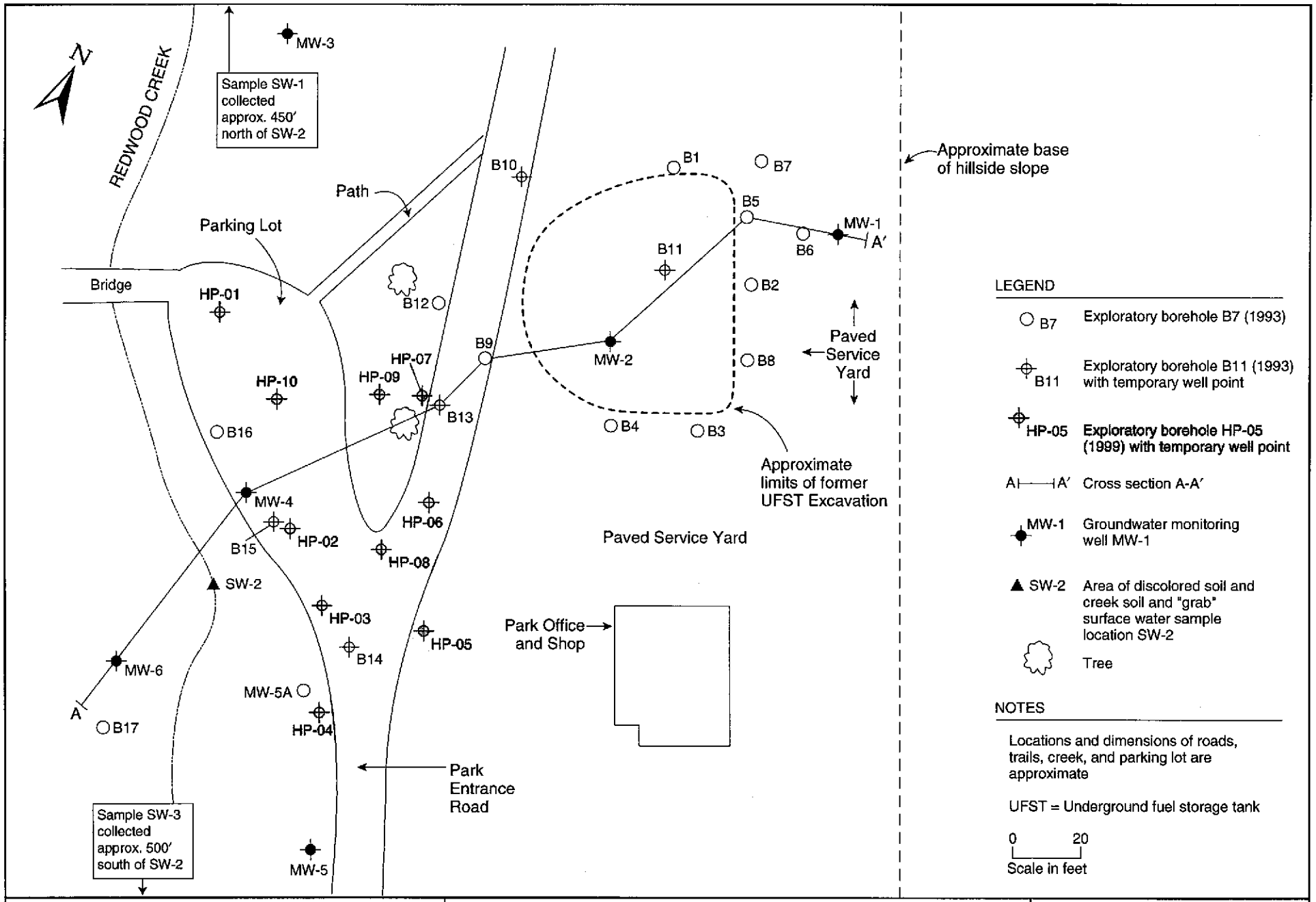
U.S.G.S. TOPOGRAPHIC MAP SHOWING SITE LOCATION

Redwood Regional Park Service Yard Oakland, Alameda County, California	By: MJC	NOVEMBER 1997	★ Stellar Environmental Solutions Geoscience & Engineering Consulting
	Figure 1		



Stellar Environmental Solutions

Geoscience & Engineering Consulting

Site Plan and Cross Section A-A' Location
Redwood Regional Park Service Yard, Oakland, CA

Figure 2

by: MJC | MAY 1999

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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 onsite 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. Figure 2 shows the approximate limits of the final UFST 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) TPHg, 1,300 total petroleum hydrocarbons-diesel range (TPHd), 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 ACDEH approval, the soil was relocated to Sibley Regional Preserve in Contra Costa County, California for further aeration and final disposition at that site.

Initial Site Characterization

At the request of ACDEH, a technical workplan was submitted (Parsons, 1993b), and an initial site characterization was conducted 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. Seventeen exploratory boreholes were drilled, five of which were converted to temporary well points. A total of 27 soil and 5 grab-groundwater samples were collected for laboratory analysis (Parsons, 1993c). No significant soil contamination was detected in soil boreholes immediately

north, south, or east of the former UFST remedial excavation. Fuels in soil were detected in soil boreholes up to 90 feet southwest of the former UFST excavation; maximum soil concentrations detected included 1,900 mg/Kg TPHg, 1,300 mg/Kg total petroleum hydrocarbons-kerosene range (TPHk), and 198 mg/Kg BTEX constituents. Maximum fuel concentrations detected in groundwater collected from temporary well points included 810,000 µg/L TPHg, 2,300,000 µg/L TPHk, 570 µg/L TPHd, and 125,000 µg/L BTEX (including 12,000 µg/L benzene) (Parsons, 1993c).

Groundwater Monitoring and Sampling

Prior to the recent (April 1999) sampling event, 13 groundwater monitoring, sampling, and analysis events have been conducted on an approximately quarterly frequency since November 1994. The lateral extent of groundwater contamination by TPHg, TPHd, and BTEX constituents is well-defined by existing site groundwater monitoring wells; currently, the maximum detected concentrations are in downgradient well MW-4 adjacent to Redwood Creek, approximately 130 feet southwest of the former UFSTs. Groundwater contaminant concentrations have shown an overall decreasing trend, with the exception of an unusually wet winter that resulted in a rebound of groundwater contamination levels to near historical maxima. A detailed analysis of site hydrochemical trends is presented in Section 5.0.

Creek Soil and Surface Water Sampling

In early 1994, discolored soil was observed in the eastern bed of Redwood Creek immediately downstream of the fish ladder, approximately 150 feet 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 TPHd; neither TPHg 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 shows these sampling locations, and Section 4 provides a detailed discussion of analytical results.

Historical ACDEH-approved revisions to the groundwater sampling program have included: 1) discontinuing hydrochemical sampling and analysis in wells MW-1, MW-3, MW-5, and MW-6; and 2) reducing the frequency of creek surface water sampling from quarterly to semi-annually (ACDEH, 1996). The latter recommendation has not yet been implemented due to continued concern over potential impacts to Redwood Creek.

Prior to the recent activities summarized in this report, the most recent phase of the investigation was the September 1998 groundwater and surface water monitoring event, and a critical evaluation of historical data as regards hydrochemical trends and an assessment of site closure criteria (SES, 1998b).

SITE REGULATORY HISTORY

Alameda County Health Care Services Agency, Department of Environmental Health (ACDEH) has been the lead regulatory agency for the case since its inception, with regulatory correspondence with the District going back to the January 1994 review of the December 1993 ES report documenting the UFST's removal. The ACDEH is a Local Oversight Program (LOP) to the RWQCB, and provides its own oversight until some resolution such as site closure is agreed upon, at which time it sends its recommendation to the RWQCB for approval of the closure. Other interested regulatory agencies, such as the California Department of Fish and Game (CDFG), communicate their concerns directly to ACDEH.

While ACDEH is usually in concurrence with the RWQCB's position on the need to remediate and on site closure criteria, they can also differ from it based on the case-by-case findings. The ACDEH has no published guidance regarding TPH or the fuel-related aromatic hydrocarbons BTEX and MTBE. They generally adhere to the basic non-degradational policy, but recognize that some degradation is unlikely to be irreversible and will accept case closures where there is the demonstration that no public health or ecological risks will occur as a result of the residual contamination.

Mr. Thomas Peacock of ACDEH wrote the District in September 1997 suggesting that recommendations needed to be formulated to address site contamination. He further suggested that some form of in-situ remediation, such as an oxygen releasing compound (ORC) might be considered. In early 1998 the CDFG communicated their concern about the potential ecological impact to the creek from the release into the creek recorded in two of the dry weather sampling events. In July 1998 the District met with ACDEH and CDFG, and the parties concluded that the District should complete an assessment of whether remediation was needed, and if so, what method would be most appropriate to move the site towards closure resolution. The current investigation was designed to satisfy those objectives.

2.0 PHYSICAL SETTING

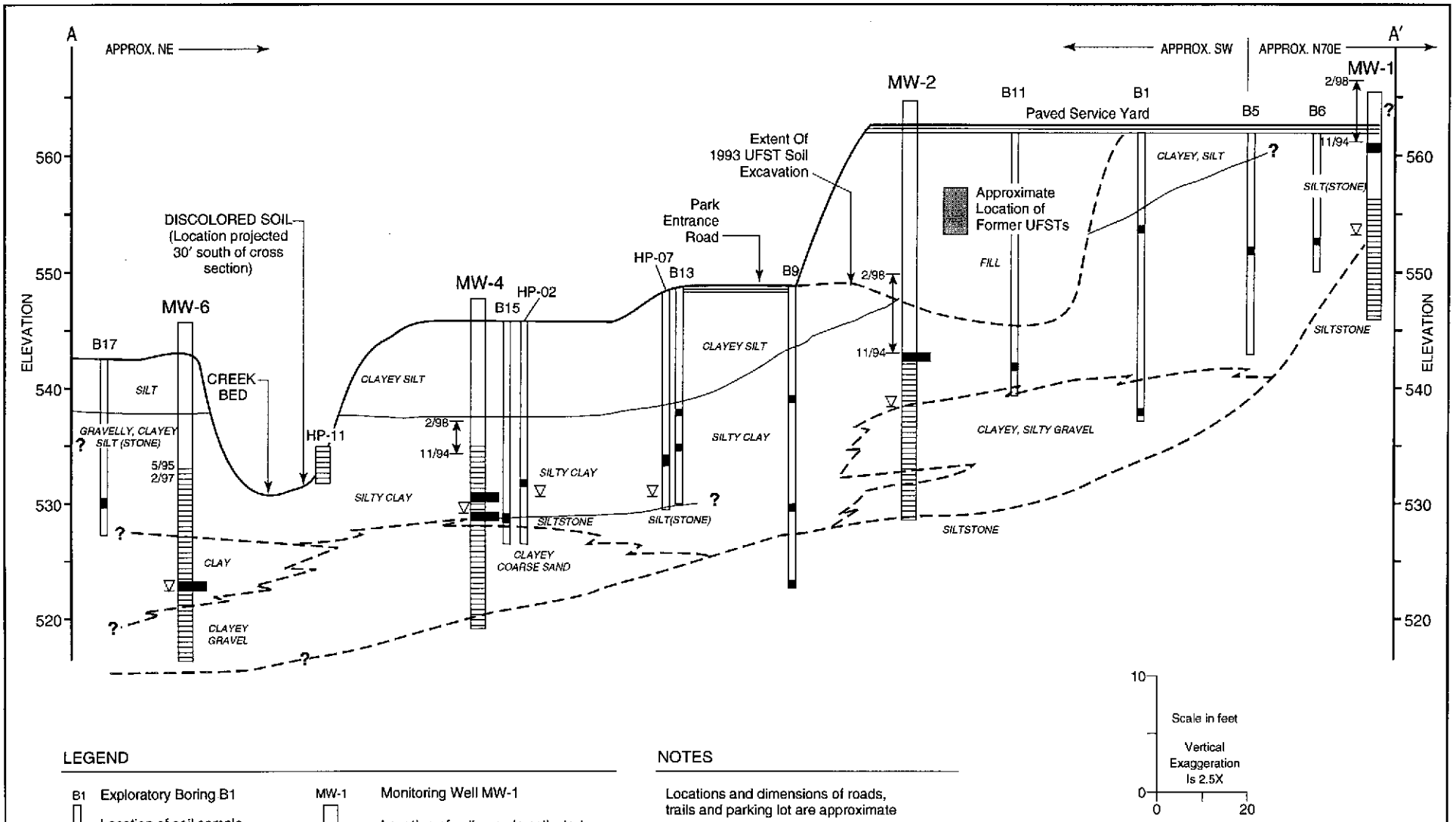
The following evaluation of the hydrogeologic conditions at the project site is based on geologic logging and water level measurements collected at the site since September 1993. This section summarizes site geology and groundwater and surface water hydrology.

GEOLOGY

The site is located approximately 7 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 elongated structural depression bounded by the Santa Cruz Mountains on the west and the Diablo Range on the east. The Oakland-Berkeley Hills, in which the site is located, 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 3 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 (Borcherdt et al., 1975). Overlying the bedrock in Redwood Creek canyon is Quaternary alluvium consisting of silt, sand, and gravel. The lateral and vertical variations in lithology are pronounced, as is typical in this type of depositional environment. Subsurface stratigraphy, along with other pertinent information at the site, is illustrated in cross section A-A' (Figure 3). These data are based on soil borehole data acquired during the 1993 initial site characterization and the November 1994 well installation program. 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 all monitoring well boreholes, 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.



LEGEND

- B1 — Exploratory Boring B1
- Location of soil sample collected for laboratory analysis
- MW-1 — Monitoring Well MW-1
- Location of soil sample collected for laboratory analysis
- Well screen interval
- ▽ First encountered groundwater during drilling
- 4/99 / 11/94 — Range of static water levels measured between November 1994 and April 1999 showing dates of measured maxima and minima

NOTES

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

Some borings projected into cross section (see Figure 2)

★ Stellar Environmental Solutions Geoscience & Engineering Consulting	**Cross Section A-A'** **Redwood Regional Park Service Yard, Oakland, CA**	**Figure 3** by: MJC | MAY 1999

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GROUNDWATER HYDROLOGY

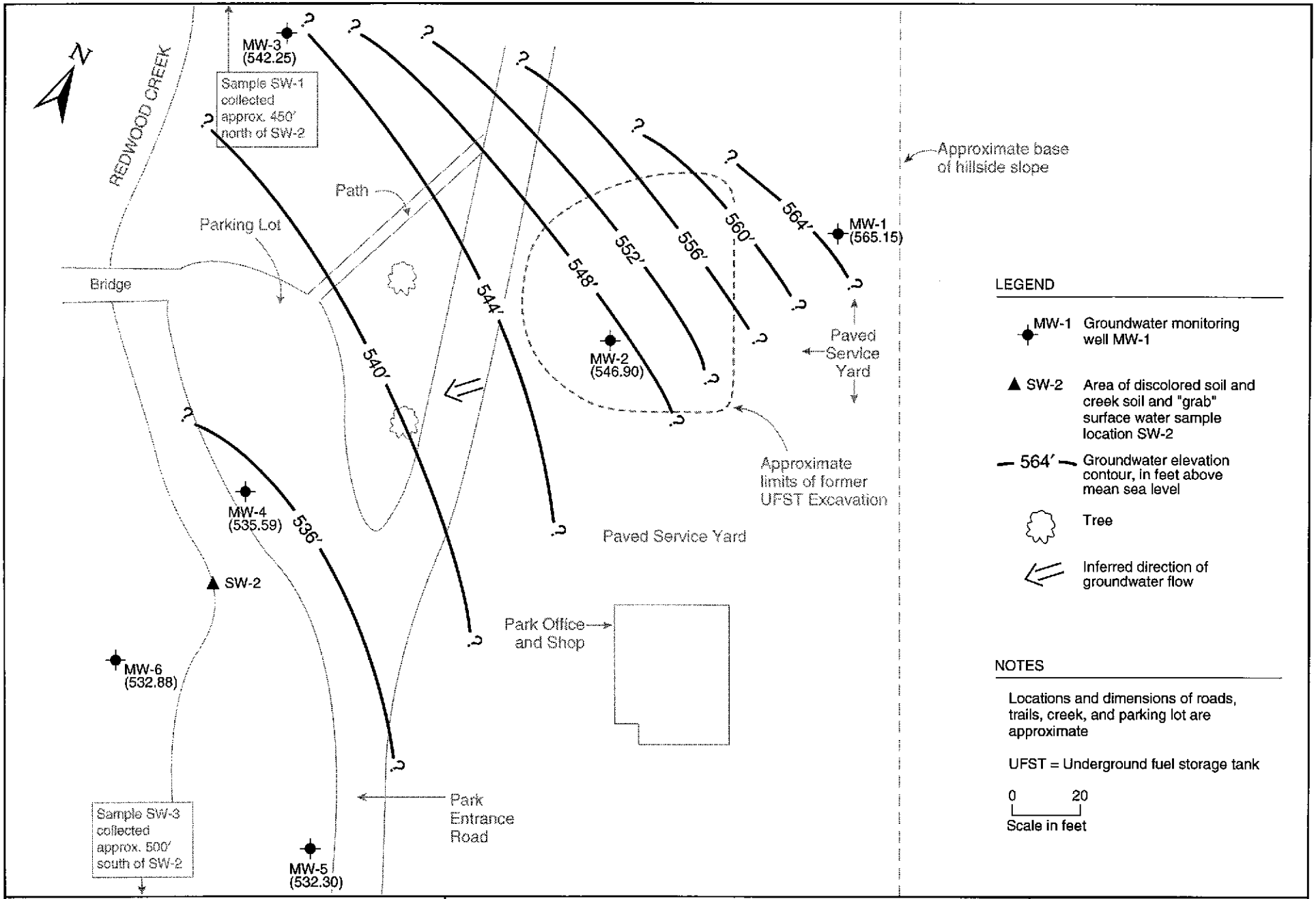
Lithology and Water Levels

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 is first observed at the top of the clayey, silty sand-gravel zone in all boreholes except upgradient location MW-1, where it was encountered near the surface. In areas downgradient of the former UFST source area, first occurrence of groundwater is generally observed between 12.5 and 19 feet bgs. Water levels in open boreholes and wells equilibrate several feet above first occurrence of groundwater during drilling, indicating confining conditions. Perched water zones were observed in several boreholes in the 1999 investigation. Because they are well above the top of the capillary fringe (elevation of highest groundwater), these perched zones are not pathways for contaminant transport in areas downgradient of the former UFSTs. Figure 3 shows the range of static water levels measured in site wells between November 1994 and April 1999.

Figure 4 shows a groundwater elevation map constructed from the April 1999 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. It is inferred that local groundwater flow direction west of Redwood Creek is toward the east (toward the creek). As would be expected, the groundwater flow path near the creek bends southward (downstream) due to the hydraulic influence of the creek. The groundwater gradient is relatively steep—approximately 2 feet per foot—between well MW-1 and the former UFST source area. The increased groundwater gradient in the source area is inferred to result from the topography and the highly disturbed nature of sediments in the landslide debris. Downgradient from the UFST source area, well MW-2 and Redwood Creek, the groundwater gradient is approximately 0.1 feet per foot.

Groundwater Velocity Estimate

Estimating groundwater velocity based on both empirical or site-specific field data and theoretical considerations is important in evaluating the timeline of the plume migration and options for remediation. The empirical conditions used in the velocity estimation are hydraulic gradient, hydrochemical data, the distance from the source to the creek, and the age of the original leak. Theoretical conditions include assumed hydraulic conductivity and effective porosity from literature-based sources. The estimate is usually good where the empirical and theoretical data corroborate each other.



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Groundwater Elevation Map–April 6, 1999
Redwood Regional Park Service Yard, Oakland, CA

Figure 4

by: MJC | MAY 1999

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The site specific condition used to estimate groundwater velocity include the estimated date when leakage from the source UFSTs began, the date when contamination was first observed to be discharging to the creek, the distance from the source to the creek, and the measured hydraulic gradient. The theoretical conditions of hydraulic conductivity and effective porosity are based on the indication of materials encountered at the water table in boreholes in the vicinity of the former UFSTs as predominantly clayey silt and silty clay.

Using the site lithology (variations of silty clay to the 5- to 10-foot thick clayey coarse-grained sand/clayey gravel unit) and literature-based data yield a range of hydraulic conductivity values of approximately 0.003 to 0.05 ft/day and an effective porosity value of 30 to 35 percent based on soil type (Fetter, 1988). Given a groundwater gradient of 0.1 feet per feet as estimated from static water level measurements west of the UFST source area, this would yield a groundwater velocity of <1 feet to about 5 feet per year. This groundwater velocity is lower than that indicated by the site-specific empirical data.

Why?

The UFSTs were installed by 1968. It is a reasonable assumption that it took at least 5 years for significant leaks or spills to develop, by 1973. The distance to the Creek from the source is 150 feet. The daylighting of the plume into the Creek was reported in 1993. These data indicate that the groundwater velocity, at least along preferential migrational pathways of higher permeability, is calculated at 1993-1973 = 20 years and 150 feet/20 years = 7.5 feet/year. This velocity estimate may also be low because the number of years that creek discharge was occurring before the 1993 discovery of it is unknown. A conservative estimate of groundwater velocity within the aquifer material is between 8 and 10 ~~years~~ feet per year, with the rate of movement within the clay rich zones being substantially less. The average linear groundwater velocity may also vary ~~from~~ per year depending on the flow conditions. In the absence of groundwater pumping test data the velocity range of 7 to 10 feet per year is a reasonable one to use given the site conditions.

SURFACE WATER HYDROLOGY

Redwood Creek borders the site to the west, and is a seasonal creek known for the occurrence of rainbow trout. Creek flow in the vicinity of the site shows significant season variation. During the summer and fall dry season, the creek has no flow, and standing water is limited to discontinuous pools. During the winter and spring wet season, the creek flows vigorously with water depths over 1 foot in places. Redwood Creek flows from northwest to southeast and discharges into Upper San Leandro Reservoir, located approximately 1 mile southeast of the site. Redwood Creek is a gaining stream (i.e., it is recharged by groundwater) in the vicinity of the site, as evidenced by wet creek banks above the stream surface and by historical observations of fuel-contaminated capillary fringe

soils in the eastern bank of Redwood Creek. Section 5.0 presents a site-specific conceptual model of contaminant transport in the context of groundwater discharge to Redwood Creek.

3.0 APRIL 1999 STREAM BIOASSESSMENT

The CDFG requested in their October 26, 1998 letter that a "seasonal instream bioassessment program" be implemented to provide evidence of whether impacts to fish and/or aquatic life are occurring as a result of detected site contamination, and hence if further remediation is warranted (Rugg, 1998). **The CDFG Water Pollution Control Laboratory (WPCL) is the CDFG group that established the bioassessment protocols; they have recommended that a minimum of two seasonal events be conducted: the first bioassessment event just after the rainy season (spring), and the second event prior to onset of heavy rains (winter).** These two stages will best represent the variations in the macroinvertebrate life cycle and community development. Based on preliminary input from CDFG, we understand that if initial results suggest an impact to the creek, the bioassessment program could include several years of seasonal bioassessment events in order to evaluate both current conditions and the potential increase in contaminant concentrations at the creek/groundwater interface.

The initial bioassessment event was conducted on April 2, 1999 by the CDFG WPCL in accordance with their March 1996 protocols, entitled "California Stream Bioassessment Procedure (Habitat Assessment and Biological Sampling; Macroinvertebrate Laboratory and Data Analyses; and Field and Laboratory Quality Assurance/Control), and the monitoring strategy followed that recommended for point source pollution (CDFG, 1996). This method is a regional adaptation of the USEPA Rapid Bioassessment Protocols, and is recognized by the USEPA as California's standard bioassessment procedure. **The method utilizes measures of the stream's benthic macroinvertebrate (BMI) community and its physical/habitat structure.** BMIs can have a diverse community structure with individual species residing within the stream for a period of months to several years. The biological and physical assessment integrates the effects of water quality over time and provides a baseline assessment of a stream's ecological health. A copy of the assessment protocols is included in Appendix B.

The event consisted of a 2-person CDFG team conducting an assessment/sampling of four "riffles" (sampling/assessment locations), including:

- Two upstream riffles (RC-U1 and RC-U2), approximately 300 meters and 200 meters upstream of the SW-2 location (area of contaminated groundwater discharge);

- One source area riffle (RC-GZ), approximately 3 meters downstream of the SW-2 location; and
- One downstream riffle (RC-D1), approximately 50 meters downstream of SW-2.

The CDFG report indicates that these locations were the best available representations of MBI habitat to evaluate potential impacts associated with site contamination. Three replicate samples were collected at each location to ensure statistical precision.

Field tasks completed include:

- Biological sampling (including completing a California Stream Bioassessment Procedure Field Worksheet at each riffle).
- Physical and habitat assessment.
- Taxonomic laboratory analyses and calculation of BMI metrics of five dominant taxa.
- Data compilation including statistical analysis.
- Qualitative assessment of impacts to the macroinvertebrate population assessed.

The full CDFG WPCL report summarizing the biostream assessment event is included in Appendix B. **The authors conclude that the benthic macrobiotic invertebrate communities at all sampled locations are indicative of normal conditions after spring flows, and there is no evidence of adverse impacts associated with site contamination.** They note that taxonomic richness metrics were approximately half as high in the area of contaminated groundwater discharge (SW-2 and RC-GZ), but they attribute that to stream physical and habitat structure differences at that location (steeper gradient and less available habitat). As agreed upon in the technical workplan, the CDFG WPCL report recommends that a follow-on bioassessment event be conducted just prior to the onset of winter rains to assess potential impacts at the end of the macroinvertebrate life cycle.

4.0 APRIL-MAY 1999 FIELD INVESTIGATION

This section presents the field program data collection. Included are the surface and groundwater sampling, rationale for the borehole locations, sampling depths and analytical methods, and a summary of the drilling and sampling methods. Subsequent Section 5.0 discusses the analytical results in the context of contaminant distribution, both current and historical, and presents a conceptual model of contaminant fate and transport. Appendix E contains the Alameda County Public Works drilling permit for the investigation. Appendix F contains photodocumentation of the borehole drilling and sampling program. The recent (April-May1999) field investigation program included three field components:

1. April 6, 1999 groundwater and creek surface water monitoring event;
2. April 14 and 15, 1999 exploratory bore program; and
3. May 24, 1999 Redwood Creek bank survey and sampling.

The description of each element of the field program is presented below. The analytical data and findings from the field activities are then presented in the following Section 5.0 of this report.

GROUNDWATER MONITORING WELL AND SURFACE WATER SAMPLING

Monitoring and sampling protocols were in accordance with the October 1998 SES technical workplan. Activities conducted include:

- Measuring static water levels and field analyzing groundwater samples for indicators of natural attenuation in all six site wells;
- Collecting groundwater analytical samples from the two site wells within the contaminant plume (MW-2 and MW-4); and
- Collecting creek surface water samples for laboratory analysis and field analyzing surface water samples for dissolved oxygen.

Groundwater level monitoring and creek sampling were conducted by SES. Groundwater monitoring well purging, sampling and field analyses were conducted by BlaineTech Services under direct supervision of SES personnel. The locations of all site monitoring wells and creek water

sampling locations are shown on Figure 2. Well construction information is summarized in Table 1. Appendix C contains the groundwater monitoring field record.

Table 1
Groundwater Monitoring Well Construction Data

Well	Well Depth	Screened Interval	Depth to TOC	Ground Surface Elevation	TOC Elevation
MW-1	18	7-17	-2.3	563.6	565.9
MW-2	36	20-35	-2.4	564.1	566.5
MW-3	42	7-41	-2.8	558.1	560.9
MW-4	26	10-25	-2.1	546.0	548.1
MW-5	26	10-25	-2.3	545.2	547.5
MW-6	26	10-25	-2.3	543.3	545.6

Notes:

1) TOC = Top of Casing
2) All depths are feet below ground surface unless otherwise specified. Negative values for "Depth to TOC" indicate that the TOC is above ground surface.
3) All elevations are feet above USGS mean sea level (MSL). Elevations were surveyed by EBRPD relative to USGS Benchmark No. JHF-49. All wells are 4-inch inside diameter.

GROUNDWATER LEVEL MONITORING AND SAMPLING

Static water levels were measured (Appendix C) in all six site wells on April 6, 1999. All water level measurements were made using an electric water level indicator. Pre-purge groundwater samples from all wells were field analyzed for indicators of natural attenuation including ferrous iron, dissolved oxygen, and oxygen reduction potential (ORP, or redox potential).

Groundwater sampling of MW-2 and MW-4 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 collecting groundwater samples, a pre-cleaned submersible pump was used to purge a minimum of three casing volumes from each well. Electrical conductivity (EC), hydrogen ion index (pH), temperature (T), and turbidity of purge water samples were measured during well purging, to document the stabilization of formation-water in the wells. Glass sample containers were filled with sample water from a pre-cleaned Teflon™ bailer. The water sample collected from well MW-4 had a noticeable petroleum odor and sheen, and the historically observed orange algal bloom was also observed in the MW-4 sample.

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 60 gallons of purge water and decontamination rinsate from the current groundwater sampling event was containerized in the onsite plastic tank. The purge water will continue to be accumulated in the onsite tank until it is full, at which time it will be transported offsite for proper disposal.

CREEK-GROUNDWATER INTERFACE SURVEY AND SAMPLING

On May 24, 1999 Bruce Rucker of SES completed a survey of the apparent width of the plume daylighting in the Redwood Creek bank immediately downslope from the groundwater plume identified in the monitoring wells and hydropunch samples. The "pot-holing" survey method entailed exploratory probing with a pick and shovel into the creek bank immediately above the Creek water surface to define the limits of plume-impacted area based on hydrocarbon discolored and odiferous soil, algal bloom zones, and hydrocarbon sheen on groundwater. No evidence of contamination could be obtained by pot-holing directly beneath the creek bed due to immediate inflow of creek water.

The borehole adjacent to the creek (HP-11) was installed on May 22, 1999. The purpose of this temporary well point was to collect a grab-groundwater sample immediately upgradient of the point of discharge to the creek. This temporary well point was installed within a hand-dug hole approximately 18 inches square and 12 inches deep. Approximately 5 gallons of standing turbid water was purged from the hole, then the well point was installed and consisted of 2-inch OD PVC casing installed within a 4-inch OD PVC conductor casing. The bottom of the screened interval was just above the creek surface water level. Sand was emplaced in the annular space between the two casings, which were both slotted over a 6-inch interval, then the entire hole was filled with sand. Another 10 gallons of water was purged from the hole, then a grab groundwater sample was collected from the well point. Following sampling, the well point was removed and the hole was covered with nearby clean soil. During purging of the well point, groundwater was observed flowing out of the upgradient side of the hole at an elevation higher than the creek surface water level, confirming that the grab-groundwater sample was not influenced by creek flow.

Petroleum sheen and/or algal bloom were noted in the majority of the capillary fringe contamination in the creek bank, on the creek surface in low-flow areas in the immediately vicinity of SW-2 and HP-11, and at two low-flow areas within 15 feet of SW-2 and HP-11.

CREEK SURFACE WATER SAMPLING

Surface water samples were collected on April 1999 from locations SW-1, SW-2, and SW-3 in Redwood Creek (see Figure 2 for locations). 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. Surface water samples were also field analyzed for dissolved oxygen. At the time of sampling, the creek was flowing briskly and depth of water at the sampling locations was approximately 6 to 12 inches. At the SW-2 location, where contaminated groundwater discharge to the creek has historically been observed, petroleum odor was noted as was orange algae growing on the saturated portion of the creek bank. It is inferred that this algae is utilizing the petroleum as a carbon source, and is therefore a good indicator of the presence of petroleum contamination.

BOREHOLE LOCATION, SAMPLING AND ANALYTICAL METHOD SELECTION

Eleven exploratory boreholes were drilled in the area between the former UFSTs and the creek. The boreholes were located generally on two approximately north-south trending transects approximately 50 feet apart. Boreholes were located on approximately 20-foot centers along each transect. Additional boreholes were installed between the two transects in the area of inferred greatest contamination, and one borehole was located immediately adjacent to the creek. Figure 2 shows the borehole locations.

One soil sample was collected from ten of the boreholes (not including HP-11 adjacent to the creek) for laboratory analysis of chemicals of concern (TPHg, TPHd, BTEX, and MTBE). Soil samples were collected within the capillary fringe in the zone of inferred greatest contamination, based on PID readings. One soil sample was also collected from each of two boreholes within the water-bearing zone for analysis for total organic carbon. One grab-groundwater sample was collected from each borehole from the upper water-bearing zone. All groundwater samples (except HP-11) were analyzed for the chemicals of concern as well as for indicators of natural attenuation (dissolved oxygen, redox potential, nitrate, and sulfate).

DRILLING AND SAMPLING PROCEDURES

Drilling was conducted on April 14 and 15, 1999 by Fisch Environmental Services, under direct supervision of an SES California Registered Geologist. All boreholes (except HP-11) were drilled

with the Geoprobe™ system which advances an approximately 2-inch diameter steel rod containing acetate sleeves for core recovery. Drilling and sampling equipment was decontaminated between each bore by steam cleaning. Sleeves selected for laboratory analysis were capped with non-reactive caps, labeled and transported under chain-of-custody to the laboratory. Grab-groundwater samples were collected with vacuum pump tubing inserted through a temporary PVC well casing installed in the boreholes, and were transferred to appropriate preserved containers for transport to the laboratory. Sample handling, preservation, and documentation was in accordance with USEPA protocols.

All bores were geologically logged by visual inspection of soil cores using the Unified Soils Classification System (USCS). Copies of the geologic logs are included in Appendix G. Soil samples were field-screened with a photoionization detector (PID) for evidence of soil contamination to assist in the selection of samples for laboratory analysis and as a cost-effective technique for supplementing laboratory-analyzed samples to delineate soil contamination. Following sampling activities, the boreholes were tremie-grouted to the surface with a cement-bentonite grout slurry. All investigation-derived waste (unused soil samples and decontamination rinsate) was temporarily containerized onsite for subsequent offsite disposal.

5.0 FIELD AND LABORATORY ANALYTICAL RESULTS

This section presents the field and laboratory analytical results of the current (April-May 1999) subsurface investigation, including surface water, groundwater well, exploratory hydropunch and creek bank sampling results. Field and laboratory analyses included for the first time the measurement of natural attenuation parameters of redox potential and dissolved oxygen (in the field) and ferrous iron and sulfate (in the laboratory).

GROUNDWATER WELL AND SURFACE WATER ANALYTICAL RESULTS

All creek surface water and groundwater samples were analyzed for historical constituents of concern, including TPHg, TPHd, BTEX, and MTBE. Table 2 and Figure 5 summarize the analytical results of the September 1998 creek surface water and groundwater samples. Section 5.0 presents a detailed discussion of the significance of the analytical results.

Natural Attenuation Parameters Measured

All of the groundwater monitoring wells and none of the surface water samples were analyzed for indicators of natural attenuation. Dissolved oxygen and redox potential were measured in the field using electronic meters. Nitrogen and sulfate were analyzed in the laboratory. Table 3 shows the results which indicate a wide range of values. The implications of these natural attenuation parameters are discussed in the next report section.

Creek Surface Water Samples

No compounds were detected above their respective method reporting limits in either the upstream (SW-3) or downstream (SW-1) locations. TPHg, MTBE, benzene, ethylbenzene, and total xylenes were detected at the SW-2 location (area of contaminated groundwater discharge). Neither TPHd nor toluene were detected at that location. Dissolved oxygen concentrations ranged from 8.0 mg/L to 10.2 mg/L, indicating that creek surface water is well oxygenated and not anaerobic.

Groundwater Sample Results

As shown in Table 2, TPHg, benzene, ethylbenzene, total xylenes, and MTBE were detected in both MW-2 and MW-4 samples in the current sampling event. For these constituents, concentrations in

Table 2
Groundwater and Creek Surface Water
Sample Analytical Results, April 6, 1999
Redwood Regional Park Corporation Yard - Oakland, California

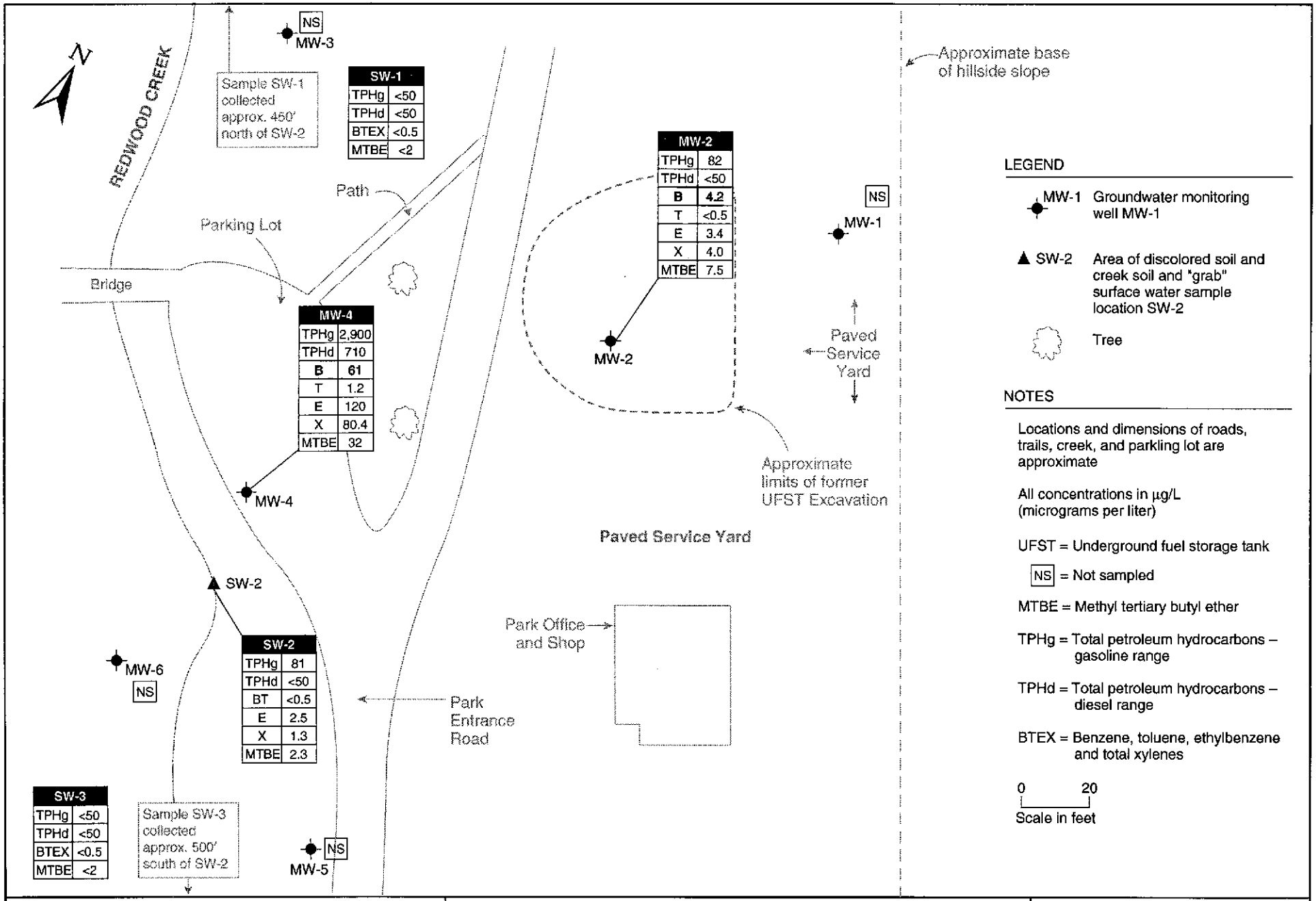
Compound	Concentrations in µg/L						
	TPHg	TPHd	Benzene	Toluene	Ethyl-benzene	Total Xylenes	MTBE
Groundwater Samples							
MW-2	82	< 50	4.2	< 0.5	3.4	4.0	7.5
MW-4	2,900	710	61	1.2	120	80.4	32
Creek Surface Water Samples							
SW-1	< 50	< 50	< 0.5	< 0.5	< 0.5	< 0.5	< 2
SW-2	81	< 50	2.0	< 0.5	2.5	1.3	2.3
SW-3	< 50	< 50	< 0.5	< 0.5	< 0.5	< 0.5	< 2

Notes:
MTBE = Methyl tertiary butyl ether
TPHg = Total petroleum hydrocarbons - gasoline range (equivalent to total volatile hydrocarbons - gasoline range)
TPHd = Total petroleum hydrocarbons - diesel ranges (equivalent to total extractable hydrocarbons - diesel range)
µg/L = Micrograms per liter, equivalent to parts per billion (ppb)

Table 3
Groundwater Sample Analytical Results:
Natural Attenuation Indicators, April 1999
Redwood Regional Park Corporation Yard - Oakland, California

Sample I.D.	Nitrogen (as Nitrate) (mg/L)	Sulfate (mg/L)	Dissolved Oxygen (mg/L)	Ferrous Iron (mg/L)	Redox Potential (milliVolts)
MW-1	< 1.0	150	2.0	ND	120
MW-2	< 1.0	100	6.8	ND	-155
MW-3	< 1.0	42	1.7	0.02	53
MW-4	< 1.0	19	3.7	2.0	268
MW-5	< 1.0	24	1.8	0.02	64
MW-6	< 1.0	86	2.3	0.04	23

Notes: mg/L = Milligrams per liter, equivalent to parts per million (ppm); NA = Not Analyzed; ND = Not Detected



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Groundwater Monitoring Well and Surface Water Analytical Results–April 6, 1999
Redwood Regional Park Service Yard, Oakland, CA

Figure 5

by: MJC | MAY 1999

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the MW-4 samples were approximately one order of magnitude greater than the MW-2 concentrations. Neither TPHd nor toluene were detected above the method reporting limit in the MW-2 samples. Section 6.0 discusses the groundwater analytical results in the context of regulatory agency criteria. Section 7.0 discusses the significance of the report findings, including remedial action considerations.

EXPLORATORY BORE SOIL AND GRAB-GROUNDWATER ANALYTICAL RESULTS

Tables 4 and 5 present petroleum and aromatic hydrocarbon analytical results for borehole soil and groundwater samples, respectively. Table 6 presents analytical results of natural attenuation indicators (nitrogen and sulfate) in borehole groundwater samples.

Natural Attenuation Parameters Measured

Nine of the ten groundwater samples (HP-01 through HP-09) were analyzed for indicators of natural attenuation, including nitrogen (as nitrate) and sulfate. Dissolved oxygen and redox potential were not measured in the hydropunch samples because they would not be representative. Nitrogen was below the detection limit in all but one of the samples (HP-05) that had a nitrate concentration just above the method detection limit. Sulfate was detected in eight of the nine samples, ranging in concentration from 7.7 mg/L to 100 mg/L.

Quality Control Sample Analytical Results

One field duplicate sample (MW-0A) was collected from well MW-4 and analyzed for TPHg, BTEX and MTBE 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: 11 percent (TPHg); 20 percent (benzene); 82 percent (toluene); 20 percent (total xylenes); and 10 percent (MTBE). With the exception of the toluene results, these data suggest very good reproducibility of lab results. Field duplicate samples will continue to be analyzed and evaluated to determine if the recent MTBE results are an anomaly.

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 D), with one exception. The surrogate recovery for one QC sample was outside the acceptance limits due to matrix interference (sample turbidity). It is unlikely that this single QC deviation significantly affects the data quality. The only other QC deficiency in the soil, groundwater and surface water data set was sample HP-03-GW analyzed for TPHd beyond the method-specified holding time, and therefore the analytical result may be lower than actual.

Table 4
Borehole Soil Sample Analytical Results:
Petroleum and Aromatic Hydrocarbons, April 1999
Redwood Regional Park Corporation Yard - Oakland, California

Sample I.D.	Sample Depth (feet bgs)	Concentrations in mg/kg						
		TPHg	TPHd	Benzene	Toluene	Ethyl-benzene	Total Xylenes	MTBE
HP-01-17.5'	17.5'	< 1.0	3.8	< 0.005	< 0.005	< 0.005	< 0.005	< 0.02
HP-02-14'	14'	970	640	1.3	1.3	5.5	8.7	1.0
HP-03-13'	13'	< 1.0	5.8	< 0.005	< 0.005	< 0.005	< 0.005	< 0.02
HP-04-15'	15'	< 1.0	1.7	< 0.005	< 0.005	< 0.005	< 0.005	< 0.02
HP-05-15'	15'	< 1.0	4.3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.02
HP-06-11'	11'	1,700	360	1.4	2.7	21	81	< 0.8
HP-07-12'	12'	2.9	340	0.028	< 0.005	0.13	0.347	0.02
HP-08-15.5'	15.5'	580	83	< 0.1	1.0	4.7	4.7	< 0.4
HP-09-15'	15'	610	630	1.5	1.5	3.8	11.2	< 0.5
HP-10-14'	14'	500	76	0.19	1.6	2.0	3.21	2.3

Notes:

MTBE = Methyl tertiary butyl ether

TPHg = Total petroleum hydrocarbons-gasoline range (equivalent to total volatile hydrocarbons)

TPHd = Total petroleum hydrocarbons-diesel range (equivalent to total extractable hydrocarbons)

mg/kg = Milligrams per kilogram, equivalent to parts per million (ppm)

Table 5
Borehole Groundwater Sample Analytical Results:
Petroleum and Aromatic Hydrocarbons, April 1999
Redwood Regional Park Corporation Yard - Oakland, California

Sample I.D.	Concentrations in µg/L						
	TPHg	TPHd	[redacted]	Toluene	Ethyl-benzene	Total Xylenes	MTBE
HP-01-GW	1,300	850	< 0.5	< 0.5	< 0.5	0.67	< 2
HP-02-GW	31,000	270,000	760	12	1,100	833	260
HP-03-GW	3,700	1,400 (a)	25	0.71	130	40.5	31
HP-04-GW	67	< 50	< 0.5	< 0.5	< 0.5	< 0.5	15
HP-05-GW	< 50	< 50	< 0.5	< 0.5	< 0.5	< 0.5	18
HP-06-GW	54,000	16,000	830	< 13	2,800	11,000	190
HP-07-GW	42,000	15,000	750	49	2,500	5,290	230
HP-08-GW	13,000	1,900	150	5.4	570	931	120
HP-09-GW	40,000	6,700	1,700	110	2,100	6,890	200
HP-10-GW	23,000	8,400	53	3.2	600	928	57
HP-11-GW	2,000	440	30	0.85	92	53.3	31

Notes:

MTBE = Methyl tertiary butyl ether

TPHg = Total petroleum hydrocarbons-gasoline range (equivalent to total volatile hydrocarbons)

TPHd = Total petroleum hydrocarbons-diesel range (equivalent to total extractable hydrocarbons)

µg/L = Micrograms per liter, equivalent to parts per billion (ppb)

(a) Sample analyzed beyond method-specified holding time and result may be lower than actual.

Table 6
Borehole Drilling Groundwater Sample Analytical Results:
Natural Attenuation Indicators, April 1999
Redwood Regional Park Corporation Yard - Oakland, California

Sample I.D.	Nitrogen (as Nitrate) (mg/L)	Sulfate (mg/L)
HP-01-GW	< 0.5	**60**
HP-02-GW	< 0.5	< 5.0
HP-03-GW	< 0.5	**61**
HP-04-GW	< 0.5	**70**
HP-05-GW	**0.9**	**100**
HP-06-GW	< 0.5	**7.7**
HP-07-GW	< 0.5	**21**
HP-08-GW	< 0.5	**10**
HP-09-GW	< 0.5	**14**
HP-10-GW	NA	NA

Notes: mg/L = Milligrams per liter, equivalent to parts per million (ppm); NA = Not Analyzed

6.0 REGULATORY CONSIDERATIONS

The Applicable Relevant and Appropriate Regulations (ARARs) for this site are presented here to give a regulatory context to the problem before presenting the interpretation of findings and consideration of remedial action. The ARARs generally should be considered in the light of the following:

- **There is a significant volume of residual petroleum and aromatic hydrocarbon contamination in the former UFST source area and in the capillary fringe extending approximately 150 downgradient to Redwood Creek.** This contaminated soil will continue to be a long-term source of groundwater contamination. However, given the site conditions, remediation of this contaminated soil by excavation and offsite disposal is neither practical nor cost-effective.
- **Groundwater contamination is currently greatest at or near the downgradient edge of the site, adjacent to Redwood Creek.** Groundwater daylights at the base of the slope within the creek during the low flow period in summer, and site contaminants have been sporadically detected in creek surface water at a localized point of groundwater discharge.
- Site groundwater is not utilized for drinking water. Redwood Creek flows to Upper San Leandro Reservoir, a municipal water supply; however, downstream creek surface water samples have never contained concentrations of concern as a result of the dilution effect from the stream. Human health risk associated with site contamination would be limited to short-term exposure to contaminated surface water.
- Redwood Creek is a protected trout stream, and discharge of contaminated groundwater should be evaluated in the context of impacts to benthic invertebrates as indicator of the overall riparian environment.
- The lead regulatory agency for the site investigation is the Alameda County Health Care Services Agency, Department of Environmental Health (ACDEH). The ACDEH is a Local Oversight Program (LOP) to the RWQCB, and provides its own oversight until some resolution such as site closure is agreed upon, at which time it sends its recommendation to the RWQCB for approval of the closure. The California Department of Fish and Game (CDFG) has communicated their concerns directly to ACDEH as regards potential impacts to Redwood Creek.

The following subsections present potentially applicable criteria for evaluating site contamination in soil, groundwater and surface water, and compare site contamination to the relevant criteria.

SOIL CONTAMINATION

Cleanup and Further Assessment Criteria

Regulatory agencies can require remediation of petroleum-contaminated soil if they deem its impact significant. The evaluation of impacts can take numerous forms, from the general adoption of a non-degradational standpoint to the need to demonstrate definitive human health or ecological impacts of significance. Generally, the first regulatory assessment evaluates if the contamination is hazardous, which would be the case for hydrocarbons if it were ignitable or toxic, and/or if residual soil contamination contributes to groundwater and/or surface water contamination resulting in unacceptable impacts.

The California Regional Water Quality Control Board (RWQCB) has historically utilized a Designated Level Methodology (DLM) as a guide in determining if a waste (i.e., contaminated soil) at a given site should be classified as a designated waste and, if so, what cleanup level is needed. The DLM calculations are site-specific and consider the depth to groundwater, type of soil, total pollutant load, amount of rainfall, and attenuation factors. In addition, the feasibility and cost benefit of soil remediation is a point of consideration.

Historically the RWQCB used 100 mg/Kg in soil as a general criterion for initiating groundwater characterization (RWQCB, 1989), published in the Leaking Underground Fuel Storage Tank (LUFT) Manual guidance document. The LUFT guidance has been largely superceded by the findings of the Lawrence Livermore National Laboratory (LLNL) report in October 1995 (LLNL, 1995). The LLNL report completed a statistical analysis of hydrocarbon plume characteristics of length and persistence in hundreds of RWQCB cases throughout the state, concluding that hydrocarbons will slowly degrade over time and are more significantly limited in size than previously thought. These findings prompted the RWQCB to adopt an evaluation of residual TPH contamination in the context of an assessment of risk on a case-by-case basis, encouraging the use of risk-based corrective action (RBCA) assessments.

Comparison of Site Data to Regulatory Criteria

Sufficient site characterization has been conducted to confirm the extent and magnitude of residual soil contamination, and that this will be an ongoing source of groundwater contamination. It is highly unlikely that residual soil contamination would be deemed hazardous based on ignitability or toxicity. Site analytical data confirm that residual soil contaminant concentrations exceed DLM guidance criteria, and impacts to groundwater from residual soil contamination are confirmed by site

groundwater analytical data. Therefore, additional soil characterization is not warranted for these specific objectives. Additional soil characterization could be utilized in the future to evaluate the potential effectiveness of remedial strategies.

GROUNDWATER CONTAMINATION

Cleanup and Further Assessment Criteria

There are several potentially applicable standards for groundwater contamination: all are drinking water standards and include:

- Federal and California primary and secondary Maximum Contaminant Levels (MCLs) and MCL goals;
- California Department of Health Services (DHS) action levels (ALs) for toxicity, taste, and odor; and
- California Environmental Protection Agency (Cal/EPA) Applied Action Levels (AALs).

The standard that can be applied by the lead regulatory is the strictest of any applicable state or federal standards, and these can be used as cleanup goals. Table 7 summarizes the groundwater quality criteria, and recent maximum site concentrations, and includes only the California and federal MCLs which are generally the most stringent of the drinking water standards. The majority of the groundwater quality standards are human health risk-based, and apply to groundwater that is a drinking water source; however, drinking water standards can be applied to sites where groundwater is not a drinking water source. Cleanup action level criteria can be determined by natural geochemical conditions at a site. For example, where an existing aquifer has a sustained yield of less than 200 gallons per day or the electrical conductivity is greater than 5,000 µmhos/cm, the California State Water Resources Control Board (SWRCB) considers the aquifer not usable as a potential public water supply. Historical groundwater monitoring data indicate that the site groundwater conditions meet the criteria for a potential public water supply, and therefore drinking water standards could be applied as cleanup standards.

There are no published numerical groundwater quality standards for TPH. This is because TPH is a complex mixture of dozens of individual compounds that varies by commercial grade; therefore, each mixture behaves differently as regards toxicity, transport, and fate. TPH is specifically regulated under the RWQCB general "nondegradation of beneficial use" policy (RWQCB, 1992), which essentially is a zero-discharge policy.

Table 7

Surface and Ground Water Quality Criteria for Detected Contaminants

Analyte	Groundwater Regulatory Limit (µg/L)	Maximum Detected Groundwater Concentration & Date (a) (µg/L)	Surface Water Regulatory Limit (µg/L)	Maximum Historical Detected Surface Water Concentration (b) (µg/L) Number of Samples / Number of Exceedances
TPH-gasoline	No limit established	**54,000** – 2/99	No limit established	**350**
TPH-diesel	No limit established	**270,000** – 2/99	No limit established	**130**
Benzene	1 (Ca MCL-Prim) 71 (IRIS-H20)	**1,700** – 2/99	 0.34 (WQO-DW) 21 (WQO-Other) 21 (IRIS-H20+Org) 71 (IRIS-H20) 130 (EPA Tier II)	**13** 4 / 12 0 / 12 0 / 12 0 / 12 0 /12
Toluene	40 (fed MCL-Sec-Prop) 1,000 (fed MCL-Prim-Prop) 200,000 (IRIS-H20)	**110** – 2/99	 9.8 (EPA Tier II) 6,800 (IRIS-H20+Org) 200,000 (IRIS-H20)	**0.89** 0 / 12 0 / 12 0 / 12
Ethylbenzene	30 (fed MCL-Sec-Prop) 680 (Ca MCL-Prim) 29,000 (IRIS-H20)	**2,800** – 2/99	 7.3 (EPA Tier II) 3,100 (IRIS-H20+Org) 29,000 (IRIS-H20)	**19** 1 / 12 0 / 12 0 / 12
Total Xylenes	20 (fed MCL-Sec-Prop) 1,750 (Ca MCL-Prim)	**11,000** – 2/99	 13 (EPA Tier II)	**10.7** 0 / 12
MTBE	5 (Ca MCL-Sec-Pro) 14 (Ca MCL-Prim-Pro)	**260** – 2/99	No limit established	**2.3**

Notes:

(a) Concentrations detected since February 1998 in site monitoring wells or temporary well points

(b) Concentrations detected since 1993 in Redwood Creek

Ca MCL-Prim = State of California Primary Maximum Contaminant Level for drinking water

Ca MCL-Sec-Prop = State of California Secondary Maximum Contaminant Level (proposed) for drinking water

EPA Tier II = USEPA Tier II values from Proposed Water Quality Guidance for the Great Lakes System, 1993

Fed MCL-Prim-Prop = Federal Primary MCL (proposed); Fed MCL-Sec-Prop = Federal Secondary MCL (proposed)

WQO - DW= California State Water Resources Control Board (SWRCB) Water Quality Objective for inland surface waters that are potential drinking water sources

WQO – Other = SWRCB Water Quality Objective for inland surface waters that are not potential drinking water sources

IRIS-H20 = Environmental Protection Agency Integrated Risk Information System - concentration at which there is a human carcinogenicity risk of 10E-6 or less for consumption of water only.

IRIS-H20+Org = Environmental Protection Agency Integrated Risk Information System - concentration at which there is a human carcinogenicity risk of 10E-6 or less for consumption of water only.

Site-specific groundwater cleanup standards (especially for TPH) can be calculated using the now common risk-based corrective action (RBCA) modeling approach that determines acceptable levels of residual soil and groundwater contamination that are protective of specified downgradient health risk or ecological receptors. Because of the documented discharge of contaminated groundwater into Redwood Creek, the immediate concern of ACDEH and CDFG is potential impacts to Redwood Creek resulting from groundwater discharge. It is likely that these agencies will require, at a minimum, that groundwater contamination concentrations not exceed those that pose unacceptable impacts to Redwood Creek, as discussed in the following paragraphs.

Comparison of Site Data to Regulatory Criteria

Maximum fuel concentrations detected in site groundwater samples during the previous year of groundwater monitoring and temporary well point sampling that are in excess of published regulatory agency ARARs for groundwater include:

- Benzene (1,700 µg/L; exceeds the California Primary MCL and IRIS human health criteria).
- Toluene (110 µg/L, exceeds the proposed Federal Secondary MCL).
- Ethylbenzene (2,800 µg/L; exceeds the California and Federal MCLs).
- Total xylenes (11,000 µg/L; exceeds the California and Federal MCLs).
- MTBE (260 µg/L; exceeds the proposed MCLs).

As noted previously, greater groundwater contaminant concentrations are inferred to exist in the central portion of the groundwater plume between historical sampling locations.

SURFACE WATER CONTAMINATION

Regulatory Criteria

As shown in Table 7, there are numerous numerical "action levels" and guidance criteria for surface water quality, including:

- USEPA Integrated Risk Information System (IRIS) values for consumption of aquatic organisms and/or water (human health risk-based).
- SWRCB Water Quality Objectives (WQOs) for inland surface waters (SWRCB, 1991) (aquatic toxicity-based and calculated base on a 30-day average of sample concentrations).
- Oak Ridge National Laboratory (ORNL) Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota (ORNL, 1996) (aquatic toxicity-

based); Table 7 presents the most stringent of the "benchmark" screening values, which are the USEPA Tier II water quality guidance criteria.

As for groundwater, there are no numerical criteria published for TPH in fresh (non-saline) surface water. There is inherent technical difficulty in determining point-of-discharge concentrations in surface water due to immediate dilution effects, and due to the uncertainty of the geometry and dynamics of the creek-groundwater interface. Therefore, it is possible that regulatory agencies could utilize immediately upgradient groundwater concentrations as representative of worst-case surface water concentrations. A more technically defensible and rigorous approach is to calculate site-specific target levels by conducting aquatic toxicity bioassay testing, the next more intensive step beyond the CDFG bioassessment procedure which approximates the minimum threshold conditions at which the benthic macroinvertebrate community shows impacts.

In addition to numerical criteria, the RWQCB publishes beneficial uses for various surface water bodies, which are used to establish water quality criteria and discharge prohibitions (RWQCB, 1992). There are no listed direct beneficial uses for Redwood Creek, but the existing fish ladder within 30 feet of the area where the plume intermittently daylights indicates the creek to be a sensitive receptor. 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.

The CDFG has a "zero discharge" policy that prohibits petroleum discharge into waters of the state [Fish and Game Code Section 5650 (a) (1)]. The code allows a discharge if the following two criteria are met: 1) it is infeasible to completely remove the petroleum; and 2) release is not adversely affecting the instream biota. Adverse effects include acute and chronic toxicity, as well as reproductive effects on fish and invertebrates. A copy of the CDFG code is included in Appendix B. As discussed in Section 3.0, SES retained the CDFG Water Pollution Control Laboratory (WPCL) to implement its protocol for conducting instream bioassessments to evaluate impacts to aquatic life. The results of the bioassessment can be used directly by CDFG to determine if unacceptable impacts to the creek are occurring.

Comparison of Site Data to Criteria

No site-sourced contaminants have been detected in excess of regulatory numerical criteria in site creek water samples during the previous year of creek water monitoring. The only contaminants that have been historically detected in creek water samples in excess of published regulatory agency ARARs for surface water are:

- Benzene — Detected in 4 out of the 12 surface watering monitoring events since February 1995 (all at location SW-2 near the contaminated groundwater discharge, at concentrations ranging from 1.9 to 13 µg/L, which exceed the 0.34 µg/L WQO for inland surface waters that are potential drinking water sources (note 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).
- Ethylbenzene — Detected in 1 event (19 µg/L, August 1997) at location SW-2, in excess of the EPA Tier II value for aquatic toxicity.

As discussed previously, the results of the CDFG WPCL instream bioassessment indicated no adverse impacts to benthic macroinvertebrate communities at the site.

7.0 DISTRIBUTION AND TRANSPORT OF CONTAMINATION AND DISCUSSION OF FINDINGS

This section discusses the current distribution of soil and groundwater contamination (and natural attenuation indicators) based on the current (April-May 1999) subsurface investigation. Appendix A contains historical soil and groundwater analytical data that were used to supplement the April 1999 borehole analytical data for evaluating the distribution of residual contamination. A subsequent subsection compares the current contaminant distribution to historical conditions. Appendix H contains the certified analytical laboratory report and chain-of-custody record for the borehole soil and groundwater samples.

SUBSURFACE INVESTIGATION

April 1999 Soil Samples

Petroleum and Aromatic Hydrocarbons

TPHg was detected in six of the ten capillary fringe soil samples collected in April 1999. Detected concentrations ranged from 2.9 mg/kg to 1,700 mg/kg. TPHd was detected in all ten boreholes, ranging in concentration from 1.7 mg/kg to 640 mg/kg. Only four of the boreholes had TPHd concentrations above 100 mg/kg. BTEX constituent concentrations generally show the same distribution as for TPHg. In general, volatile analyte concentrations (TPHg, BTEX and MTBE) are lower relative to TPHd in borehole samples on the fringe of the contaminant plume, as would be expected due to natural attenuation and/or volatilization.

The lateral extent of residual fuel contamination in capillary fringe soil is well defined by historical and current borehole analytical results:

- To the east (upgradient) in the former UFST source area.
- To the north (cross-gradient) by borehole HP-01 (and previous boreholes B1, B10 and B12).
- To the south (cross-gradient) by boreholes HP-03, HP-04 and HP-05 (and previous borehole MW-5).
- To the west (downgradient) at Redwood Creek where the capillary fringe is exposed in the upgradient creek bank.

Data from previous boreholes (MW-6 and B17) documented that soil contamination does not extend downgradient beyond Redwood Creek. A detailed survey of the creek bank was conducted on May 21, 1999 by SES to estimate the distribution of residual soil contamination adjacent to the creek. The capillary fringe (and associated contaminated soil) was observed between several feet upstream of HP-11 and extended approximately 15 feet downstream. Both the HP-11 grab groundwater sample and the soil within the above described zone showed evidence of significant contamination during sampling and the survey. The zone of contamination was thickest (approximately 2 feet) between HP-11 and a point approximately 10 feet downstream. Contamination in the saturated zone (below the creek water level) was evident by pot-holing an additional 15 feet downstream. Therefore the combined width of the discharge area is estimated to be approximately 30 feet, including the upstream capillary fringe zone and the downstream area where only below-creek surface contamination was evident. Neither residual soil contamination nor groundwater discharging above the creek surface water level was evident anywhere else along the creek.

As shown on Figure 6, the zone of capillary fringe contaminated soil above 1,000 mg/kg TPH (TPHg + TPHd) is lenticular shaped, extends approximately 150 feet from the center of the former UFST source area to Redwood Creek, varies in width between approximately 20 and 40 feet (approximate average of 30 feet), and is widest approximately halfway between the source area and the creek. As shown on Figure 7, the thickness of this zone varies between 3 and 8 feet and averages approximately 4.5 feet over the length of the zone. This corresponds to an approximate volume of 850 cubic yards. A subsequent subsection ("Conceptual Model") discusses in detail a site-specific conceptual model of contaminant fate, transport and distribution, which forms the basis for the estimated extent of residual soil contamination.

Total Organic Carbon

Two soil samples (HP-02-17.5' and HP-06-11.5') were analyzed for total organic carbon (TOC), which is an indicator of the potential for natural attenuation. The samples had 0.12 percent and 0.19 percent TOC, respectively.

April 1999 Groundwater Contamination Distribution

Fuel contaminants in groundwater were detected at concentrations of concern in eight of the ten boreholes. In general, TPHg concentrations are significantly greater than TPHd concentrations, as has been the case historically. The only exception is the sample from borehole HP-02 which showed TPHd concentration one order of magnitude greater than the TPHg concentration. There is no apparent explanation for this anomalous result. As would be expected, BTEX and MTBE constituents generally show the same distribution as for TPHg. The current investigation data suggest that the greatest total TPH (TPHg + TPHd) contamination in groundwater is located at the

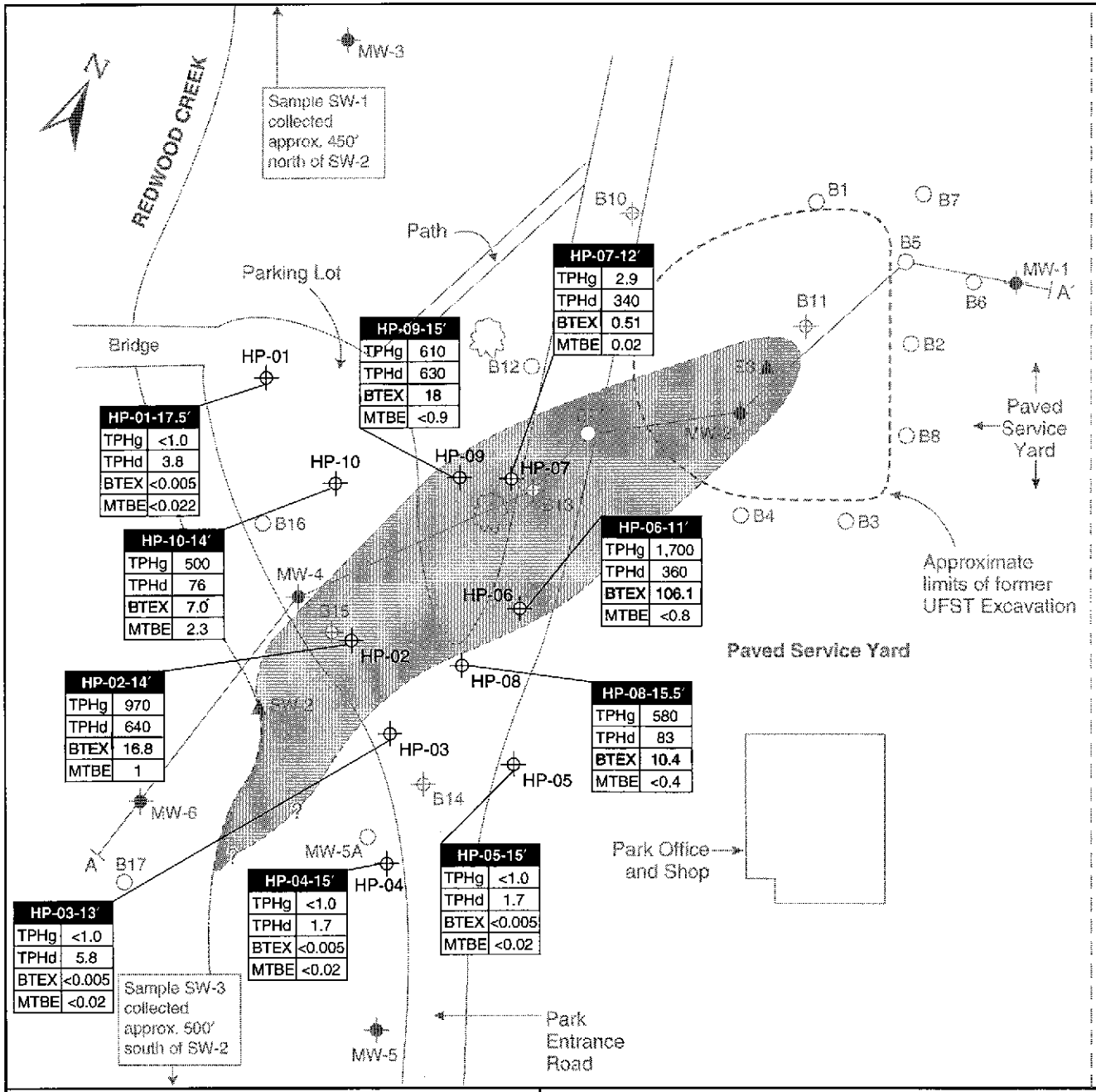
downgradient edge of the plume in the vicinity of borehole HP-02 (approximately 300,000 µg/L). Total TPH concentrations decrease along the plume axis closer to the source area. However, significant total TPH concentrations (approximately 47,000 µg/L to 70,000 µg/L) were detected at the most upgradient 1999 boreholes (HP-06, HP-07, and HP-09) up to 60 feet upgradient of HP-02, suggesting a substantial mass of groundwater contamination that will continue to migrate downgradient toward the creek.

The lateral extent of fuel contamination at concentrations of concern in groundwater is well defined to the north by borehole HP-01 (and previous borehole B10), and to the south by boreholes HP-04 and HP-05 (and monitoring well MW-5). Data from previous monitoring of well MW-6 documented that groundwater contamination does not extend downgradient beyond Redwood Creek. While soil and groundwater contaminant concentrations are not directly comparable, the lateral extent of the groundwater plume generally coincides with the lateral extent of soil contamination, as would be expected.

As shown on Figure 8, the current data suggest that groundwater contamination above 10,000 µg/L TPH (TPHg + TPHd) comprises an elliptical plume that extends approximately 100 feet from the downgradient edge of the former UFST source area to Redwood Creek, and is approximately 60 feet wide (total of 6,000 square feet). The leading edge of the plume at the Redwood Creek interface appears to be about 30 feet wide. A smaller zone (approximately 200 square feet) with TPH contamination above 100,000 µg/L is located in the immediate vicinity of borehole HP-02 at the leading edge of the plume.

The width of saturated-zone contamination immediately upgradient of the creek bank is estimated to be approximately 30 feet, based on the May 24, 1999 "pot-holing" survey. As discussed in more detail in the following subsection (Conceptual Model), the thickness of the groundwater plume varies seasonally. When the water table is highest, the saturated zone corresponds to the top of the capillary fringe. In the summer the water table drops several feet creating the unsaturated capillary fringe of residual contaminated soil. The base of the saturated zone is the top of the weathered siltstone bedrock unit, encountered at depths between 25 and 35 feet. As shown on Figure 9, the maximum thickness of the plume is approximately 10 feet.

The maximum groundwater contamination detected in 1993 boreholes was at the B-13, near the 1999 borehole HP-07, which is approximately 60 feet upgradient of 1999 borehole HP-02 where the maximum groundwater concentrations were detected in 1999. The 1993 groundwater maxima at B-13 in 1993 was approximately one order of magnitude greater than at HP-07 in 1999, but the location was not exactly reproduced, being up to 10 feet apart. Based on the range of estimated



LEGEND

○ B7	Exploratory boring B7 (1993)
B11 ⊕	Exploratory boring B11 (1993) with temporary well point
HP-01 ⊕	Exploratory boring HP-01 (1999) with temporary well point
A — A'	Cross section A-A'
MW-1 ⊕	Groundwater monitoring well MW-1
▲ SW-2	Area of discolored soil and creek soil and "grab" surface water sample location SW-2

NOTES

Locations and dimensions of roads, trails, creek, and parking lot are approximate

UFST = Underground fuel storage tank

Approximate boundaries of residual soil contamination >1,000 mg/kg TPH (TPHg & TPHd)

TPHg = Total petroleum hydrocarbons – gasoline range

TPHd = Total petroleum hydrocarbons – diesel range

BTEX = Benzene, toluene, ethylbenzene and total xylenes

MTBE = Methy tertiary butyl ether

All concentrations in mg/kg (milligrams per kilogram)

0 20
Scale in feet

99012-16-a

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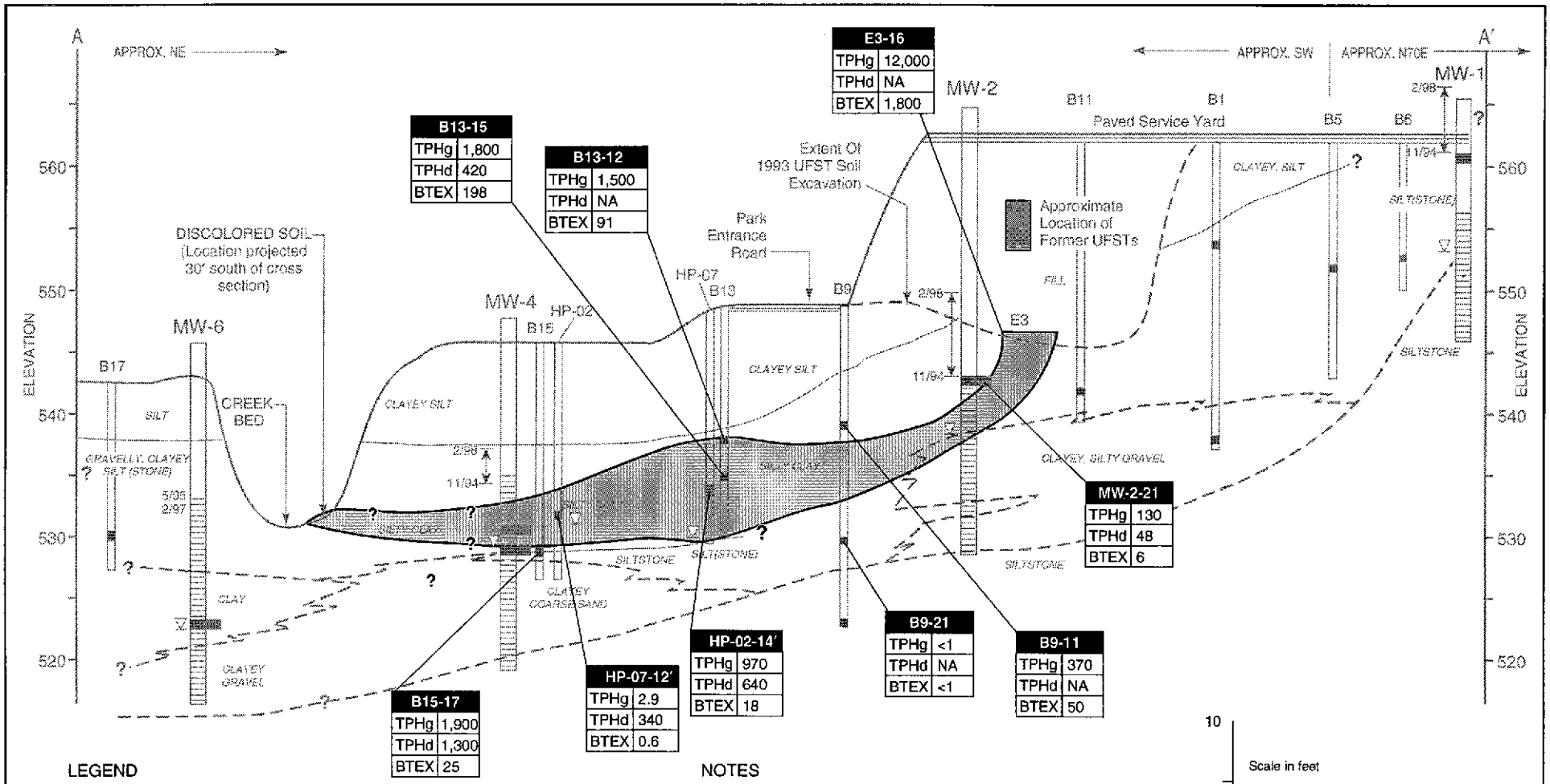
April 1999 Borehole Soil Analytical Results and Plan View of Residual Soil Contamination Redwood Regional Park Service Yard, Oakland, CA

Figure 6

by: MJC | MAY 1999



LEGEND

- B1 — Exploratory Boring B1
- Location of soil sample collected for laboratory analysis
- ▽ First encountered groundwater during drilling (4/99)
- Approximate boundaries of residual capillary fringe contaminated soil >1000 mg/kg TPH (TPHg & TPHd)
- MW-1 — Monitoring Well MW-1
- Location of soil sample collected for laboratory analysis
- Well screen interval
- 4/99 / 11/94 — Range of static water levels measured between November 1994 and April 1999 showing dates of measured maxima and minima

NOTES

Locations and dimensions of roads, trails and parking lot are approximate

UFST = Underground fuel storage tank

NA = Not analyzed

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

Some borings projected into cross section (see Figure 2)

99012-17

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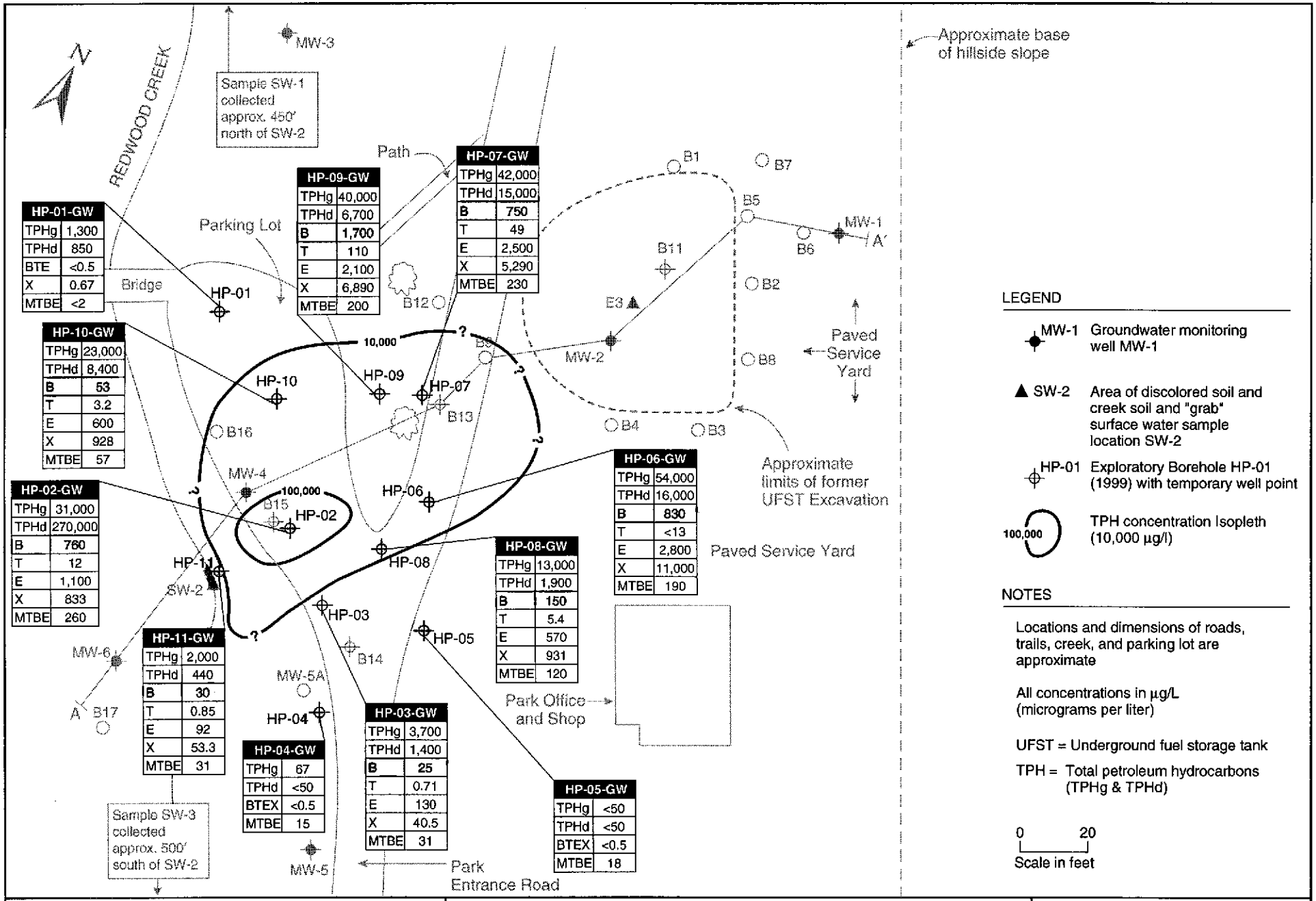
Cross Section Showing Residual Soil Contamination Redwood Regional Park Service Yard, Oakland, CA

Figure 7

by: MJC

MAY 1999



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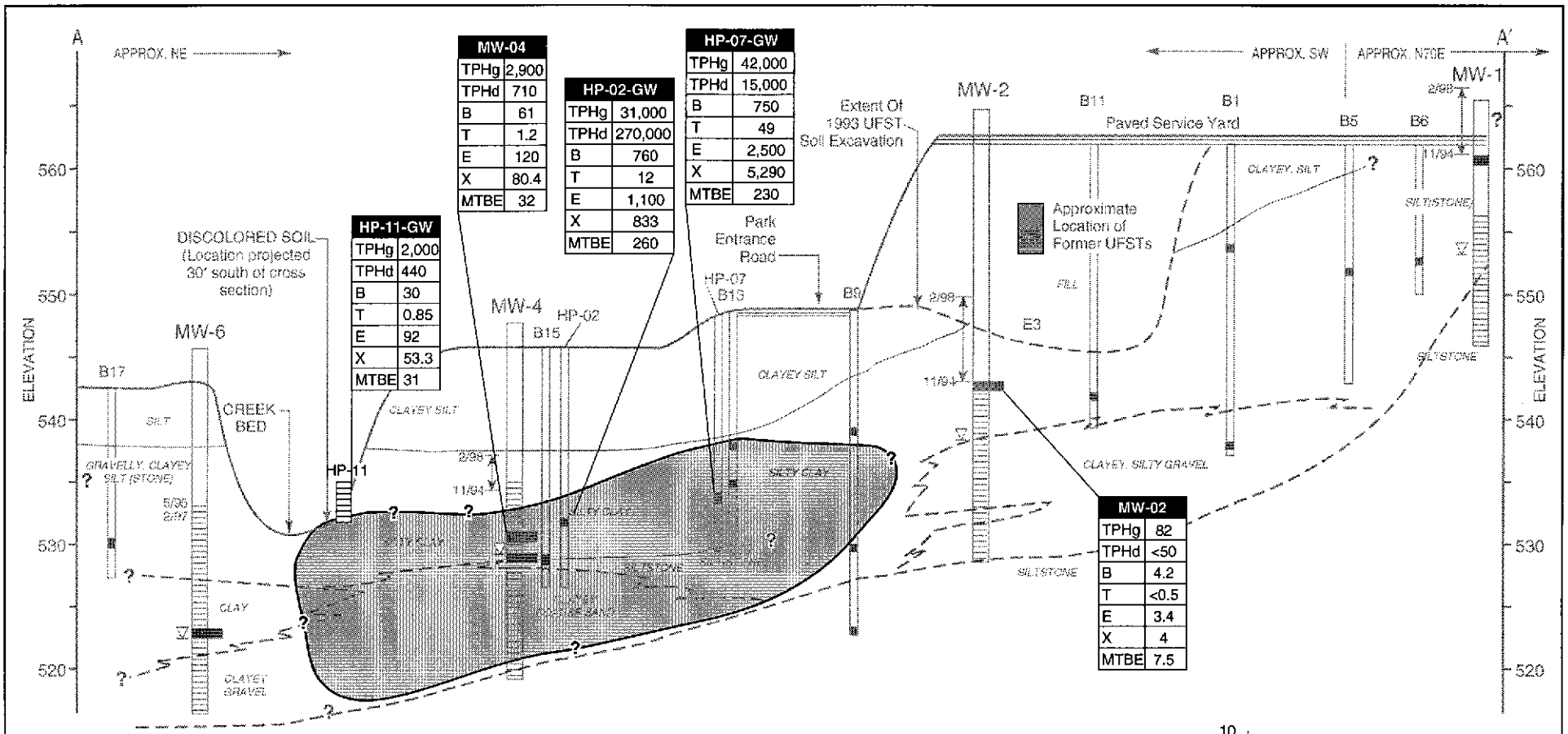
April 1999 Borehole Groundwater Analytical Results and Plan View of Groundwater Contamination Redwood Regional Park Service Yard, Oakland, CA

Figure 8

by: MJC | MAY 1999

99012-18-a



LEGEND

- B1 — Exploratory Boring B1
- Location of soil sample collected for laboratory analysis
- First encountered groundwater during drilling (4/99)
- Approximate boundaries of groundwater contamination >10,000 µg/L TPH (TPHg & TPHd)
- MW-1 — Monitoring Well MW-1
- Location of soil sample collected for laboratory analysis
- Well screen interval
- 4/99 / 11/94 — Range of static water levels measured between November 1994 and April 1999 showing dates of measured maxima and minima

NOTES

Locations and dimensions of roads, trails and parking lot are approximate

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Well casing and boring widths not to scale

Some borings projected into cross section (see Figure 2)

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Cross Section Showing Groundwater Contamination Redwood Regional Park Service Yard, Oakland, CA

Figure 9

by: MJC

MAY 1999

99012-19

groundwater velocities (8 to 10 feet per year, Section 3.0), we infer that the 1993 "slug" detected in 1993 near HP-07 would have migrated about 48 to 60 feet downgradient, which would place it at or close to the HP-02 location where the recent data showed the highest contamination concentrations. The comparison of the historical and current results is discussed in more detail later in this section.

While it is likely that contaminant concentrations in that "slug" would have reduced somewhat due to natural attenuation and volatilization, reduction by an order of magnitude is not viable over the limited distance of 60 feet. Therefore, we infer that groundwater contaminant concentrations could currently be greater in the zone just upgradient of HP-02. Fuel concentrations in groundwater at HP-11, immediately upgradient of the groundwater-creek discharge zone, are two orders of magnitude less than at HP-02, approximately 20 feet upgradient. Limited contaminant reduction between HP-2 and HP-11 would be expected due to degradation. It is also likely that differences in temporary well point construction and sampling could have resulted in lower concentrations at HP-11 (i.e. HP-11 was constructed in an excavated hole screened over several inches, while HP-02 was in a deep borehole and screened over several feet). However, the large difference in concentrations suggests that groundwater-creek discharge concentrations are likely to increase in the near future.

Borehole grab-groundwater sample concentrations can be significantly greater than those of comparably located groundwater monitoring well samples, due both to sampling methods and lithologic influence. The bore HP-10, located further from the inferred centerline of the groundwater plume than is MW-4, would be expected to show lower concentrations, but in fact showed higher concentrations. We infer that local variations in site lithology have created finger-like zones of greater permeability that result in higher groundwater concentrations along preferential pathways. In addition, the 15-foot long screened interval of well MW-4 allows entry of groundwater from a much thicker interval than the 5- to 10-foot screens of the temporary well points. Petroleum constituents at high concentrations tend to act as light non-aqueous phase liquids (LNAPLs), and would concentrate in the upper portion of the water-bearing zone. Therefore, the longer screened interval coupled with well purging prior to sampling likely draws in groundwater that varies in contaminant concentration, while the temporary well points are selectively sampling the upper, more contaminated groundwater.

Creek Surface Water Contamination

As discussed previously, TPH and aromatic hydrocarbons have been historically detected at the SW-2 location where contaminated groundwater discharges to Redwood Creek. Contamination is generally detected only during periods of low creek flow when the contamination is not immediately swept away and diluted. It is also during periods of low creek flow when contaminated (discolored)

soil is evident in the creek bank, providing empirical evidence of the capillary fringe zone of residual contaminated soil. Historical contaminant concentrations in creek surface water samples are several orders of magnitude below immediately upgradient groundwater samples.

Source Area Contaminant Distribution

While no soil or groundwater samples were collected in the current investigation in the area of the former UFST source area, previous investigation data documented the extent and magnitude of contamination in that area at that time (1993 and 1994). The 1993 remedial action resulted in the removal of approximately 600 cubic yards (CY) of TPH-contaminated soil. The extent of the residual contaminated soil left in the area of the excavation was primarily a function of the concern over unstable ground immediately upslope (east) of the excavation. An estimated 20 to 100 CY of TPH-contaminated soil remains at the source area. **The maximum concentrations of residual soil contamination detected in excavation base and sidewall samples included 12,000 milligrams per kilogram (mg/Kg) TPHg, 1,300 TPHd, 80 mg/Kg benzene, 390 mg/Kg toluene, 230 mg/Kg ethylbenzene, and 1,100 mg/Kg total xylenes.** This area is now completely paved and would be expected to act as a continued source to groundwater contamination only during seasonal periods of high groundwater elevations.

CONTAMINANT TRANSPORT CONCEPTUAL MODEL

Site contamination was initiated at an indeterminate time following installation of the UFSTs by 1968, and resulted from UFST and/or piping leaks and/or overfilling, which are conservatively estimated to have started in 1973 (5 years after the installation). The hydrocarbon ~~contamination~~ fuel contamination migrated downward, likely in an inverted cone geometry following available preferential pathways. Downward contaminant migration may have been aided by surface infiltration and/or return flow in the landslide debris materials in the source area.

Part of the contamination sorbed onto the soil, and part mixed with water to move into the aqueous-phase. The migration of the hydrocarbons into aqueous-phase resulted in the predominant mechanism of advective flow for the lateral migration of the groundwater as it moves downgradient. As contaminated groundwater flows downgradient and the water column fluctuates in elevation seasonally, a "smear" zone of contamination is created between the highest and lowest elevations of groundwater at a particular location. During the winter season when water levels are at their highest, contamination is sorbed from the aqueous phase onto soil solids. When the water table drops in the summer months, the "smear" zone is exposed as the unsaturated capillary fringe. Subsequent seasonal increases in water table elevations allow contaminant desorption from the soil solids into the aqueous phase, providing a continued source of groundwater contamination at locations downgradient of the UFST source area. Contaminant sorption and desorption can also

occur within the saturated zone, and can result in fluctuations in groundwater contaminant levels depending on sorption kinetics and contaminant concentrations.

The top of the "smear" zone is defined by the highest groundwater elevation encountered during drilling (not equilibrated water levels in an open borehole or well). Because site groundwater occurs under confining conditions, as evidenced by equilibrated water levels several feet above first occurrence of groundwater during drilling, the upper level of the "smear" zone can be higher at locations where the soil is more permeable. This was observed during the 1999 drilling program at HP-03 where groundwater was encountered 1 to 3 feet higher than the adjacent cross-gradient boreholes (see borehole geologic logs). An empirical demonstration of the top of the smear zone is the depth at which soil contamination is first encountered, by lab analysis and/or PID readings in soil samples. By definition, the base of the "smear" zone is the top of the water-bearing zone at its lowest elevation (summer and fall).

As discussed in a previous section, site groundwater discharges to Redwood Creek. **As confirmed in the May 1999 installation of temporary well point HP-11 adjacent to the creek, during the winter and spring seasons the water table elevation is above the base of the creek and the creek is "gaining" by groundwater input.** During the dry summer season, the water table elevation drops and exposes the capillary fringe in the creek bank, and discolored soil can be observed in the creek bank nearest to the site. That area of discolored soil is approximately 2 feet thick (above the base of the creek) and approximately 15 feet wide. During low flow water conditions, there is an accumulation of a petroleum sheen on the creek surface, and an associated algal bloom that appears to be utilizing the petroleum as a carbon (food) source. It is at these low flow conditions that petroleum contamination has been sporadically detected in creek surface water samples. As expected, contaminant concentrations in surface water samples, when detectable, are orders of magnitude below immediately upgradient groundwater concentrations, due to the immediate dilution by creek flow.

Historical soil and groundwater sampling and groundwater elevation monitoring in MW-6 across Redwood Creek from the site indicate that the creek acts as a hydrologic barrier to groundwater. In other words, the creek is the local hydraulic low point, and site groundwater does not migrate beneath the creek and to the other side. The width of the groundwater plume at the most downgradient borehole locations (approximately 20 feet east of the creek) is estimated to be 60 feet wide, and is likely up to 10 feet thick, the base of the aquifer being the top of the siltstone bedrock. The width of the groundwater plume immediately upgradient of the creek is not known, but is expected to approximate the width of the observed smear zone, which is approximately 30 feet wide. Because creek water depth is seldom more than 1 foot and the zone of discolored soil is only 2 feet above the creek base, it appears that only the upper portion of the aquifer is discharging into the creek.

As shown in the geologic logs (Appendix F), groundwater was first encountered during drilling at its highest level in boreholes HP-02 and HP-03, which are directly upgradient of the discolored soil location. Groundwater elevations at adjacent downgradient boreholes (HP-1 and HP-04) were 1 to 2 feet deeper. The flowpath of site-sourced groundwater that is present beneath the elevation of the creek base very likely curves downstream as it reaches the creek, and flows in the downstream direction. A detailed visual survey of the creek banks was conducted by SES in May 1999. The area of discolored soil was observed in the condition noted above. No other areas of discolored soil or evidence of contaminated groundwater discharge were noted upstream or downstream of that area.

NATURAL ATTENUATION INDICATORS

Numerous field and laboratory studies have concluded that the subsurface behavior of petroleum hydrocarbons is significantly impacted by their high capacity to undergo biodegradation (Bouwer and McCarth, 1984; Vogel et. al., 1987; Pitter and Chudoba, 1990; Calabrese and Kostecki, 1992; Nyer, 1993; McDonald and Kavanaugh, 1994; McAllister and Chiang, 1994; Wilson et. al., 1994; Lawrence Livermore National Laboratory, 1995). Petroleum hydrocarbons require molecular oxygen for breakdown of the ring structure of specific constituents. Accordingly, although biodegradation of hydrocarbons can occur under anaerobic conditions, hydrocarbon biodegradation is greatest under aerobic conditions. As a result of the demonstrated degradability of petroleum hydrocarbons, monitored natural attenuation (MNA) has been found to be a viable option for addressing many hydrocarbon plumes, replacing the need for active remediation, when there are no sensitive receptors that could be impacted before the MNA reduced the concentrations to acceptable levels. Specifically, biodegradation of petroleum hydrocarbons in groundwater has a significant role in creating a stable plume, minimizing groundwater plume configuration and concentrations over time (Lawrence Livermore National Laboratory, 1995). Hydrocarbon biodegradation and presence of a stable plume are the basis for application of risk-based methodologies in support of site closure (RWQCB, 1996).

Site Evidence of Natural Attenuation

The site data show some natural attenuation is occurring, but that the 150 feet distance between the source and the Creek was insufficient to biodegrade the contaminants before they discharged to Redwood Creek. In the absence of a continuing source, the primary evidence of biodegradation is a declining trend in hydrocarbon concentrations. Historical groundwater quality data at the site reflect a declining trend in concentrations and occurrence of biodegradation at the lateral margins of the plume and the portion of the plume decapitated by the 1993 remediation. An exception to this trend is the centerline of the plume still indicated to have relatively elevated concentrations that is located between HP-09 and HP-02. Additional evidence of the historical occurrence and potential

for future occurrence of biodegradation can be obtained from analysis of groundwater for specific biodegradation-indicator parameters including:

Dissolved Oxygen

Dissolved oxygen (DO) is the most thermodynamically-favored electron acceptor used in aerobic biodegradation of hydrocarbons. Active aerobic biodegradation of petroleum hydrocarbon compounds requires at least 1 mg/L to 2 mg/L of DO in groundwater. During aerobic biodegradation, DO levels are reduced in the hydrocarbon plume as respiration occurs. Therefore, DO levels that vary inversely to hydrocarbon concentrations are consistent with the occurrence of aerobic biodegradation.

Oxidation-Reduction Potential

The oxidation-reduction potential (ORP), or redox potential of groundwater is a measure of electron activity and is an indicator of the relative tendency of a solute species to gain or lose electrons. The ORP of groundwater generally ranges from -400 millivolts (mV) to +800 mV; under oxidizing conditions the ORP of groundwater is positive, while under reducing conditions the ORP is typically negative or less positive. Reducing conditions (less positive ORP) are consistent with occurrence of anaerobic biodegradation. Therefore, ORP values of groundwater inside a hydrocarbon plume are typically less than those measured outside of the plume.

Sulfate Analyses

Lower concentrations within the plume relative to outside the plume are generally indicative of the occurrence of biodegradation.

General Mineral Analyses

An inverse relationship between general minerals, including Fe2+, Mn2+, NO3- and SO42-, and hydrocarbon concentrations, is also indicative of the occurrence of biodegradation. Specifically, anaerobic degradation and oxidation of compounds is implied where general mineral concentrations are low and TPH concentrations are high.

Supporting Biodegradation Data From April 1999 Analyses

A single round of biodegradation-indicator (bio-indicator) parameters was collected at the site in April 1999 in site wells and temporary well points. All of the six monitoring wells were analyzed for DO, ORP, ferrous iron (Fe2+), and sulfate, while the hydropunch samples were analyzed for Fe2+ and sulfate only. The data indicate DO levels in groundwater wells ranged from 1.7 to 6.8 mg/L, sufficient for the occurrence of biodegradation. The range of DO indicate that variable levels

of natural attenuation is occurring. Furthermore, the ORP levels ranged from -155 millivolts to 268 millivolts, consistent with the presence of both reducing conditions and oxidizing conditions. Only one well, MW-2, located at the original source, showed reducing conditions. The well (MW-4) with the highest contamination showed the highest oxidizing conditions. Fe2+ concentrations ranged from non-detectable levels to 0.04 mg/L. Sulfate ranged from 19 to 150 mg/L, with the 100 mg/L occurring in well MW-2 outside of main plume and the 19 mg/L occurring at well MW-4 in the centerline of the plume. Although bio-indicator data at the site are limited, the following site data relationships suggest higher attenuation rates in less impacted well MW-2 compared to the more impacted well MW-4: these data do not appear to show any trends!

- DO levels in impacted well MW-4 (3.7 mg/l) compared to less impacted well MW-2 (6.8 mg/l);
- ORP levels in impacted well MW-4 (268 milllivolts) compared to less impacted well MW-2 (-155 millivolts): weak - no apparent relationship!
- Fe2+ levels in impacted well MW-4 (2.0 mg/l) compared to less impacted well MW-2 (none detected); and
- Sulfate levels in impacted well MW-4 (19 mg/L) compared to less impacted well MW-2 (100 mg/L). The sulfate data is the most supportive of some indication of biodegradation occoring at MW-4.

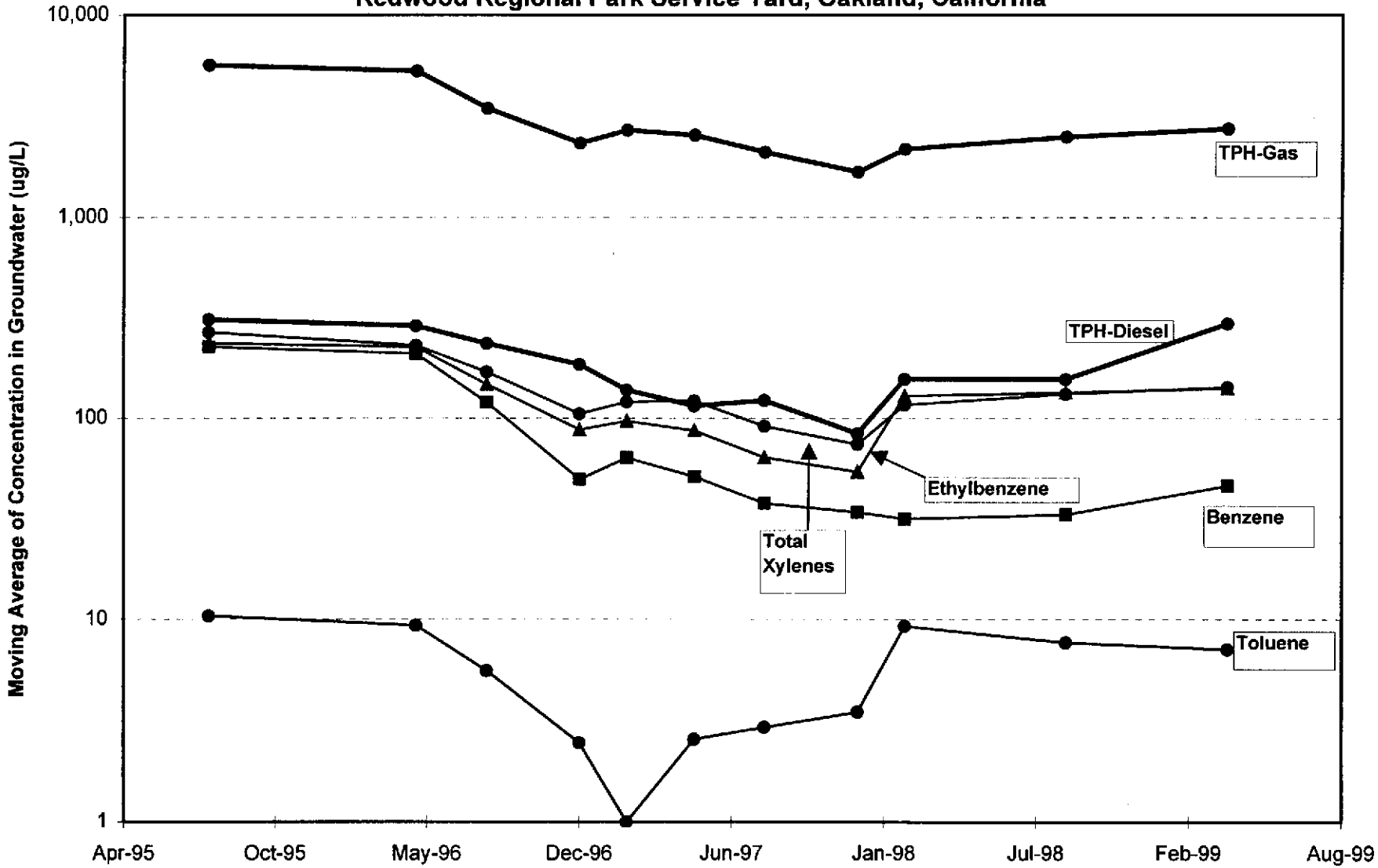
Future monitoring for bio-indicator analyses may allow for a more complete evaluation of the occurrence of biodegradation at the site.

TREND ANALYSIS AND PLUME STABILITY

There have been 14 groundwater monitoring events completed in site wells since November 1994. Data from these events form the basis of the hydrochemical trend analyses completed in this report. Hydrochemical trend analyses were performed for the analytes TPHg, TPHd and BTEX. A tabular summary of historical hydrochemical analyses is provided in Table A.2 (Appendix A) and hydrochemical trend plots for individual constituents are also included in Appendix A.

Figure 10 illustrates the hydrochemical trends for all of the hydrocarbon compounds analyzed for in the downgradient well MW-4. This well has historically shown the highest and most persistent concentrations. The figure presents these data as a four quarter moving average on a logarithmic scale to enhance trend lines and allow for the comparison of all the chemicals of concern on one plot.

Figure 10
Historical Ground Water Analytical Results: Well MW-4
Four Quarter Moving Average
Redwood Regional Park Service Yard, Oakland, California



Lab-sum

All constituents have shown a general decrease since groundwater monitoring began in 1994. Four-quarter moving average concentrations showed a general decrease through early 1998, when average concentrations began to increase, likely due to increasing groundwater elevations during the anomalously wet winters of 1998 and 1999, and subsequent desorption of contamination from the capillary fringe. Ethylbenzene, toluene, and total xylenes in well MW-4 have shown a stabilized or reducing trend line since early 1998. The TPHg concentrations have shown a slightly increasing trend since early 1998, and the TPHd and benzene concentrations have shown a somewhat steeper increase in that time period. These data reflect the continuing downgradient migration of petroleum contamination from upgradient locations.

Appendix A contains the full set of hydrochemical plots for each of the constituents and without the smoothing effect inherent in the four-quarter moving average. The concentrations show a wide range of fluctuations within the general trends, reflecting the seasonal groundwater elevation effects on the residual contaminated soil acting as continuing input source.

The stability of the plume and the general effects of natural attenuation, coupled with volatilization, can be evaluated by comparing site groundwater contamination concentration reductions from historical maxima to current conditions. Because of the significant seasonal variations in groundwater contaminant concentrations, contaminant reduction calculations in Table 8 are based on November 1994 and September 1998 analytical results, as these events are representative of the same seasonal conditions.

An additional data set that can be used to qualitatively assess plume stability and changes in contaminant distribution over time is to compare borehole sample analytical data between historical and the current investigations. Two locations within the plume boundaries have closely spaced boreholes that were sampled in 1993 and again in 1999, including the location represented by B13 (1993) and HP-07 (1999) and the location represented by B15 (1993) and HP-02 (1999). Table 8 compares the soil and groundwater analytical data from these boreholes.

In 1993, groundwater contaminant concentrations were approximately two orders of magnitude greater in the upgradient borehole B13 vs. the downgradient borehole B15 (distance of approximately 60 feet). In 1999 the groundwater concentrations are generally comparable or higher at downgradient borehole HP-02 vs. upgradient borehole HP-07 (with the exception of toluene). The 1999 groundwater concentrations have increased significantly at the downgradient location HP-02 relative to 1993 concentrations and have decreased at the upgradient location HP-07 relative to 1993. Total 1999 TPH groundwater concentrations at the downgradient location (and intermediate borehole HP-09) are significantly lower than the maximum concentrations detected in the 1993 upgradient location. These data indicate that, between 1993 and 1999, the center of contaminant

Table 8
Comparison of Historical and Current Investigation Results
Redwood Regional Park Corporation Yard - Oakland, California

Sample I.D.	TPHg	TPHd	Benzene	Toluene	Ethyl-benzene	Total Xylenes
Groundwater Samples (µg/L)						
B13 (1993)	810,000	2,300,000	12,000	18,000	22,000	73,000
HP-07 (1999)	42,000	15,000	750	49	2,500	5,290
B15 (1993)	16,000	99,000	20	< 100	330	810
HP-02 (1999)	31,000	270,000	760	12	1,100	833
Soil Samples (mg/kg)						
B13 (1993)	1,500	420	< 0.4	< 0.4	13	78
HP-07 (1999)	2.9	340	0.028	< 0.005	0.13	0.347
B15 (1993)	1,900	1,300	1.1	0.8	9.1	14
HP-02 (1999)	970	640	1.3	1.3	5.5	8.7

Notes:
TPHg = Total petroleum hydrocarbons-gasoline range (equivalent to total volatile hydrocarbons)
TPHd = Total petroleum hydrocarbons-diesel range (equivalent to total extractable hydrocarbons)
µg/L = Micrograms per liter, equivalent to parts per billion (ppb)
mg/kg = Milligrams per kilogram, equivalent to parts per million (ppm)

mass moved downgradient from the source area and is currently at the near the downgradient edge of the site, near Redwood Creek. It is unlikely that contaminant degradation of one order of magnitude would occur over the short flow path between 1993 borehole B13 and 1999 borehole HP-02, suggesting that maximum site groundwater concentrations are likely upgradient of the HP-02 location. This is supported by the estimated groundwater velocity that predicts an advective transport distance of 48 to 60 feet since 1993, as discussed previously.

In 1999 soil contaminant concentrations are greater at the downgradient location HP-02 and HP-08 compared to the upgradient points HP-07 and HP-09, corroborating that the center of mass of contamination has moved from the source area downgradient towards the edge of the site. In addition, soil concentrations in 1999 have decreased at both locations relative to the 1993 samples.

This suggests that natural attenuation and/or volatilization have been active in reducing capillary fringe soil concentrations over time.

While not as closely spaced as the above "coupled" boreholes, a comparison of the 1993 data at borehole B14 and the nearby 1999 borehole HP-04 is also useful. These boreholes are both located on the southern edge of the contaminated zone near its downgradient limit, approximately 130 feet from the source area. Elevated concentrations of all fuel constituents (except toluene) were detected in B14 in 1993 in soil and groundwater. In 1999 only TPHg (in groundwater) and TPHd (in soil) were detected in nearby borehole HP-04, and at a concentrations three orders of magnitude below the 1999 concentrations. These data confirm that natural attenuation and/or volatilization have been effective in reducing contaminant concentrations at the fringe of the plume, in effect shrinking the plume width.

PROJECTED FUTURE TRENDS AND REMEDIAL OPTIONS

As discussed previously, the majority of contaminated soil in the UFST source area was removed in 1993. Due to the location of the excavation being near the top of a landslide area, the excavation could not remove small pockets of relatively high concentration TPH-contaminated soil. Remediation by excavation at the site provided the residual TPH in the soil with more available oxygen through the layer of permeable backfill material overlying the original excavation. This should provide more oxygen transfer critical to aerobic degradation. The continued decrease in groundwater concentrations at source area well MW-2 confirms that the contaminant plume is in the process of "disconnecting" from the source area; however, long-term source area contributions will continue to some degree as long as groundwater is in contact with contaminated soil and is allowed to migrate downgradient.

The distribution of the residual TPH soil at depth along the length of the 150-foot long plume makes it practically and economically burdensome to remove. It is well documented in the literature that petroleum hydrocarbons in soil and groundwater will diffuse and slowly degrade by microbial utilization of the hydrocarbons as a carbon food source to break it down into benign byproducts of carbon dioxide, water and biomass. This process of natural attenuation is favored by optimal conditions of soil moisture, nutrients, the presence of TPH-degrading microbes, and sufficient distance between the source area and any identified downgradient receptor to allow the plume to stabilize. Typical literature-cited in-situ biodegradation rates calculated from respiration tests at bioventing pilot tests are between 500 and 1,000 mg/kg TPHd per year (Makdisi and others, 1992; Miller and others, 1993). In this environment, where there is no supplied oxygen as there is in the case of a bioventing system, the degradation rates will be slower.

As discussed in the previous section, attenuation at the site is demonstrated on the fringes of the plume, but is muted in the centerline of the plume. A maximum microbial respiration rate and subsequent hydrocarbon attenuation is achieved when TPH concentrations exceed an "optimum" concentration relative to the microbial population. Resultant decreases in dissolved oxygen inhibit further attenuation, which typically occurs along plume centerlines and in source areas. Attenuation in these conditions can be improved with supplemental oxygen, delivered via either venting, injection or introduction of oxygen-releasing compounds.

The range of groundwater velocities in the plume area is estimated to be 8 to 10 feet per year. Current conditions include a 30- to 60-foot wide groundwater fuel plume in the approximately 20-foot long area between the downgradient edge of the parking area and Redwood Creek, a steep vegetated hillside slope with no vehicle access. There is no reasonably cost-effective method for remediating contamination within this zone. A substantial mass of groundwater and capillary fringe soil contamination is located upgradient of that zone, primarily under the parking lot. Based on the current plume configuration and hydraulic regime, we infer that groundwater contamination equaling or exceeding current site maxima could persist at the downgradient plume limits (adjacent to Redwood Creek) for at least several years.

Implementing a remedial action should be considered if current or future conditions result in unacceptable impacts to Redwood Creek. Current conditions, evidenced by the CDFG WPCL bioassessment findings and historical surface water sampling results, do not suggest current unacceptable impacts. Despite the elevated groundwater concentrations at immediately upgradient locations, the groundwater discharge-creek interface system suggests that only the vertically upper portion of the plume is contacting the creek, and the remaining contaminant mass is below the creek base. However, conditions could worsen as higher groundwater concentrations migrate downgradient and reach the creek. A significant site constraint is the relatively short distance between the current inferred center of contaminant mass and Redwood Creek, which precludes installation of an effective "trigger" monitoring well system between the plume and the creek.

Significant reduction of contaminant concentrations and duration of discharge could be achieved by a number of methods. The most effective to inhibit impact to Redwood Creek would be a passive or relative hydraulic barrier, such as a cutoff wall, funnel-and-gate configuration, reactive wall or groundwater extraction trench across the plume's longitudinal axis at the most downgradient accessible location. However, this remedial strategy may not be viable based on high cost and disruption to the park operation.

Another potentially effective technique would be installation of an array of closely-spaced boreholes across the longitudinal axis of the plume that are screened over the saturated interval and contain an

oxygen-releasing compound (ORC). This passive remedial technique creates a highly oxygenated zone in the areas where natural attenuation is limited by oxygen availability. The density of spacing is configured such that an "oxygen barrier" is created, effectively preventing significant plume migration beyond the array. The primary advantages of this technique are that it requires only a one-time program of borehole installation, minimizing impacts to park operations, and the relatively lower cost compared to other remedial strategies. The potential disadvantage of remediation by ORC are the site-specific constraints, especially as regards limited space. Ideal conditions for this technique include a downgradient monitoring point(s) that can be used to evaluate the effectiveness of the technology. In this case, treatment boreholes would necessarily be installed at the most downgradient locations possible in order to achieve maximum control on the plume. If two or more longitudinal arrays were installed, a monitoring point could be placed between the arrays to provide an evaluation of at least the upgradient portion of the treatment area.

8.0 SUMMARY, CONCLUSIONS AND PROPOSED ACTIONS

SUMMARY AND CONCLUSIONS

The conclusions presented in this section are based on previous investigation and remediation reports, field investigation descriptions, analytical results, and interpretations delineated and developed in the body of this report. Interpretations are based on data collected by previous investigators between 1993 and February 1998, and on the results of the SES field investigations conducted between September 1998 and April 1999.

- **The site utilized two UFSTs (diesel and gasoline) that were excavated and removed from the site in 1993, along with 600 CYof contaminated soil.** An estimated volume of 850 CY of petroleum-contaminated soil with concentrations above 1,000 mg/Kg is estimated to be left in place in the area of the original excavation and downgradient of it along the pathway of the plume. Most of the residual contaminated soil exists in the capillary fringe up to 150 feet downgradient of the former UFSTs, resulting from the sorption of fuel constituents from contaminated groundwater onto capillary fringe soils during periods of high groundwater elevation. This soil contamination will be a long-term source of groundwater contamination.
- Groundwater sampling conducted on an approximately quarterly frequency since November 1994 (14 events) has shown an overall decreasing concentration trend in groundwater contaminants, which include gasoline, diesel and BTEX. MTBE was detected in both the source area and the downgradient monitoring wells when it was analyzed for the first time in September 1998.
- Near-maximum historical groundwater contaminant concentrations were detected in February 1998, coinciding with unusually heavy rains and correspondingly high groundwater elevations, which likely desorbed capillary fringe soil contamination into groundwater. The recent (April 1999) groundwater analytical data showed results consistent with previous analyses, with maximum concentrations detected in well MW-4.
- Maximum groundwater contaminant concentrations in site wells have historically been detected in downgradient well MW-4, suggesting that the center of mass of the contaminant groundwater plume has moved from the UFST source area, beyond well MW-2.

- Significantly greater groundwater contamination detected in the April 1999 subsurface investigation suggest that MW-4 is not located directly along the plume's longitudinal axis. The recent data also suggest that there is a substantial mass of groundwater contamination upgradient of the parking lot's downgradient edge, which will continue to migrate toward Redwood Creek, and that future impacts to Redwood Creek from contaminated groundwater discharge may be worse than at present.

- The April 1999 hydropunch groundwater data indicate that the centerline of the contaminant plume—the line of maximum groundwater contamination—is located coincident with borehole location HP-02, approximately 20 feet south of well MW-4. Redwood Creek is a hydraulic barrier preventing contaminated groundwater migration beyond the creek. The flowpath of groundwater in the immediate vicinity of the creek is likely to follow [illegible], and would be expected to follow in the downstream direction (south) [illegible].

- Discharge of petroleum-contaminated groundwater into Redwood Creek is evidenced by: historical observation of petroleum-discolored soil in the bank of Redwood Creek downgradient of the former UFSTs; sporadic detection of fuel constituents in creek surface water samples collected at that location; and the growth of an algae on the surface water surface at that location suggesting that the petroleum is serving as a carbon source.

- A site reconnisance of the Creek bank was performed on May 22, 1999; by digging into the bank material above the Creek, a 30-feet wide by approximately 2-feet thick zone of discharge to Redwood Creek was identified. Groundwater contamination below the base of Redwood Creek is likely to also be present, but is not expected to impact the aquatic environment. A grab-groundwater sampling point, located in the creek bank just above the area where historical fuel concentrations were detected in surface water samples, showed concentrations far higher than the concentrations detected in the surface water, but also significantly lower than concentrations detected in upgradient hydropunch samples. The trace concentrations in the surface water compared to the groundwater plume is attributed to the dilution effect in the stream.

- The limits of the groundwater contaminant plume are well-defined by site groundwater monitoring wells and the April-May 1999 subsurface investigation, and extend from the source area to Redwood Creek, a distance of approximately 150 feet. The area of the plume with TPH concentrations > 10,000 µg/L is up to 60 feet wide by 100 feet long, and begins approximately 30 feet downgradient of the source area, suggesting that the plume is becoming "disconnected" from the former UFST source area. The leading edge of the plume daylighting in the creek banks is approximatley 30 feet wide.

- Natural attenuation is indicated to be occuring at the site, mainly at the plume margins and former source area versus the higher contamintion centerline of the plume. The higher concentration in the center line of the plume is likely to limit oxygen required for microbial biodegradation.
- The CDFG code stipulates a policy of zero discharge of petroleum to surface waters, unless it can be demonstrated that complete removal of the petroleum is infeasible and that instream biota are not affected. The results of the initial stream bioassessment event (April 1999) indicate no impacts to the benthic macroinvertebrate community in Redwood Creek. A minimum of one additional bioassessment event before this year's rains is recommended by CDFG to complete the evaluation of the full life cycle of potentially impacted macroinvertebrates.
- There are no established cleanup criteria for residual soil contamination by TPH. The RWQCB has a to-be-considered ARAR of 1 mg/kg total BTEX in soil. However, the need for remedial action in the soil media and the remedy selection for corrective action should be based on potential impacts to groundwater and surface water quality resulting from desorption of soil contamination.
- Site groundwater contaminants that have been historically (and recently) detected in excess of drinking water standards include benzene, ethylbenzene, total xylenes, and MTBE; there are no drinking water standards for TPH compounds. While it is unlikely that site groundwater would be used as a drinking water source, drinking water standards could be applied by regulators as cleanup standards.
- Benzene is the only site-sourced contaminant that has been detected in creek surface water samples in excess of published water quality objectives (WQOs) for surface waters that are a potential drinking water source. Ethylbenzene has been detected once in excess of the USEPA water quality guidance criterion. Based on the absence of detectable contamination immediately downstream of the site, it is very unlikely that site contamination has the potential to impact the nearest municipal drinking water source (Upper San Leandro Reservoir).

PROPOSED ACTIONS

Following the District's review of the draft of this report, the District has elected to implement the following actions to address regulatory concerns:

- **Meet with ACDEH and CDFG to discuss the results, conclusions and recommendations of this investigation, especially as regards the need to mitigate any unacceptable impacts associated with residual site contamination.**

- If regulatory agencies deem mitigation is necessary, conduct a limited feasibility study to determine the most appropriate and cost-effective remedial strategy.
- Continue the established program of quarterly groundwater elevation monitoring (all site wells) and sampling (wells MW-2 and MW-4 only). Based on a previous comparative site study, we recommend that all groundwater samples collected for laboratory analysis be collected following well purging.
- Continue the established program of quarterly surface water sampling, with one revision. **Discontinuing sampling at the upstream location SW-1 is warranted, given that no significant surface water contamination has historically been detected at that location.** The previous ACDEH-approved recommendation to decrease the frequency of surface water sampling from quarterly to semi-annually is not technically appropriate at this time, given the documented impacts to Redwood Creek from discharge of contaminated groundwater and the need to monitor the discharge closely.
- **Per the recommendation of CDFG, complete a follow-on instream bioassessment of macroinvertebrates prior to the onset of winter rains (fall 1999)** to assess potential impacts at the end of the macroinvertebrate life cycle.
- **Complete and submit to ACDEH and CDFG a letter-format report following the next quarterly groundwater and surface water monitoring and sampling event (summer 1999) and a comprehensive report following the subsequent sampling and bioassessment (spring/fall 1999), including conclusions regarding the findings and proposed actions to address remaining regulatory issues.**

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10.0 LIMITATIONS

This report has been prepared for the exclusive use of East Bay Regional Park District and their authorized representatives or the Regulators. No reliance on this report shall be made by anyone other than the client and regulators 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 site 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 of the area. The SES personnel who performed this limited remedial investigation 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.

Historical Soil Analytical Results

Table A.1
Summary of Historical Soil Sample Analytical Results
Redwood Regional Park Service Yard
Oakland, California

Sample I.D.	Depth (ft bgs)	Concentrations in mg/kg					
		TPHg	TPHd/k	Benzene	Toluene	Ethyl-benzene	Total Xylenes
*UFST Excavation Confirmation Samples – May & June 1993 (*indicates soil at that location was removed)*							
DT-1*	10	NA	**4**	< 0.005	< 0.005	< 0.005	< 0.005
DT-2*	10	NA	**3**	< 0.005	< 0.005	< 0.005	< 0.005
GT-1*	12	**800**	NA	**6.3**	**43**	**18**	**94**
GT-2	12	**2,200**	NA	**19**	**120**	**45**	**250**
E1-17	17	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
E2-16	16	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
E3-16	16	**12,000**	NA	**80**	**390**	**230**	**1,100**
E4-13	13	**6**	NA	**0.37**	**0.006**	**0.1**	**0.1**
E5-7.5	7.5	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
Exploratory Borehole Samples – September and October 1994							
B1-11	11	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B1-27	27	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B2-11	11	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B2-15	15	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B3-12	12	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B3-18	18	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B4-18	18	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B4-23	23	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B5-11	11	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B7-12	12	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B8-4	4	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B8-10	10	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B9-11	11	**370**	NA	**1.7**	**7.9**	**6.9**	**34**
B9-21	21	< 1	NA	**0.1**	**0.011**	**0.017**	**0.069**
B9-28	28	< 1	NA	< 0.005	**0.033**	**0.035**	**0.14**

Sample I.D.	Depth (ft bgs)	Concentrations in mg/kg					
		TPHg	TPHd/k	Benzene	Toluene	Ethyl-benzene	Total Xylenes
B10-6	6	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
B10-21	21	< 1	7	< 0.005	< 0.005	< 0.005	< 0.005
B11-11.5	11.5	< 1	< 2	**0.021**	< 0.005	< 0.005	< 0.005
B12-14.5	14.5	**150**	NA	**0.24**	**0.44**	**1.7**	**4.6**
B12-15	15	**77**	NA	**0.15**	**0.24**	**0.9**	**2.7**
B12-21	21	**97**	NA	**0.46**	**1.2**	**2**	**5.4**
B13-12	12	**1,500**	NA	< 0.4	< 0.4	**13**	**78**
B13-15	15	**1,800**	**420**	**8.8**	**39**	**30**	**120**
B14-18	18	**210**	**50**	**0.017**	**0.1**	**0.34**	**0.63**
B15-17	17	**1,900**	**1,300**	**1.1**	**0.8**	**9.1**	**14**
B16-17.5	17.5	**50**	NA	< 0.1	< 0.1	**0.2**	**0.2**
B17-12.5	12.5	< 1	NA	< 0.005	< 0.005	< 0.005	< 0.005
Monitoring Well Installation Borehole Samples – October 1994							
MW1-5	5	< 1	**3**	< 0.005	< 0.005	< 0.005	< 0.005
MW-21	21	**130**	**48**	**0.31**	**0.18**	**1.3**	**4.4**
MW3-10	10	< 1	**3**	< 0.005	< 0.005	< 0.005	< 0.005
MW3-25	25	< 1	**5**	< 0.005	< 0.005	< 0.005	< 0.005
MW4-15.5	15.5	**22**	**4**	< 0.005	**0.038**	< 0.005	**0.49**
MW4-16.5	16.5	**10**	**43**	< 0.005	**0.009**	**0.11**	**0.21**
MW5A-15	15	**570**	**200**	< 0.005	**1.1**	**1.9**	**2.9**
MW5-15	15	< 1	**2**	< 0.005	< 0.005	< 0.005	< 0.005
MW6-19	19	< 1	**2**	< 0.005	< 0.005	< 0.005	< 0.005
Exploratory Borehole Samples - April 1999							
HP-01-17.5'	17.5'	< 1.0	**3.8**	< 0.005	< 0.005	< 0.005	< 0.005
HP-02-14'	14'	**970**	**640**	**1.3**	**1.3**	**5.5**	**8.7**
HP-03-13'	13'	< 1.0	**5.8**	< 0.005	< 0.005	< 0.005	< 0.005
HP-04-15'	15'	< 1.0	**1.7**	< 0.005	< 0.005	< 0.005	< 0.005
HP-05-15'	15'	< 1.0	**4.3**	< 0.005	< 0.005	< 0.005	< 0.005
HP-06-11'	11'	**1,700**	**360**	**1.4**	**2.7**	**21**	**81**
HP-07-12'	12'	**2.9**	**340**	**0.028**	< 0.005	**0.13**	**0.347**
HP-08-	15.5'	**580**	**83**	< 0.1	**1.0**	**4.7**	**4.7**

Sample I.D.	Depth (ft bgs)	Concentrations in mg/kg					
		TPHg	TPHd/k	Benzene	Toluene	Ethyl-benzene	Total Xylenes
15.5'							
HP-09-15'	15'	**610**	**630**	**1.5**	**1.5**	**3.8**	**11.2**
HP-10-14'	14'	**500**	**76**	**0.19**	**1.6**	**2.0**	**3.21**

Notes:

TPHg – Total petroleum hydrocarbons – gasoline range (equivalent to total volatile hydrocarbons)

TPHd/k – Total petroleum hydrocarbons – diesel/kerosene ranges (equivalent to total extractable hydrocarbons)

NA = Not Analyzed

mg/kg = milligrams per kilogram (equivalent to parts per million – ppm)

Historical Groundwater Analytical Results

TABLE A.2

HISTORICAL GROUNDWATER MONITORING WELL ANALYTICAL RESULTS

REDWOOD REGIONAL PARK SERVICE YARD, OAKLAND, CALIFORNIA

(all concentrations in µg/L, equivalent to parts per billion [ppb])

Well MW-2									
Event	**Date**	**TPH-G**	**TPH-D**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**Total BTEX**	**MTBE**
1	Nov-94	**66**	*< 50*	**3.4**	*< 0.5*	*< 0.5*	**0.9**	**4.3**	*NA*
2	Feb-95	**89**	*< 50*	**18**	**2.4**	**1.7**	**7.5**	**29.6**	*NA*
3	May-95	*< 50*	*< 50*	**3.9**	*< 0.5*	**1.6**	**2.5**	**8**	*NA*
4	Aug-95	*< 50*	*< 50*	**5.7**	*< 0.5*	*< 0.5*	*< 0.5*	**5.7**	*NA*
5	May-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
6	Aug-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
7	Dec-96	*< 50*	*< 50*	**6.3**	*< 0.5*	**1.6**	*< 0.5*	**7.9**	*NA*
8	Feb-97	*< 50*	*< 50*	**0.69**	*< 0.5*	**0.55**	*< 0.5*	**1.24**	*NA*
9	May-97	**67**	*< 50*	**8.9**	*< 0.5*	**5.1**	*< 1.0*	**14**	*NA*
10	Aug-97	*< 50*	*< 50*	**4.5**	*< 0.5*	**1.1**	*< 0.5*	**5.6**	*NA*
11	Dec-97	**61**	*< 50*	**21**	*< 0.5*	**6.5**	**3.9**	**31.4**	*NA*
12	Feb-98	**2,000**	**200**	**270**	**92**	**150**	**600**	**1,112**	*NA*
13	Sep-98	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	**7**
14	Apr-99	**82**	**710**	**4.2**	*< 0.5*	**3.4**	**4**	**11.6**	**7.5**

NA = Not Analyzed for this constituent

TABLE A.2 (continued)

Well MW-4									
Event	Date	TPH-G	TPH-D	Benzene	Toluene	Ethylbenzene	Total Xylenes	Total BTEX	MTBE
1	Nov-94	2,600	230	120	4.8	150	88	363	*NA*
2	Feb-95	11,000	330	420	17	440	460	1,337	*NA*
3	May-95	7,200	440	300	13	390	330	1,033	*NA*
4	Aug-95	1,800	240	65	6.8	89	66.5	227	*NA*
5	May-96	1,100	140	51	*< 0.5*	*< 0.5*	47	98	*NA*
6	Aug-96	3,700	120	63	2	200	144	409	*NA*
7	Dec-96	2,700	240	19	*< 0.5*	130	92.9	242	*NA*
8	Feb-97	3,300	*< 50*	120	1.0	150	102.5	374	*NA*
9	May-97	490	*< 50*	2.6	6.7	6.4	6.7	22	*NA*
10	Aug-97	1,900	150	8.6	3.5	78	52.6	143	*NA*
11	Dec-97	1,000	84	4.6	2.7	61	54.2	123	*NA*
12	Feb-98	5,300	340	110	24	320	402	856	*NA*
13	Sep-98	1,800	*<50*	8.9	*< 0.5*	68	26.9	104	23
14	Apr-99	2,900	710	61	1.2	120	80.4	263	32

NA = Not Analyzed for this constituent

TABLE A.2 (continued)

Well MW-5									
Event	**Date**	**TPH-G**	**TPH-D**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**Total BTEX**	**MTBE**
1	Nov-94	**50**	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
2	Feb-95	**70**	*< 50*	**0.6**	*< 0.5*	*< 0.5*	*< 0.5*	**0.6**	*NA*
3	May-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
4	Aug-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
5	May-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
6	Aug-96	**80**	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
7	Dec-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
8	Feb-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
9	May-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
10	Aug-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
11	Dec-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
12	Feb-98	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
13	Sep-98	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*
Groundwater monitoring in this well discontinued with ACDEH approval									

NA = Not Analyzed for this constituent

TABLE A.3

HISTORICAL SURFACE WATER ANALYTICAL RESULTS

REDWOOD REGIONAL PARK SERVICE YARD, OAKLAND, CALIFORNIA

(all concentrations in µg/L, equivalent to parts per billion [ppb])

Sampling Location SW-1 (Upstream)									
Event	**Date**	**TPH-G**	**TPH-D**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**Total BTEX**	**MTBE**
1	Feb-94	**50**	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
2	May-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
3	May-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
4	Aug-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
5	Dec-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
6	Feb-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
7	Aug-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
8	Dec-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
9	Feb-98	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
10	Sep-98	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*
11	Apr-99	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*

NS = Not Sampled

NA = Not Analyzed for this constituent

TABLE A.3 (continued)

Sampling Location SW-2 (Area of Contaminated Groundwater Discharge)									
Event	Date	TPH-G	TPH-D	Benzene	Toluene	Ethylbenzene	Total Xylenes	Total BTEX	MTBE
1	Feb-94	**130**	*< 50*	**1.9**	*< 0.5*	**4.4**	**3.2**	**9.5**	*NA*
2	May-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
3	Aug-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
4	May-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
5	Aug-96	**200**	*< 50*	**7.5**	*< 0.5*	**5.4**	*< 0.5*	**12.9**	*NA*
6	Dec-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
7	Feb-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
8	Aug-97	**350**	**130**	**13**	**0.89**	**19**	**10.7**	**43.6**	*NA*
9	Dec-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
10	Feb-98	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
11	Sep-98	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*
12	Apr-99	**81**	*<50*	**2.0**	*< 0.5*	**2.5**	**1.3**	**5.8**	**2.3**

NS = Not Sampled

NA = Not Analyzed for this constituent

TABLE A.3 (continued)

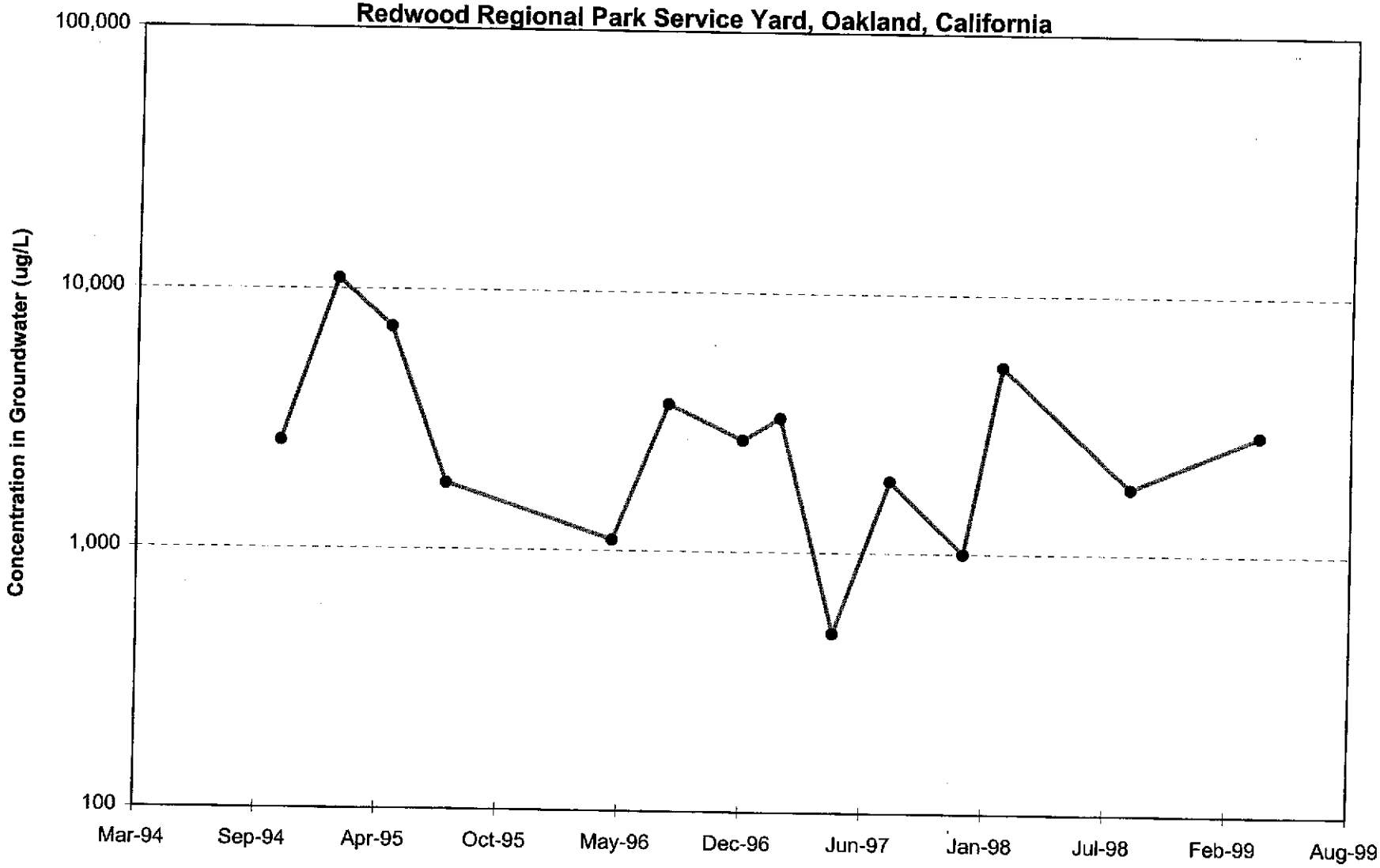
Sampling Location SW-3 (Downstream)									
Event	**Date**	**TPH-G**	**TPH-D**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**Total BTEX**	**MTBE**
1	May-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
2	Aug-95	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
3	May-96	*< 50*	*74*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
4	Aug-96	**69**	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
5	Dec-96	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
6	Feb-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
7	Aug-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
8	Dec-97	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
9	Feb-98	*< 50*	*< 50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*NA*
10	Sep-98	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*
11	Apr-99	*< 50*	*<50*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	—	*< 2*

NS = Not Sampled

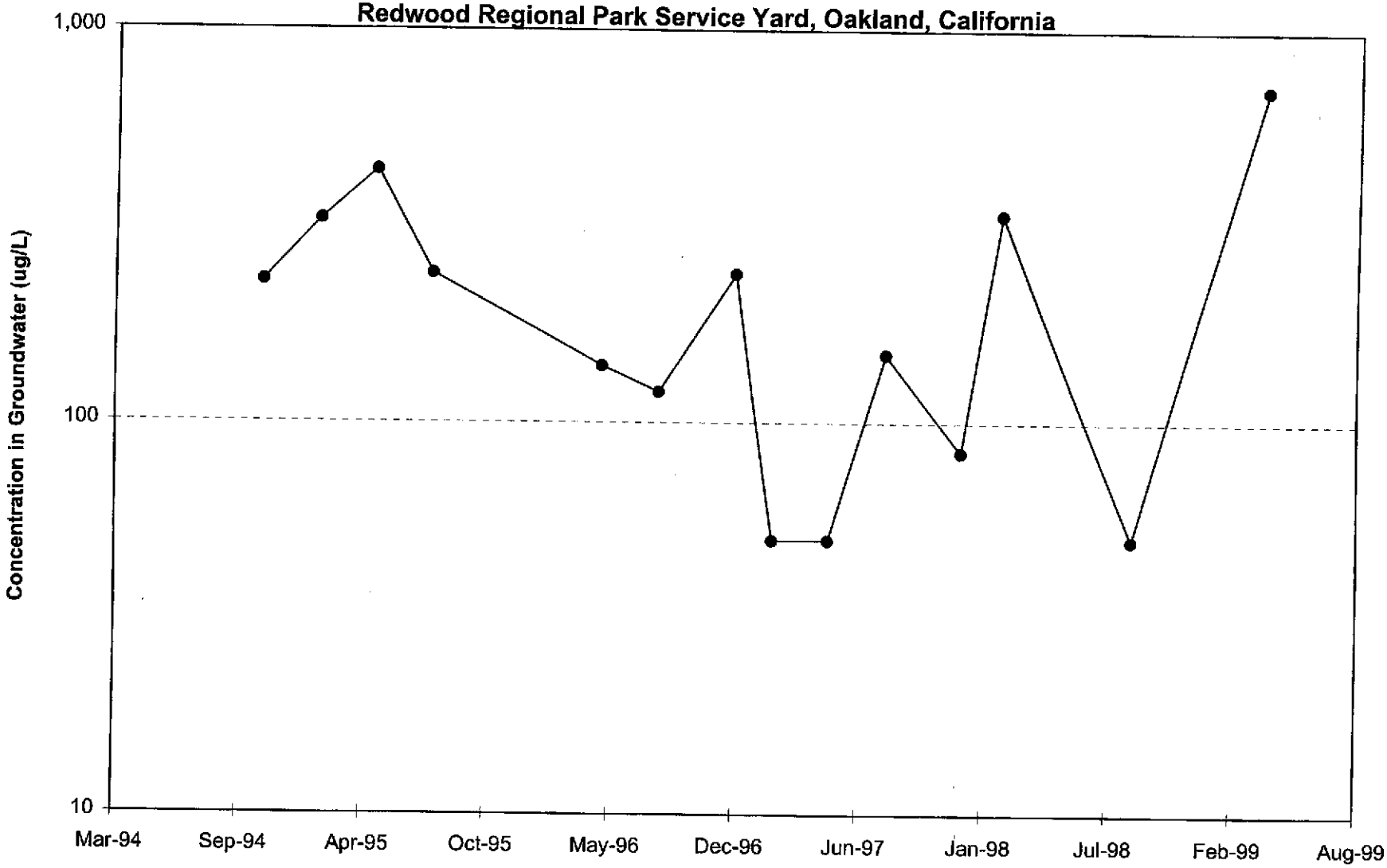
NA = Not Analyzed for this constituent

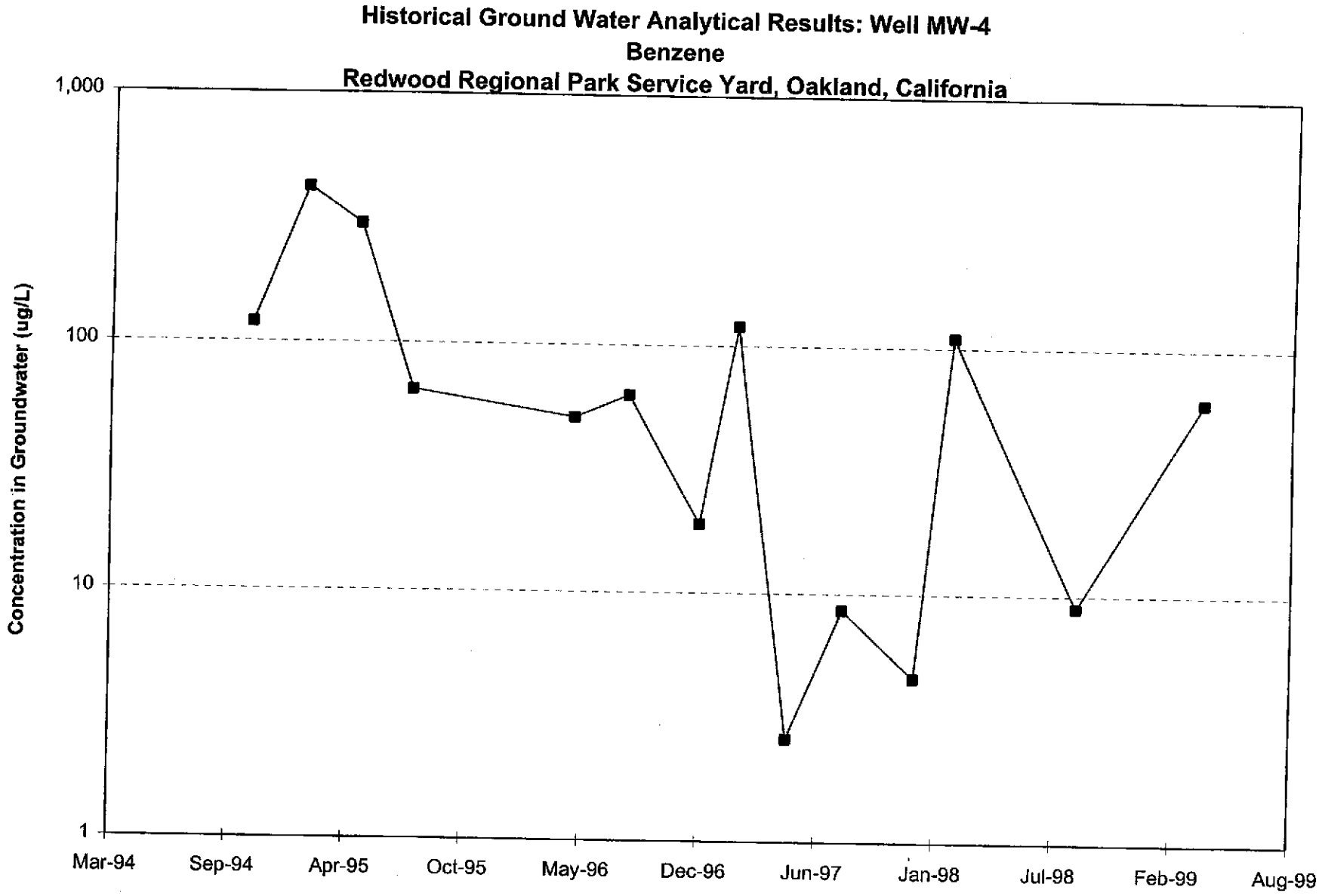
Hydrochemical Trend Analyses

Historical Ground Water Analytical Results: Well MW-4
TPH-gasoline
Redwood Regional Park Service Yard, Oakland, California

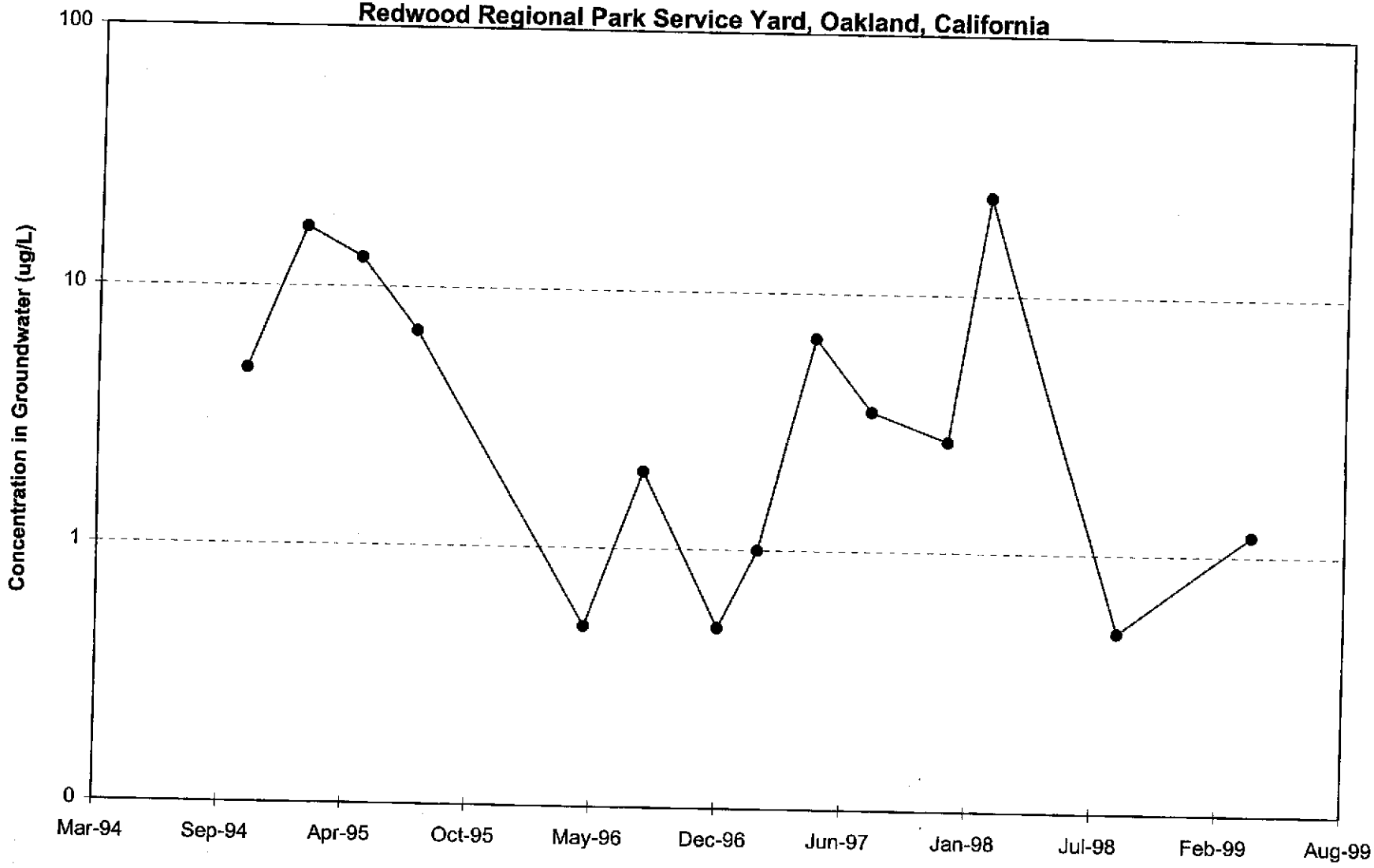


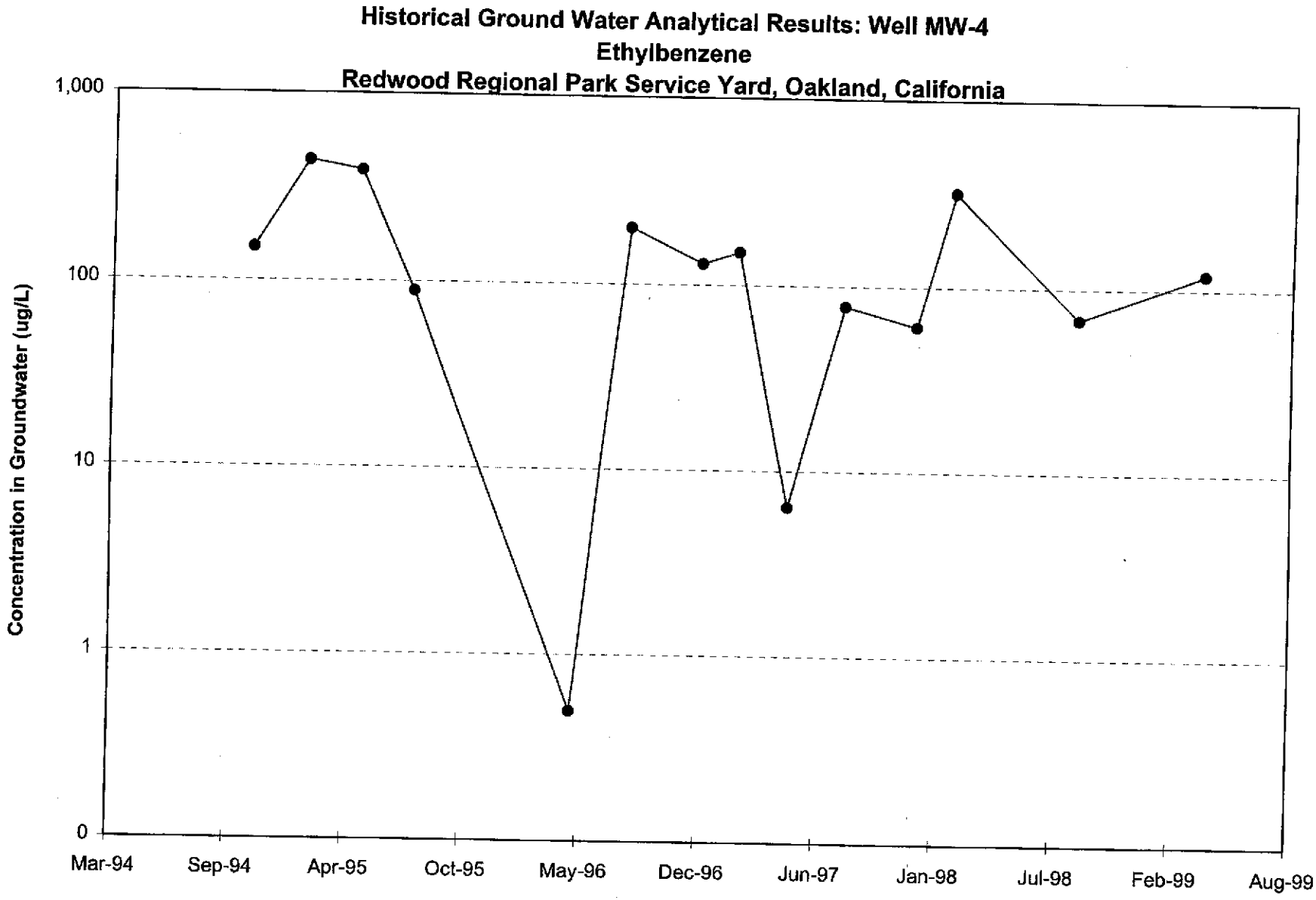
Historical Ground Water Analytical Results: Well MW-4
TPH-diesel
Redwood Regional Park Service Yard, Oakland, California



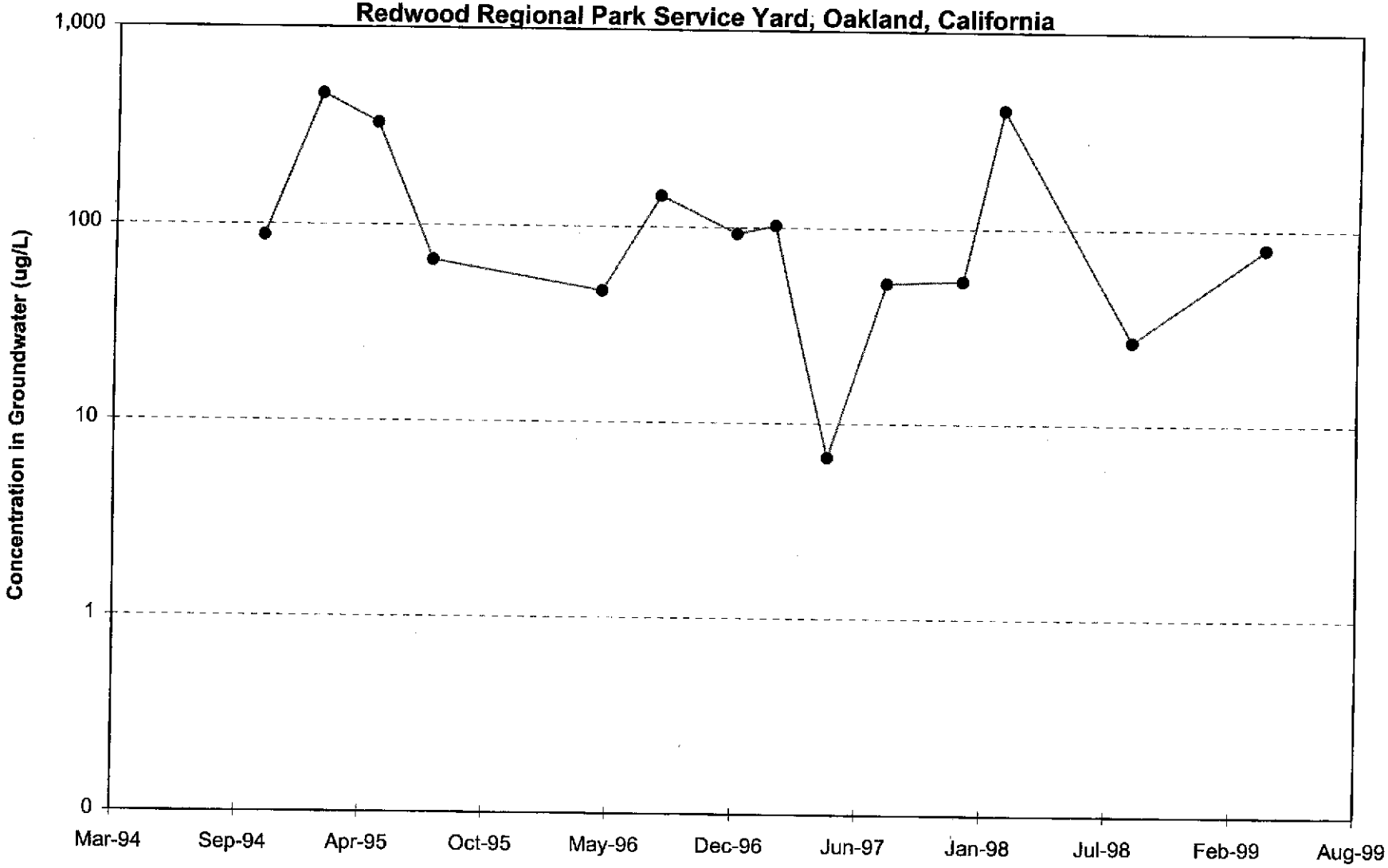

Historical Ground Water Analytical Results: Well MW-4
Benzene
Redwood Regional Park Service Yard, Oakland, California
Concentration in Groundwater (ug/L)
1,000
100
10
1
Mar-94
Sep-94
Apr-95
Oct-95
May-96
Dec-96
Jun-97
Jan-98
Jul-98
Feb-99
Aug-99

Historical Ground Water Analytical Results: Well MW-4
Toluene
Redwood Regional Park Service Yard, Oakland, California




Historical Ground Water Analytical Results: Well MW-4
Ethylbenzene
Redwood Regional Park Service Yard, Oakland, California
Concentration in Groundwater (ug/L)
1,000
100
10
1
0
Mar-94
Sep-94
Apr-95
Oct-95
May-96
Dec-96
Jun-97
Jan-98
Jul-98
Feb-99
Aug-99

Historical Ground Water Analytical Results: Well MW-4
Total Xylenes
Redwood Regional Park Service Yard, Oakland, California



CDFG Code

(2) A total allowable catch, reflecting the long-term yield each species is capable of sustaining, using the best available science and bearing in mind the ecological importance of the species and the variability of marine ecosystems.

(3) A permanent reduction in harvest.

(c) Funding to prepare the recovery and management plan and any planning and scoping meetings shall be derived from the fees collected for the abalone stamp.

(d) On or before January 1, 2008, and following the adoption of the recovery and management plan by the commission, the department may apply to the commission to reopen sport or commercial fishing in all or any portion of the waters described in Section 5521. If the commission makes a finding that the resource can support additional harvest activities and that these activities are consistent with the abalone recovery plan, all or a portion of the waters described in Section 5521 may be reopened and management measures prescribed and implemented, as appropriate. The commission may close or, where appropriate, may establish no-take marine refuges in any area opened pursuant to this section if it makes a finding that this action is necessary to comply with the abalone management plan.

(e) If the commission determines that commercial fishing is an appropriate management measure, priority for participation in the fishery shall be given to those persons who held a commercial abalone permit during the 1996-97 permit year.

(Added by Statutes 1997 Chap. 787)

CHAPTER 2. POLLUTION

Article 1. General

5650. Pollute Waters; Hazardous Substances List

(a) Except as provided in subdivision (b), it is unlawful to deposit in, permit to pass into, or place where it can pass into the waters of this state any of the following:

(1) Any petroleum, acid, coal or oil tar, lampblack, aniline, asphalt, bitumen, or residuary product of petroleum, or carbonaceous material or substance.

(2) Any refuse, liquid or solid, from any refinery, gas house, tannery, distillery, chemical works, mill, or factory of any kind.

(3) Any sawdust, shavings, slabs, or edgings.

(4) Any factory refuse, lime, or slag.

(5) Any cocculus indicus.

(6) Any substance or material deleterious to fish, plant life, or bird life.

(b) This section does not apply to a discharge or a release that is expressly authorized pursuant to ***, and in compliance with, the terms and conditions of a waste discharge requirement pursuant to Section 13263 of the Water Code or a waiver issued pursuant to subdivision (a) of Section 13269 of the Water Code issued by the State Water Resources Control Board or a regional water quality control board after a public hearing, or that is expressly authorized pursuant to, and in compliance with, the terms conditions of a federal permit *** for which the State Water Resources Control Board or a regional water quality control board has, after a public hearing, issued a water quality certification pursuant to Section 13160 of the Water Code. This section does not confer additional authority on the State Water Resources Control Board, a regional water quality control board, or any other entity.

(c) It shall be an affirmative defense to a violation of this section if the defendant proves, by a preponderance of the evidence, all of the following:

(1) The defendant complied with all applicable state and federal laws and regulations requiring that the discharge or release be reported to a government agency.

(2) The substance or material did not enter the waters of the state or a storm drain that discharges into the waters of the state.

(3) The defendant took reasonable and appropriate measures to effectively mitigate the discharge or release in a timely manner.

(d) The affirmative defense *** in subdivision (c) *** does not apply and may not be raised in an action for civil penalties or injunctive relief pursuant to Section 5650.1.

(e) The affirmative defense in subdivision (c) does not apply and may not be raised by any defendant who has on two prior occasions in the preceding five years, in any combination within the same county in which the case is prosecuted, either pleaded nolo contendere, been convicted of a violation of this section, or suffered a judgment for a violation of this section or Section 5650.1. This subdivision shall apply only to cases filed on or after January 1, 1997.

(f) The affirmative defense in subdivision (c) does not apply and may not be raised by the defendant in any case in which a district attorney, city attorney, or Attorney General alleges, and the court finds, that the defendant acted willfully.

(Amended Statutes 1997 Chap. 766)

5650.1. Water Pollution - Civil Penalties

(a) Every person who violates Section 5650 is subject to a civil penalty of not more than twenty-five thousand dollars ($25,000) for each violation.

(b) The civil penalty imposed for each separate violation pursuant to this section is separate, and in addition to, any other civil penalty imposed for a separate violation pursuant to this section or any other provision of law.

(c) In determining the amount of any civil penalty imposed pursuant to this section, the court shall take into consideration all relevant circumstances, including, but not limited to, the nature, circumstance, extent, and gravity of the violation. In making this determination, the court shall consider the degree of toxicity and volume of the discharge, the extent of harm caused by the violation, whether the effects of the violation may be reversed or mitigated, and with respect to the defendant, the ability to pay, the effect of any civil penalty on the ability to continue in business, any voluntary cleanup efforts undertaken, any prior history of violations, the gravity of the behavior, the economic benefit, if any, resulting from the violation, and any other matters the court determines justice may require.

(d) Every civil action brought under this section shall be brought by the Attorney General upon complaint by the department, or by the district attorney or city attorney in the name of the people of the State of California, and any actions relating to the same violation may be joined or consolidated.

(e) In any civil action brought pursuant to this chapter in which a temporary restraining order, preliminary injunction, or permanent injunction is sought, it is not necessary to allege or prove at any stage of the proceeding that irreparable damage will occur if the temporary restraining order, preliminary injunction, or permanent injunction is not issued, or that the remedy at law is

inadequate.

(f) After the party seeking the injunction has met its burden of proof, the court shall determine whether to issue a temporary restraining order, preliminary injunction, or permanent injunction without requiring the defendant to prove that it will suffer grave or irreparable harm. The court shall make the determination whether to issue a temporary restraining order, preliminary injunction, or permanent injunction by taking into consideration, among other things, the nature, circumstance, extent, and gravity of the violation, the quantity and characteristics of the substance or material involved, the extent of environmental harm caused by the violation, measures taken by the defendant to remedy the violation, the relative likelihood that the material or substance involved may pass into waters of the state, and the harm likely to be caused to the defendant.

(g) The court, to the maximum extent possible, shall tailor any temporary restraining order, preliminary injunction, or permanent injunction narrowly to address the violation in a

Bioassessment Protocols

CALIFORNIA STREAM BIOASSESSMENT PROCEDURE

(HABITAT ASSESSMENT AND BIOLOGICAL SAMPLING)

The California Stream Bioassessment Procedure (CSBP) is a standardized protocol for assessing physical and biological conditions of wadable streams in California. There are two companion documents for this procedure: "California Stream Bioassessment Procedure (Macroinvertebrate Laboratory and Data Analyses)" and "California Stream Bioassessment Procedure (Field and Laboratory Quality Assurance/Control)". The CSBP is a regional adaptation of the national Rapid Bioassessment Protocols described in "Rapid Bioassessment Protocols for use in Streams and Rivers: Benthic Macroinvertebrates and Fish" (EPA 444/4-89-001).

This document describes procedures for habitat assessment and biological sampling of wadable streams using benthic macroinvertebrates. Developing aquatic bioassessment techniques for California is an iterative process; contact the California Department of Fish and Game's Water Pollution Control Laboratory (WPCL) at (916) 358-2858, e-mail: jharr@sna.com or visit the California Aquatic Bioassessment Web Site (http://www.dfg.ca.gov/cabw/cabwhome.html) for the most current version of the CSBP.

MONITORING STRATEGIES

The CSBP can be used to detect aquatic impacts from point and non-point source pollution and for biological assessment of ambient water quality. This field sampling procedure was designed for collecting benthic macroinvertebrates from individual riffles chosen as part of an appropriately designed monitoring program. ***The CSBP may not be appropriate for all aquatic monitoring programs - contact WPCL for advice on proper application of the CSBP.*** The following bioassessment strategies can be employed for:

Point Sources of Pollution - There will be discernable perturbations, impacting structures or discharges into the stream with point sources of pollution. The affected section of stream and an upstream unaffected section should be surveyed for riffles having relatively similar gradient, substrate and physical/habitat condition. Each riffle becomes a potential sampling site for benthic macroinvertebrates. At least one riffle in the unaffected section should be sampled as a control. One or more riffles should be sampled in the affected section depending on the amount of detail that is required on downstream recovery. At least three samples should be collected at each riffle depending on the necessary level of statistical accuracy required for the project.

Non-point Sources of Pollution - There will be no obvious perturbations or discharges into the stream with non-point sources of pollution. The stream or stream section of interest should be surveyed for similar riffles, and then at least three riffles should be

chosen at random for collecting benthic macroinvertebrates. Only one sample from the upstream third of the riffle is necessary as long as the riffles are chosen randomly. However, collecting three or more samples as described in the point source protocol will provide additional statistical information and accuracy. The number of riffles sampled depends on the homogeneity of the stream or stream section and necessary level of statistical accuracy required for the project. A reference stream or condition is recommended for assessing possible impacts from non-point source pollution. A reference stream or stream section must be similar in physical/habitat condition and be within the same ecoregion or watershed as the impacted site. Historical data or expert consensus on biological and physical condition could be substituted if a reference stream is unavailable.

Ambient Water Quality Conditions - Biological assessment of ambient water quality for a stream or stream section provides base-line information on biological conditions, aquatic species composition and natural community variability. This information can be used to establish reference streams and reference conditions and to develop Biological Criteria as outlined by the U.S. Environmental Protection Agency in "Biological Criteria: National Program Guidance for Surface Waters" (EPA 440/5-90-004). Biological assessment for ambient water quality should be conducted seasonally (spring and/or fall) and continued on a regular basis to establish historic data and provide a management tool to detect possible changes in water quality. The monitoring strategy can be similar to that described for both point and non-point source pollution with riffles being chosen from similar reaches and/or located above and below areas of particular interest (e.g., suspected impact, physical/habitat structure, hydrologic zones, etc.).

EQUIPMENT AND SUPPLIES

D-shaped kick net (0.5mm mesh)
Wide-mouth plastic or glass jars
White enameled pan
Watershed topographic map
Measuring Tape (100 meter)
Thermometer
Forceps
95% ethanol
Pencil
Standard size 35 (0.5 mm) testing sieve Water-proof paper
California Stream Bioassessment Worksheet (CSBW)
WPCL Chain of Custody Form (COC)

PROCEDURES

Biological Sampling

1. The project supervisor should conduct a reconnaissance survey of the stream or stream section to determine appropriate sample reaches. The ideal sampling reach is a riffle at least 10 meters long with a homogenous gravel/cobble substrate and swift water velocity. However, ideal situations rarely exist. In choosing sampling reaches, emphasis should be placed on homogenous reaches that are wadable and best

resemble a riffle or run condition. Follow the monitoring strategies outlined in this document or contact the WPCL for advice on selecting individual riffles for collecting benthic macroinvertebrates.

CAUTION: Avoid walking in stream when conducting a reconnaissance survey. Each riffle used for biological assessment must be approached from downstream and no portion of the riffle disturbed until all sampling is complete. Habitat assessment should be conducted after macroinvertebrates have been collected.

2. Fill out a CSBW for each riffle section. Enter watershed name, sample identification number, date, time and names of crew members. Locate the site on the watershed topographic map using the sample identification number and enter GPS coordinates, if possible.

3. To select a transect, place the measuring tape along the bank of the entire riffle section. Each meter (3 ft) mark represents a possible transect location. Select a transect from all possible meter marks along the measuring tape using the table of random numbers. If only one transect is to be sampled, then select one meter mark in the top one-third of the riffle. To select a random number, place a finger on the page with eyes closed. From that number, go down the columns looking at the first two digits (for up to 99 transect numbers) until a usable number(s) is selected. Record the meter mark on the CSBW for each transect.

4. Once a transect is randomly selected, the objective is to collect benthic macroinvertebrates from several locations along the transect and combine them into one sample. If possible, choose three locations; the two side margins and the center of the stream. If the riffle is not ideal, then make adjustments to accommodate prevailing conditions. When making adjustments, such as increasing or reducing the number of locations for collecting organisms or sampling substrate that is not gravel/cobble, try to sample similar conditions at each reach.

5. Starting from the downstream transect, collect macroinvertebrates by placing the D-shaped kick-net on the substrate and disturbing a one by two foot section of substrate upstream of the kick-net to approximately 4-6 inches in depth. Pick-up and scrub large rocks by hand under water in front of the net. Maintain a consistent sampling effort (approximately 1-3 minutes) at each site. Combine the three collections within the kick-net. Measure and record stream temperature.

6. Place the contents of the kick-net in a standard size 35 (0.5 mm) testing sieve. Remove large organic material by hand while carefully inspecting for clinging organisms. Using the forceps, place all remaining material in the 95% ethanol filled jar. When there is considerable debris in the net, the white enameled pan is useful for inspecting the sample. However, rinse material from the pan through the sieve before placing it in the jar.

7. Using a pencil, write the following information on a piece of water-proof paper and place in the jar: sample identification number followed by -01, -02 (to identify each transect sampled from a riffled), watershed name, date and sampler's initials.

Habitat Assessment

The habitat assessment portion of this procedure should be used if a more comprehensive physical assessment is not planned. Habitat assessments can be used without biological sampling, but whenever biological sampling occurs, there must be a habitat assessment conducted for every riffle sampled.

8. Conduct a rapid assessment of physical conditions for an entire stream reach using the habitat parameters (last two pages of the CSBW) as described while walking in an upstream direction from the bottom to the top of the stream reach. The score should reflect the average conditions for the entire stream reach. Record habitat parameter scores on the cover page of a separate CSBW and make comments on any habitat impairments not covered by the habitat parameters.

9. For biological sampling, habitat parameters 1 through 3 should be used to evaluate the average condition along the transacts sampled for benthic macroinvertebrates. Habitat parameters 4 through 7 should be used to assess conditions for a larger area upstream of the riffle section. Habitat parameters 8 through 10 should be used to assess each bank immediately upstream of the riffle section. Record habitat parameter scores on the cover page of each CSBW used for biological sampling.

Sample Handling, Storage and Transfer

10. At the end of the field day, record the following information on a COC for each (or group of) biological samples: program name; watershed name; field ID numbers; sampling dates; and name, address, telephone number and signature of one of the crew members collecting the sample.

11. Verification samples and COCs must remain in a locked sample depository until a decision has been made to send them to a bioassessment laboratory for processing.

12. When transporting to a bioassessment laboratory, each (or group of) sample must be accompanied by a COC. Upon delivery, a Bioassessment Laboratory Number will be assigned to each sample. Record this number on the COC and each individual CSBW along with the name and address of the bioassessment laboratory. When all verification samples listed on the COC are accounted for, then the individual delivering the samples will sign the "Released By" portion and the laboratory personnel will sign the "Received By" portion of the COC. The original COC will remain at the laboratory and a copy will be retained by the project supervisor.

CALIFORNIA STREAM BIOASSESSMENT PROCEDURE
FIELD WORKSHEET

WATERSHED:_____ **DATE:**_____

SAMPLE ID: _____ **TIME:** _____

CREW MEMBERS:

_____

_____

_____

WATER TEMP: _____

RIFFLE LENGTH: _____
TRANSECT 1: _____
TRANSECT 2: _____
TRANSECT 3: _____

GPS COORDINATES
LONG: _____
LAT: _____

BIOASSESSMENT LABORATORY INFORMATION

Bioassessment Laboratory Number: _____

Bioassessment Laboratory Name and Address:

_____

_____

_____

_____

HABITAT ASSESSMENT PARAMETERS

1. INSTREAM COVER: _____
2. EPIFAUNAL SUBSTRATE: _____
3. EMBEDDEDNESS: _____
4. CHANNEL ALTERATION: _____
5. SEDIMENT DEPOSITION: _____
6. RIFFLE FREQUENCY: _____
7. CHANNEL FLOW: _____
8. BANK VEGETATION: L:____ R:____
9. BANK STABILITY: L:____ R:____
10. RIPARIAN ZONE: L:____ R:____

COMMENTS: _____

_____

_____

_____

CDFG - WPCL
2005 Nimbus Rd. Rancho Cordova, Ca. 95670
(916) 358-2858 FAX (916) 985-4301 e-mail: jharr@sna.com
Bioassessment homepage - http://www.dfg.ca.gov/cabw/cabwhome.html

CALIFORNIA DEPARTMENT OF FISH AND GAME
AQUATIC BIOASSESSMENT LABORATORY

WATER POLLUTION CONTROL LABORATORY
REVISION DATE - MARCH, 1996

DATE: _____

SAMPLE ID: _____

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
1. Instream Cover (Fish)	Greater than 50% mix of snags, submerged logs, undercut banks, or other stable habitat.	30-50% mix of stable habitat; adequate habitat for maintenance of populations.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% mix of stable habitat; lack of habitat is obvious.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Epifaunal Substrate	Well-developed riffle and run; riffle is as wide as stream and length extends two times the width of stream; abundance of cobble.	Riffle is as wide as stream but length is less than two times width; abundance of cobble; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than 2 times the stream width; gravel or large boulders and bedrock prevalent; some cobble present.	Riffles or runs virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Channel Alteration	Channelization or dredging absent or minimal; stream with normal, sinuous pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	New embankments present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at obstruction, constriction, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Frequency of Riffles	Occurrence of riffles relatively frequent; distance between riffles divided by the width of the stream equals 5 to 7; variety of habitat.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream equals 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is between ratio >25.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption, through grazing or mowing, minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Bank Stability (score each bank)	Banks stable; no evidence of erosion or bank failure; little potential for future problems.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach have areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Bioassessment Report of Findings

STATE OF CALIFORNIA GRAY DAVIS, *Governor*

DEPARTMENT OF FISH AND GAME
FISH AND WILDLIFE WATER POLLUTION CONTROL LABORATORY
2005 NIMBUS ROAD
RANCHO CORDOVA, CA 95670
(916) 358-2858

May 20, 1999

Bruce Rucker
Stellar Environmental Solutions
2110 Sixth Street
Berkeley, CA 94710

DFG's Water Pollution Control Laboratory conducts biological and physical/habitat assessments throughout California as part of watershed based surveys, in response to pollution spill events, to evaluate water quality problems and as part of special biological studies. Some of these bioassessment are conducted specifically as DFG projects and other are performed as a laboratory service for other state and federal water resource agencies.

The enclosed report is for a project which was conducted by our staff as a laboratory service, but payed for through the Chico State Research Foundation. This partnership between DFG and the Foundation helps to alleviate administrative burden for the state and provide a more efficient means of facilitating clients with smaller projects.

I reviewed this Water Quality Inventory Series report for Redwood Creek and found the work to be satisfactory and deserving of DFG endorsement. Please contact me if you have any questions or concerns for the content of this report.

Sincerely,

James M. Harrington
Staff Water Quality Biologist

A WATER QUALITY INVENTORY SERIES

BIOLOGICAL AND PHYSICAL/HABITAT ASSESSMENT OF CALIFORNIA WATER BODIES

Redwood Creek, Alameda County

May, 1999

Program Manager
James M. Harrington

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California Department of Fish and Game
Office of Spill Prevention and Response
Water Pollution Control Laboratory
2005 Nimbus Road, Rancho Cordova, Ca. 95670
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INTRODUCTION TO THE WATER QUALITY INVENTORY SERIES

Throughout the past century, the California Department of Fish and Game (DFG) has been the leading force in developing new techniques and conducting biological and physical habitat surveys of the state's water resources. Besides managing fish and wildlife population, DFG has also been active in investigating and enforcing pollution cases. This is somewhat unique among state fish and wildlife agencies and stems from DFG's close involvement with the State Water Resources Control Board (and the Board's nine regions) and its own anti-pollution laws contained in Fish and Game Code 5650.

The DFG's Water Pollution Control Laboratory (WPCL) was established by the State Legislature in 1967 to provide laboratory services to DFG and branches of State and Federal government which deal in environmental monitoring and regulation. The WPCL began as a analytical chemistry laboratory, developing aquatic toxicological capabilities in the 1970's and then in 1992, established the Aquatic Bioassessment Laboratory (ABL) to perform biological and physical/habitat assessment surveys, specializing in invertebrate ecology and taxonomy. The combination of these functions allows the WPCL to utilize the investigative triad (chemical, toxicological and biological) when addressing water quality concerns.

In 1993, DFG introduced standardized field sampling, laboratory identification and quality assurance/quality control (QA/QC) procedures for assessing wadeable streams utilizing benthic macroinvertebrates. These California Stream Bioassessment Procedure (CSBP) were developed from EPA guidelines (Plafkin et al. 1989) and input from aquatic biologists throughout California involved with biological monitoring. The CSBP is continually reviewed and refined through annual meetings of the California Aquatic Bioassessment Workgroup (CABW) sponsored by DFG, the State Water Resources Control Board and EPA. Now in its third revision, the CSBP is a regional adaptation of the EPA Rapid Bioassessment Protocols (Barbour et al. 1997) and is listed by the EPA as the protocol used in California to develop biocriteria (Davis et al. 1996). In 1996, DFG has also introduced a CSBP for citizen monitors and the draft California Lentic Bioassessment Protocols (CLBP) for sampling lakes, reservoirs and lagoons.

The CSBP is being used by environmental consulting firms and state water resource agencies throughout California in watershed based assessments, point-source assessment of waste discharges, evaluation of toxic spill events and ambient bioassessment programs. The DFG projects which demonstrate the use of the CSBP and other bioassessment techniques fall within three categories:

Watershed Based Surveys with the objective to assess the biological and physical/habitat condition of an entire watershed or a significant portion of its tributaries;

Point-Source Impact Assessments (Enforcement) with the objective to assess the discharge of a known deleterious pollutant on the biological and physical/habitat condition of a water body; and

Water Body Health Surveys and Special Studies with the objective to measure changes in the biological and physical/habitat condition of a water body resulting from either a specific resource management technique or land-use practice.

INTRODUCTION

In February 1999, the California Department of Fish and Game's Aquatic Bioassessment Laboratory (ABL) was contracted by Stellar Environmental Solutions to assess the impact of groundwater flow from an underground petroleum storage tank on the invertebrate riffle community in Redwood Creek within Redwood Regional Park, Alameda County. Although the storage tank was removed several years ago, low concentration petrochemical groundwater discharge continues to enter Redwood Creek. DFG's Region III water quality biologist has requested that the stream invertebrate community be monitored to assess the impact of the discharge to Redwood Creek.

The California Stream Bioassessment Procedure (CSBP), developed by the California Department of Fish and Game (DFG), was used to evaluate the benthic macroinvertebrate communities in Redwood Creek (Harrington 1996). The CSBP is a regional adaptation of the U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (Plafkin et al. 1989) and is recognized by the EPA as California's standardized bioassessment procedure (Davis et al. 1996).

The CSBP is a cost effective tool which utilizes measures of the stream's benthic macroinvertebrate (BMI) community and its physical/ habitat structure. BMIs can have a diverse community structure with individual species residing within the stream for a period of months to several years. They are also sensitive, in varying degrees, to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution (Resh and Jackson 1993). Together, biological and physical assessments integrate the effects of water quality over time, are sensitive to multiple aspects of water and habitat quality, and provide the public with more familiar expressions of ecological health (Gibson 1996).

This report presents results from samples collected on 2 April 1999.

MATERIALS AND METHODS

Monitoring Reach Descriptions

Monitoring reach descriptions are summarized in Table 1. The two uppermost riffles and the downstream riffle (RC-U1, RC-U2 and RC-D1) were similar in gradient and substrate types. The area sampled within the groundwater discharge zone had a steeper gradient and much less available habitat for macroinvertebrates than the other three sites. Despite the differences in habitat type, this was the best macroinvertebrate habitat present within the area of influence of the groundwater discharge.

Benthic Macroinvertebrate Sampling

BMIs were sampled on 2 April 1999 from four riffles in Redwood Creek within the boundaries of Redwood Regional Park.

Riffle length was determined for each riffle and a random number table was used to establish a point randomly along the upstream third of the riffle from which a transect was established

Table 1. Benthic macroinvertebrate sampling location information for reaches sampled within Redwood Creek.

Stream Name	Location Description	Site ID	Latitude/ Longitude
Redwood Creek	300 Meters Upstream of Groundwater Discharge Zone	**RC-U1**	N37°48' 13.0", W122° 08' 39.0"
Redwood Creek	200 Meters Upstream of Groundwater Discharge Zone	**RC-U2**	N37°48' 13.0", W122° 08' 39.0"
Redwood Creek	3 Meters Downstream of Contaminated Groundwater Discharge Zone, Below Fish Ladder	**RC-GZ**	N37°48' 13.0", W122° 08' 39.0"
Redwood Creek	50 Meters Downstream of Groundwater Discharge Zone	**RC-D1**	N37°48' 13.0", W122° 08' 39.0"

perpendicular to the stream flow. Starting with the transect at the lowermost riffle, the benthos within a 2 ft^2 area was disturbed upstream of a 1 ft wide, 0.5 mm mesh D-frame kick-net.

Sampling of the benthos was performed manually by rubbing cobble and boulder substrates in front of the net followed by "kicking" the upper layers of substrate to dislodge any invertebrates remaining in the substrates. The duration of sampling ranged from 60-120 seconds, depending on the amount of boulder and cobble-sized substrates that required rubbing by hand; more and larger substrates required more time to process. Three locations representing the habitats along the transect were sampled and combined into a composite sample (representing a six ft^2 area). This composite sample was transferred into a 500 ml wide-mouth plastic jar containing approximately 200 ml of 95% ethanol. This technique was repeated for each of three riffles in each reach.

Physical Habitat Quality Assessment

Physical habitat quality was assessed for the monitoring reaches using U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (RBPs) (Plafkin *et al.* 1989). Habitat quality assessments were recorded for each monitoring reach during each sampling event. Photographs were taken within each of the monitoring reaches to document overall riffle condition at the time of sampling.

BMI Laboratory Analysis

At the laboratory, each sample was rinsed through a No. 35 standard testing sieve (0.5 mm brass mesh) and transferred into a tray marked with twenty, 25 cm^2 grids. All detritus was removed from one randomly selected grid at a time and placed in a petri dish for inspection under a stereomicroscope. All invertebrates from the grid were separated from the surrounding detritus and transferred to vials containing 70% ethanol and 5% glycerol. This process was continued until 300 organisms were removed from each sample. The material left from the processed grids was transferred into a jar with 70% ethanol and labeled as "remnant" material. Any remaining

unprocessed sample from the tray was transferred back to the original sample container with 70% ethanol and archived. Macroinvertebrates were then identified to a standard taxonomic level, typically genus level for insects and order or class for non-insects using standard taxonomic keys (Brown 1972, Edmunds et al. 1976, Klemm 1985, Merritt and Cummins 1995, Pennak 1989, Stewart and Stark 1993, Surdick 1985, Thorp and Covich 1991, Usinger 1963, Wiederholm 1983, 1986, Wiggins 1996, Wold 1974).

Data Analysis

A taxonomic list of benthic macroinvertebrates identified from the samples was entered into a Microsoft Excel® spreadsheet program. Excel® was used to calculate and summarize macroinvertebrate community based metric values. A description of the metric values used to describe the community is shown in Table 2.

Quality Assessment/ Quality Control

Standard laboratory quality assessment procedures were applied to the BMI samples. Ten percent of remnant samples were re-picked to assess complete sorting of material. A voucher collection of all taxa was verified by the ABL laboratory director.

RESULTS

Dominant BMI Taxa/ General Taxonomic Notes

The five dominant taxa observed in each of the monitoring reaches are presented in Table 3. A complete list of macroinvertebrates identified from the samples is presented in Appendix 1.

The BMI communities were very similar across all the riffles sampled. The ubiquitous mayfly, *Baetis sp.* (Ephemeroptera: Baetidae) was extremely abundant, contributing two-thirds of the organisms at each site. There were very few non-insect taxa present at any site and beetles were rare at all sites.

Benthic Macroinvertebrate Community Metrics

BMI metric values are presented by transect in Table 4 and summarized by reach mean and coefficient of variation in Table 5.

Richness

BMI richness metrics were comparable among the three main riffles (RC-U1, RC-U2 and RC-D1), averaging 18-22 taxa per replicate and 13-16 EPT taxa per replicate. Taxonomic richness and EPT taxonomic richness was about half as high within the groundwater discharge zone samples.

Table 2. Bioassessment metrics used to describe characteristics of the benthic macroinvertebrate (BMI) community at sampling reaches within Redwood Creek, Alameda Co., California.

BMI Metric	Description	Response to Impairment
Richness Measures		
Taxa Richness	Total number of individual taxa	decrease
EPT Taxa	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	decrease
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae with tolerance values between 0 and 3	decrease
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963)	decrease
Tolerance/Intolerance Measures		
Tolerance Value	Value between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) or intolerant (lower values)	increase
Percent Dominant Taxon	Percent composition of the single most abundant taxon	increase
Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2	decrease
Percent Tolerant Organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10	increase
Functional Feeding Groups (FFG)		
Percent Collectors (c)	Percent of macrobenthos that collect or gather fine particulate matter	increase
Percent Filterers (f)	Percent of macrobenthos that filter fine particulate matter	increase
Percent Grazers (g)	Percent of macrobenthos that graze upon periphyton	variable
Percent Predators (p)	Percent of macrobenthos that feed on other organisms	variable
Percent Shredders (s)	Percent of macrobenthos that shreds coarse particulate matter	decrease
Abundance		
Estimated Abundance	Estimated number of macroinvertebrates in sample calculated by extrapolating from the proportion of organisms counted in the subsample	variable

Table 3. Dominant macroinvertebrate taxa (and their percent contribution) by reach from samples collected from sites within Redwood Creek.

Sample Location	Dominant Taxa				
	1	2	3	4	5
300 Meters Upstream of Groundwater Discharge Zone	*Baetis* (68)	Orthocladiinae (4)	*Osobenus* (4)	*Stenonema* (3)	*Lepidostoma* (3)
200 Meters Upstream of Groundwater Discharge Zone	*Baetis* (66)	Orthocladiinae (12)	*Isoperla* (4)	*Osobenus* (3)	*Paraleptophlebia* (2)
Groundwater Discharge Zone (RC-GZ)	*Baetis* (71)	Oligochaeta (4)	*Isoperla* (4)	*Osobenus* (3)	*Drunella* (2)
50 Meters Downstream of Groundwater Discharge Zone (RC-D1)	*Baetis* (65)	Orthocladiinae (5)	*Osobenus* (5)	Oligochaeta (3)	*Malenka* (3)

Table 4. Bioassessment metrics calculated for macroinvertebrate samples collected on 2 April 1999 from riffles in Redwood Creek, Alameda Co., California.

Redwood Creek

Site:	300 Meters Upstream of Contaminated Discharge			200 Meters Upstream of Contaminated Discharge			3 Meters Downstream of Contaminated Discharge			50 Meters Downstream of Contaminated Discharge		
Transect Number:	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:	3069	3070	3071	3066	3067	3068	3063	3064	3065	3060	3061	3062
Taxonomic Richness	18	18	19	20	23	23	15	10	8	21	25	19
Percent Dominant Taxon	65	67	63	73	72	68	68	69	55	69	60	73
EPT Taxa	14	14	14	14	16	17	13	5	5	13	15	11
EPT Index (%)	89	94	92	91	91	94	92	84	62	92	84	88
Sensitive EPT Index (%)	22	23	23	14	13	22	22	15	5	21	21	13
Percent Hydropsychidae	0	0	0	1	0	0	0	0	0	0	1	0
Percent Baetidae	66	71	64	74	73	69	68	69	55	70	61	75
Shannon Diversity	1.5	1.5	1.6	1.3	1.4	1.5	1.4	1.2	1.2	1.5	1.8	1.3
Tolerance Value	4.2	4.2	4.2	4.7	4.6	4.2	4.2	4.4	4.8	4.2	4.4	4.6
Percent Intolerant Taxa (0-2)	22	23	23	14	13	22	22	15	5	21	20	12
Percent Tolerant Taxa (8-10)	1	1	1	6	4	3	0	0	0	2	5	2
Percent Collectors	75	76	73	82	83	75	78	78	87	77	73	83
Percent Filterers	0	0	0	2	0	1	0	5	2	0	1	0
Percent Grazers	11	9	4	3	2	12	6	6	4	3	8	4
Percent Predators	9	11	17	11	11	11	9	8	2	11	14	10
Percent Shredders	5	5	6	2	3	2	8	3	5	9	4	2
Abundance (#/ sample)	282	218	230	272	335	1426	162	87	55	360	224	247

Table 5. Means and coefficients of variation (CV) for bioassessment metrics calculated from samples collected on 2 April 1999 from Redwood Creek, Alameda Co., California.

Redwood Creek

	300 Meters Upstream of Contaminated Discharge		200 Meters Upstream of Contaminated Discharge		3 Meters Downstream of Contaminated Discharge		50 Meters Downstream of Contaminated Discharge	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Taxonomic Richness	**18**	3	**22**	8	**11**	33	**22**	14
Percent Dominant Taxon	**65**	3	**71**	4	**64**	13	**67**	10
EPT Taxa	**14**	0	**16**	10	**8**	60	**13**	15
EPT Index (%)	**92**	3	**92**	2	**79**	20	**88**	5
Sensitive EPT Index (%)	**23**	2	**16**	32	**14**	59	**18**	27
Percent Hydropsychidae	**0**	--	**1**	127	**0**	--	**0**	173
Percent Baetidae	**67**	5	**72**	4	**64**	13	**68**	10
Shannon Diversity	**1.5**	4	**1.4**	8	**1.3**	7	**1.5**	18
Tolerance Value	**4.2**	1	**4.5**	6	**4.5**	7	**4.4**	5
Percent Intolerant Taxa (0-2)	**23**	3	**16**	31	**14**	58	**18**	27
Percent Tolerant Taxa (8-10)	**1**	10	**4**	29	**0**	--	**3**	67
Percent Collectors	**75**	2	**80**	6	**81**	7	**78**	7
Percent Filterers	**0**	--	**1**	79	**2**	108	**1**	125
Percent Grazers	**8**	42	**6**	102	**5**	24	**5**	46
Percent Predators	**12**	34	**11**	4	**6**	61	**12**	22
Percent Shredders	**5**	14	**2**	36	**6**	41	**5**	68
Abundance (#/ sample)	**243**	14	**677**	96	**101**	54	**277**	26

Composition Measures

The Percent Dominant Taxa metric was very high at all sites due to the extreme abundance of the mayfly *Baetis sp.* which made up 64 to 71 percent of the organisms in each sample. Due to the extreme abundance of *Baetis*, Shannon Diversity values were low at all sites, ranging from 1.3 to 1.5. The majority of the diversity was comprised of the generally disturbance intolerant insect orders, Ephemeroptera, Plecoptera and Trichoptera, which were responsible for 26 of the 50 taxa found in Redwood Creek.

Tolerance Measures

Tolerance measures indicated communities that were only moderately tolerant to disturbance, but these metrics were driven largely by the abundance of *Baetis* (tolerance value 5). Average tolerance values ranged between 4.2 to 4.5. When *Baetis* was removed from the analysis, the remaining communities were primarily composed of intolerant taxa; these intolerant taxa were responsible for two thirds of the remaining diversity.

Functional Feeding Groups

All of the FFGs were present within Redwood Creek, but filter-feeding organisms were encountered only rarely in a few sites (Table 5). Although the extreme abundance of *Baetis* was the dominant feature of the community, the remaining taxa are representative of a typical first-order forested stream system. Grazers, non-baetid collectors, predators and shredders are roughly equally abundant and filterers were rare.

Abundance

Mean abundance of organisms was moderate to low at all sites, ranging between 100 organisms/ sample within the groundwater discharge zone and 700 organisms/ sample at 200 meters upstream of the discharge zone. Abundance of organisms within the discharge zone was roughly a third as high as in the other riffles.

Physical Habitat Assessment

Physical habitat quality scores are summarized in Table 6. Photographs of the reaches are shown in Appendix 2.

All riffles scored in the "good" range of the physical habitat measures, none of the sites had notable impaired physical habitat. The upstream riffles had very similar substrates to the downstream riffle, but had slightly lower gradient and were more affected by sediment than the downstream riffle. The sampling area within the influence of the groundwater discharge was considerably less suitable for macroinvertebrate diversity, primarily because the amount of appropriate substrate was much lower than it was in the other riffles. The distribution of suitable cobble and gravel was limited to small pockets in depositional areas behind large boulders.

Quality Assessment/ Quality Control

All quality assurance measures indicate that all laboratory analyses were performed within acceptable error limits. All QA/ QC data are available upon request from the ABL.

Table 6. Physical habitat quality scores for sampling reaches within Redwood Creek. Scores for each habitat parameter range from 0 (poor) to 20 (excellent).

Habitat Parameter	Redwood Creek April 1999			
	RC-U1	RC-U2	RC-GZ	RC-D1
1. Instream Cover	10	5	15	11
2. Embeddedness	12	5	12	10
3. Velocity/ Depth Regimes	11	7	16	12
4. Sediment Deposition	12	9	12	12
5. Channel Flow	14	16	17	18
6. Channel Alteration	20	20	20	20
7. Riffle Frequency	18	18	18	16
8. Bank Vegetation	9	8	12	16
9. Bank Stability	12	12	15	17
10. Riparian Zone	7	12	10	14
TOTAL	**125**	**112**	**147**	**146**
Physical Condition	**good**	**good**	**good**	**good**

Conclusions/ Summary

These data provide no evidence of any influence of groundwater discharge from the excavated petroleum storage tank on the macroinvertebrate communities in the reaches of Redwood Creek that were sampled for this report. The BMI communities collected in April 1999 are indicative of normal conditions after spring flows. Several bioassessment metrics have lower values in samples collected in the vicinity of the contaminated groundwater discharge zone. However, this is probably a result of lower habitat availability in this region and not impact from the plume itself.

The extreme abundance of the minnow mayfly, *Baetis,* had a strong impact on many of the bioassessment metrics, obscuring the otherwise well-balanced community. The dominant effect of *Baetis* was most likely an artifact of the spring sampling season in which early colonizers like *Baetis* can dominate riffle communities. We recommend that additional samples be collected at the end of the summer or during early fall when the community should be more stable.

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APPENDIX 1

Taxonomic list of benthic macroinvertebrates identified from samples collected on 2 April 1999 from monitoring reaches within Redwood Creek

Redwood Creek

Site:			300 Meters Upstream of Contaminated Discharge			200 Meters Upstream of Contaminated Discharge			3 Meters Downstream of Contaminated Discharge			50 Meters Downstream of Contaminated Discharge		
Transect Number:			T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:			3069	3070	3071	3066	3067	3068	3063	3064	3065	3060	3061	3062
PHYLUM ARTHROPODA	TV	FFG												
Class Insecta														
Coleoptera (Adults)														
Dytiscidae														
Nebrioporus sp./Stictotarsus sp.	5	p	-	-	1	-	-	-	-	-	-	-	-	-
Coleoptera (Larvae)														
Elmidae														
Narpus sp.	4	c	-	-	-	-	-	-	-	-	-	-	-	2
Optioservus sp.	4	g	-	-	-	1	-	-	-	-	-	2	1	1
Diptera														
Canacidae			-	-	-	-	-	-	-	-	-	1	-	-
Ceratopogonidae														
Probezzia sp.	6	p	5	3	6	-	2	-	-	-	-	2	4	4
Chironomidae														
Chironominae														
Chironomini	6	c	-	-	-	-	-	-	2	-	-	-	-	-
Tanytarsini	6	f	-	-	-	2	-	3	-	1	-	-	1	-
Orthocladiinae	5	c	23	6	9	2	4	1	11	8	17	10	12	13
Tanypodinae	6	p	1	-	-	-	-	-	-	-	-	-	-	1
Phoridae			-	-	-	-	-	-	-	-	-	1	-	-
Simuliidae	6	f	-	-	-	-	-	-	-	3	1	1	-	-
Stratiomyidae														
Caloparyphus sp.	7	c	-	-	-	-	-	-	-	-	-	-	1	-
Tipulidae														
Dicranota sp.	3	p	-	-	-	-	1	-	-	-	-	-	-	-
Hexatoma sp.	2	p	-	-	-	2	-	1	-	-	-	-	-	-
Limonia sp.	6	s	-	-	-	-	-	-	-	-	3	-	-	-
Molophilus sp.	3	s	-	-	-	-	1	-	-	1	-	-	-	-
Rhabdomastix sp.	3	p	-	-	-	1	5	-	-	-	-	-	-	-
Odonata														
Cordulegastridae														
Cordulegaster dorsalis	0	p	-	-	-	-	-	-	-	-	-	-	1	-
Ephemeroptera														
Ameletidae														
Ameletus sp.	0	g	10	8	6	2	2	24	3	-	1	3	8	4
Baetidae														
Baetis sp.	5	c	184	146	144	199	211	201	109	60	30	209	137	182
Diphetor sp.	5	c	2	8	3	3	4	3	-	-	-	3	1	3
Ephemerellidae														
Drunella sp.	0	g	2	3	1	-	1	1	1	5	-	3	2	1
Heptageniidae														
Cinygmula sp.	4	g	1	-	2	1	1	3	-	-	-	-	-	-
Ironodes sp.	4	g	1	-		-	-	-	-	-	-	-	-	-
Stenonema sp.	2	g	16	7	1	3	2	7	4	-	1	2	3	4
Leptophlebidae														
Paraleptophlebia sp.	4	c	-	2	9	4	12	5	3	-	1	6	3	2
Plecoptera														
Capnidae														
Utacapnia sp.	1	s	-	-	1	-	-	-	1	-	-	-	-	-
Chloroperlidae														
Sweltsa sp.	1	p	-	-	1	-	2	3	-	-	-	4	1	-
Leuctridae														
Despaxia augusta	0	s	-	-	-	-	1	-	-	-	-	-	-	-
Nemouridae														
Malenka sp.	2	s	5	2	7	1	5	2	-	2	-	10	3	3
Perlidae														
Calineuria californica	1	p	-	1	-	1	-	1	-	-	-	-	-	-
Perlodidae														
Isoperla sp.	2	p	6	6	11	10	13	9	5	-	-	-	7	-
Kogotus sp.	2	p	1	1	3	1	1	2	1	-	-	3	3	-
Osobenus yakimae	2	p	9	9	16	12	3	7	7	5	-	15	10	9
Taeniopterygidae														
Taenionema sp.	2	g	-	2	-	-	-	-	-	-	-	-	-	-

Redwood Creek

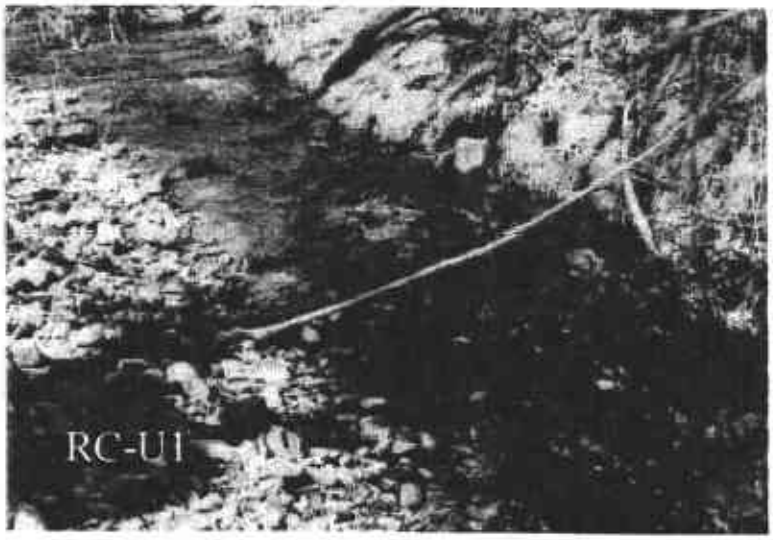
Site:			300 Meters Upstream of Contaminated Discharge			200 Meters Upstream of Contaminated Discharge			3 Meters Downstream of Contaminated Discharge			50 Meters Downstream of Contaminated Discharge		
Transect Number:			T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number:			3069	3070	3071	3066	3067	3068	3063	3064	3065	3060	3061	3062
Trichoptera														
Hydropsychidae														
Hydropsyche sp.	4	f	-	-	-	4	1	-	-	-	-	-	2	-
Lepidostomatidae														
Lepidostoma sp.	1	s	10	8	6	5	3	2	10	-	-	5	5	3
Odontoceridae														
Parthina sp.	0	s	-	-	-	-	-	1	2	-	-	11	-	-
Rhyacophilidae														
Rhyacophila sp.	0	p	3	3	-	2	4	5	1	1	1	7	2	6
Uenoidae														
Neophylax sp.	3	g	1	-	-	-	-	1	1	-	-	-	4	1
Class Arachnoidea														
Acari														
Hygrobatidae	5	p	-	-	-	-	-	2	-	-	-	-	1	3
Sperchontidae	5	p	-	-	-	-	-	-	-	1	-	1	1	-
Class Malacostraca														
Amphipoda														
Gammaridae														
Gammarus sp.	4	c	-	1	1	-	-	-	-	-	-	-	-	-
PHYLUM NEMATODA	5	p	-	-	-	-	2	-	-	-	-	-	3	1
PHYLUM PLATYHELMINTHES														
Class Turbellaria														
Tricladia														
Planariidae	4	p	-	-	-	-	-	1	-	-	-	-	-	-
PHYLUM ANNELIDA														
Class Oligochaeta	8	c	3	2	2	16	12	10	-	-	-	5	12	5
Total Organisms*			283	218	230	272	293	295	161	87	55	304	228	248

*Total Organisms will deviate from 300 when sample contains less than 300 organisms and/or when organisms are discarded in taxonomic identification (see ABAL Laboratory Procedures).

Total Organisms Recovered	282	218	230	272	293	295	162	87	55	315	224	247
Total Extra Organisms	0	0	0	0	0	2	0	0	0	43	0	0
Organisms Picked (includes extras)	283	223	235	274	300	300	160	88	56	343	235	248
Grids Processed	6	4	3	8	7	5	4	4	2	8	4	12
Total Grids Possible	6	4	3	8	8	24	4	4	2	8	4	12
Sorted	285	213	231	271	294	296	160	87	55	295	234	243
Discards	0	1	0	0	1	3	0	1	1	1	1	0
Abundance (#/ sample)	282	218	230	272	335	1426	162	87	55	360	224	247

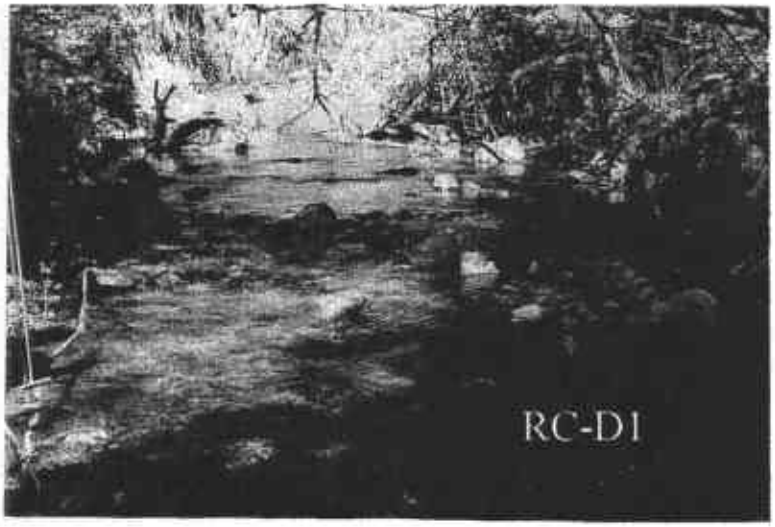
APPENDIX 2

Photographs of monitoring reaches
within Redwood Creek in on 2 April 1999


RC-U1


RC-U2


RCGW


RC-D1

WELL GAUGING DATA

Project # 990406R-1 Date 4/6/99 Client Stellas Environmental Solutions

Site Redwood Regional Park Service Yard

Well ID	Well Size (in.)	Sheen / Odor	Depth to Immiscible Liquid (ft.)	Thickness of Immiscible Liquid (ft.)	Volume of Immiscibles Removed (ml)	Depth to water (ft.)	Depth to well bottom (ft.)	Survey Point: TOB or TOC	
MW-1	4	None	None	None	None	0.75	18	TOC	
MW-2	4	none				19.60	36		
MW-3	4	none				18.65	42		
MW-4	4	petrol odor				12.51	26		
MW-5	4	none				15.20	26		
MW-6	4	none				12.72	26		
SW-1		D.O →		8.0					
SW-2		D.O →		10.2					
SW-3		D.O →		8.2					

WELL MONITORING DATA SHEET

Project #: 990406 R-1	Client: Stellar Environmental solutions
Sampler: JR	Start Date: 4-6-99
Well I.D.: MW-1	Well Diameter: 2 3 (4) 6 8 ___
Total Well Depth: 18.00	Depth to Water: 0.75'
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: ~~PVC~~ Grade	D.O. Meter (if req'd): YSI HACH

Purge Method: Bailer / Disposable Bailer / Middleburg / Electric Submersible / Extraction Pump / Other: ___

Sampling Method: Bailer / (Disposable Bailer) / Extraction Port / Other: ___

— (Gals.) X	—	= — Gals.
1 Case Volume	Specified Volumes	Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius² * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
						Ferrous Iron
9:30	61.5	7.0	1200	20	—	ND 0.0 mg
		No	Purged	⊘		

Did well dewater? Yes (No) Gallons actually evacuated: —

Sampling Time: 9:30 Sampling Date: 4/6/99

Sample I.D.: MW-1 Laboratory: —

Analyzed for: ~~TPH-G BTEX MTBE TPH-D~~ Other: Nitrate, Sulfate

Equipment Blank I.D.: @ Time Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D Other:

D.O. (if req'd):	Pre-purge:	mg/L	Post-purge:	2.0	mg/L
ORP (if req'd):	Pre-purge:	mV	Post-purge:	120	mV

WELL MONITORING DATA SHEET

Project #: 990406R-1	Client: Stellar Environmental Solutions
Sampler: JR	Start Date: 4/6/99
Well I.D.: MW-2	Well Diameter: 2 3 (4) 6 8 ___
Total Well Depth: 36'	Depth to Water: 19.60
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): YSI HACH

Purge Method: Bailer / Disposable Bailer / Middleburg / (Electric Submersible) / Extraction Pump / Other: ___

Sampling Method: Bailer / (Disposable Bailer) / Extraction Port / Other: ___

10.6 (Gals.) X 3 = 31.8 Gals.
1 Case Volume | Specified Volumes | Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius² * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
11:00	59.9	6.7	900	>200	11	cloudy
11:05	60.5	6.8	900	>200	22	turbid
11:10	58.1	6.7	800	>200	33	Ferrous Iron
						0.0 mg
						ND

Did well dewater? Yes (No) Gallons actually evacuated: 33

Sampling Time: 11:15 Sampling Date: 4/6/99

Sample I.D.: MW-2 Laboratory:

Analyzed for: (TPH-G) (BTEX) (MTBE) (TPH-D) Other: Nitrate + Sulfate

Equipment Blank I.D.: @ Time Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D Other:

D.O. (if req'd):	Pre-purge:	X mg/L	Post-purge:	6.8	mg/L
ORP (if req'd):	Pre-purge:	X mV	Post-purge:	−155	mV

WELL MONITORING DATA SHEET

Project #: 990406 R1	Client: Stellar Environmental Solutions
Sampler: JR	Start Date: 4/6/99
Well I.D.: MW-3	Well Diameter: 2 3 (4) 6 8 ___
Total Well Depth: 42'	Depth to Water: 18.65
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): YSI HACH

Purge Method: Bailer, Disposable Bailer, Middleburg, Electric Submersible, Extraction Pump, Other: ___

Sampling Method: Bailer, (Disposable Bailer), Extraction Port, Other: ___

— (Gals.) X — = — Gals.
1 Case Volume | Specified Volumes | Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius² * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
						Ferrous Iron
9:45	60.8	7.1	1000	30		0.02 mg
		NO	Purge	Q		

Did well dewater? Yes No — Gallons actually evacuated: —

Sampling Time: 9:45 — Sampling Date: 4/6/99

Sample I.D.: ~~Blank~~ MW-3 — Laboratory: —

Analyzed for: ~~TPH-G BTEX MTBE TPH-D~~ — Other: Nitrate, Sulfate

Equipment Blank I.D.: @ Time — Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D — Other:

D.O. (if req'd):	Pre-purge:	mg/L	Post-purge:	1.7	mg/L
ORP (if req'd):	Pre-purge:	mV	Post-purge:	53	mV

WELL MONITORING DATA SHEET

Project #: 990406 K-1	Client: Stellar Environmental Solutions
Sampler: SR	Start Date: 4/6/99
Well I.D.: MW-4	Well Diameter: 2 3 (4) 6 8 ____
Total Well Depth: 26'	Depth to Water: 12.51
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): YSI HACH

Purge Method: Bailer / Disposable Bailer / Middleburg / (Electric Submersible) Extraction Pump / Other: ____

Sampling Method: Bailer / (Disposable Bailer) / Extraction Port / Other: ____

8.7 (Gals.) X 3 = 26-1 Gals.
1 Case Volume | Specified Volumes | Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius² * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
10:32	68.5	7.2	800	40	9	
10:34	67.3	7.3	900	40	18	odor
10:37	67.5	7.3	1000	30	27	Ferrous Iron
						2.0 mg.

Did well dewater? Yes (No) Gallons actually evacuated: 27

Sampling Time: 10:450 Sampling Date: 4/6/99

Sample I.D.: MW-4 Laboratory:

Analyzed for: (TPH-G) (BTEX) (MTBE) (TPH-D) Other: Nitrate + Sulfate

Equipment Blank I.D.: @ Time Duplicate I.D.: MW-DA

Analyzed for: (TPH-G) (BTEX) (MTBE) ~~TPH-D~~ ~~Other:~~

D.O. (if req'd):	Pre-purge:	mg/L	Post-purge:	3.7 mg/L
ORP (if req'd):	Pre-purge:	mV	Post-purge:	268 mV

WELL MONITORING DATA SHEET

Project #: 990406 R1	Client: Stellar Environmental Solutions
Sampler: JR	Start Date: 4/6/99
Well I.D.: MW-5	Well Diameter: 2 3 (4) 6 8 ____
Total Well Depth: 26'	Depth to Water: 15.20
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): YSI HACH

Purge Method: Bailer, Disposable Bailer, Middleburg, Electric Submersible, Extraction Pump, Other: ____

Sampling Method: Bailer, ~~Disposable Bailer~~, Extraction Port, Other: ____

— (Gals.) X — = — Gals.
1 Case Volume | Specified Volumes | Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius² * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
						Farrows Iron
10:00	59.9	6.9	1100	10		0.02 mg.
		NO	Purge	0		

Did well dewater? Yes No — Gallons actually evacuated: —

Sampling Time: 1010 — Sampling Date: 4/6/99

Sample I.D.: MW-5 — Laboratory: —

Analyzed for: ~~TPH-G BTEX MTBE TPH-D~~ Other: Sulfate & Nitrate

Equipment Blank I.D.: @ Time — Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D Other:

D.O. (if req'd):	Pre-purge:	mg/L	Post-purge:	1.8	mg/L
ORP (if req'd):	Pre-purge:	mV	Post-purge:	64	mV

WELL MONITORING DATA SHEET

Project #: 990406 R-1	Client: Stellar Environmental Solutions
Sampler: SR	Start Date: 4/6/99
Well I.D.: MW-6	Well Diameter: 2 3 (4) 6 8 ____
Total Well Depth: 26'	Depth to Water: 12.72
Before: After:	Before: After:
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: (PVC) Grade	D.O. Meter (if req'd): YSI HACH

Purge Method: Bailer, Disposable Bailer, Middleburg, Electric Submersible, Extraction Pump, Other: _____

Sampling Method: Bailer, (Disposable Bailer), Extraction Port, Other: _____

____ (Gals.) X	____	= ____ Gals.
1 Case Volume	Specified Volumes	Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
2"	0.16	5"	1.02
3"	0.37	6"	1.47
4"	0.65	Other	radius² * 0.163

Time	Temp (°F)	pH	Cond.	Turbidity	Gals. Removed	Observations
						Ferrous Iron
10:15	62.8	7.2	1200	121	—	0.04 mg.
		NO	purge	&		cloudy

Did well dewater? Yes No — Gallons actually evacuated:

Sampling Time: 10:15 — Sampling Date: 4/6/99

Sample I.D.: MW-6 — Laboratory: —

Analyzed for: ~~TPH-G BTEX MTBE TPH-D~~ — Other: Nitrate & Sulfate

Equipment Blank I.D.: @ Time — Duplicate I.D.:

Analyzed for: TPH-G BTEX MTBE TPH-D — Other:

D.O. (if req'd):	Pre-purge:	2.2 mg/L	Post-purge:	mg/L
ORP (if req'd):	Pre-purge:	23 mV	Post-purge:	mV

STELLAR ENVIRONMENTAL SOLUTIONS

Chain of Custody Record

Laboratory: Curtis & Tompkins
Address: 2323 Fifth Street, Berkeley CA 94710

Method of Shipment: hand delivered
Shipment No.: —
Airbill No.: —
Cooler No.: —

Lab job no.:
Date:
Page ___ of ___

Client: STELLAR ENV. SOLUTIONS
Address: 2110 SIXTH ST, BERKELEY, CA
Project Manager: R. MAKDISI / BRUCE RUCKER
Telephone No.: (510) 644-3123
Fax. No.: 510 / 644-3859
Project Name: REDWOOD REG PARK
Project Number:
Samplers: (Signature) Bruce M. Rucker

Sample	DATE	TIME		Sample type	Type/Size of Container			Filtered	# of Containers	~~TPH-G~~	TVH + BTEX + MTBE	TPH-D	NITRATE	SULFATE
MW-1	4/6/99	1010		H_2O	1L poly				1				X	X
MW-2	↓	1115		↓	1L poly, VOAs, amber glass				4		X	X	X	X
MW-3		1015			1L poly				1				X	X
MW-4		1050			1L poly, VOAs, amber glass				4		X	X	X	X
MW-5		1020			1L poly				1				X	X
MW-6		1025			1L poly				1				X	X
MW-OA				(BR)	~~1L poly~~, VOAs				2		X			
SW-1		900			1L Poly, VOAs, amber glass				3 ~~4~~		X	X	~~X~~	~~X~~
SW-2		845			1L Poly, " "				3 ~~4~~		X	X	~~X~~	~~X~~
SW-3	↓	830		↓	1L Poly " "				3 ~~4~~		X	X	~~X~~	~~X~~

NO

Relinquished by:	Date	Received by:	Date	Relinquished by:	Date	Received by:	Date
Signature: B.M. Rucker	4/6/99	Signature: [signature]	4/6/99	Signature		Signature	
Printed: Bruce Rucker	Time	Printed: TRAVERS	Time	Printed	Time	Printed	Time
Company: Stellar Environmental	1200	Company: C&T	1200	Company		Company	
Reason: lab drop off				Reason			

Relinquished by:	Date	Received by:	Date
Signature		Signature	
Printed	Time	Printed	Time
Company		Company	
Reason			

Comments:

Curtis & Tompkins, Ltd., Analytical Laboratories, Since 1878
2323 Fifth Street, Berkeley, CA 94710, Phone (510) 486-0900, Fax (510) 486-0532

A N A L Y T I C A L R E P O R T

Prepared for:

Stellar Environmental Solutions
2110 6th Street
Berkeley, CA 94710

Date: 15-APR-99
Lab Job Number: 138787
Project ID: N/A
Location: Redwood Reg. Park

Reviewed by:

Reviewed by:

Curtis & Tompkins, Ltd.

Laboratory Number: **138787**
Client: **Stellar Environmental Solutions**
Project Name: **Redwood Reg. Park**

Receipt Date: **04/06/99**

CASE NARRATIVE

This hardcopy data package contains sample results and batch QC results for ten water samples received from the above referenced project. All samples were received cold and intact.

Total Volatile Hydrocarbons: The bromofluorobenzene surrogate recovery for sample MW-4 (138787-004) was outside acceptance limits due to matrix interference. The surrogate recovery has been flagged. No other analytical problems were encountered.

BTXE: No analytical problems were encountered.

Total Extractable Hydrocarbons: No analytical problems were encountered.

General Chemistry: No analytical problems were encountered.

STELLAR ENVIRONMENTAL SOLUTIONS

Chain of Custody Record

138787

Laboratory: Curtis & Tompkins
Address: 2323 Fifth Street
Berkeley CA 94710

Method of Shipment: hand delivered
Shipment No.: —
Airbill No.: —
Cooler No.: —

Lab job no.:
Date:
Page ___ of ___

Client: STELLAR ENV. SOLUTIONS
Address: 2110 SIXTH ST
BERKELEY, CA

Project Manager: R. MAKDISI / BRUCE RUCKER
Telephone No.: (510) 644-3123
Fax. No.: 510 / 644-3859

Project Name: REDWOOD REG PARK
Project Number: ___ | DATE | TIME |
Samplers: (Signature) Bruce M. Rucker

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Filtered	# of Containers	~~TPH-G~~	TVH + BTEX + MTBE	TPH-D	Nitrate	Sulfate
1	MW-1	4/6/99	1010		H_2O	1L poly				1				X	X
2	MW-2	↓	1115		↓	1L poly, VOAs, amber glass				4		X	X	X	X
3	MW-3		1015			1L poly				1				X	X
4	MW-4		1050			1L poly, VOAs, amber glass				4		X	X	X	X
5	MW-5		1020			1L poly				1				X	X
6	MW-6		1025			1L poly				1				X	X
7	MW-0A				(BR)	~~Dw~~, VOAs				2		X		X	X
8	SW-1		900			1L poly, VOAs, amber glass			3	~~4~~		X	X	~~X~~	~~X~~
9	SW-2		845			1L poly, " "			3	~~4~~		X	X	~~X~~	~~X~~
10	SW-3	↓	830		↓	1L poly " "			3	~~4~~		X	X	~~X~~	~~X~~
														NO	NO

Relinquished by:	Date	Received by:	Date	Relinquished by:	Date	Received by:	Date
Signature: B. M. Rucker	4/6/99	Signature: [signature]	4/6/99	Signature:		Signature:	
Printed: Bruce Rucker	Time	Printed: TRAVERS	Time	Printed:	Time	Printed:	Time
Company: Stellar Environmental	1200	Company: C & T	1200	Company:		Company:	
Reason: lab drop off				Reason:			

Relinquished by:	Date	Received by:	Date
Signature:		Signature:	
Printed:		Printed:	Time
Company:	Time	Company:	
Reason:			

Comments:

TVH-Total Volatile Hydrocarbons

Client: Stellar Environmental Solutions
Location: Redwood Reg. Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138787-002	MW-2	47277	04/06/99	04/07/99	04/07/99	
138787-004	MW-4	47277	04/06/99	04/08/99	04/08/99	
138787-007	MW-OA	47277	04/06/99	04/08/99	04/08/99	
138787-008	SW-1	47277	04/06/99	04/07/99	04/07/99	

Matrix: Water

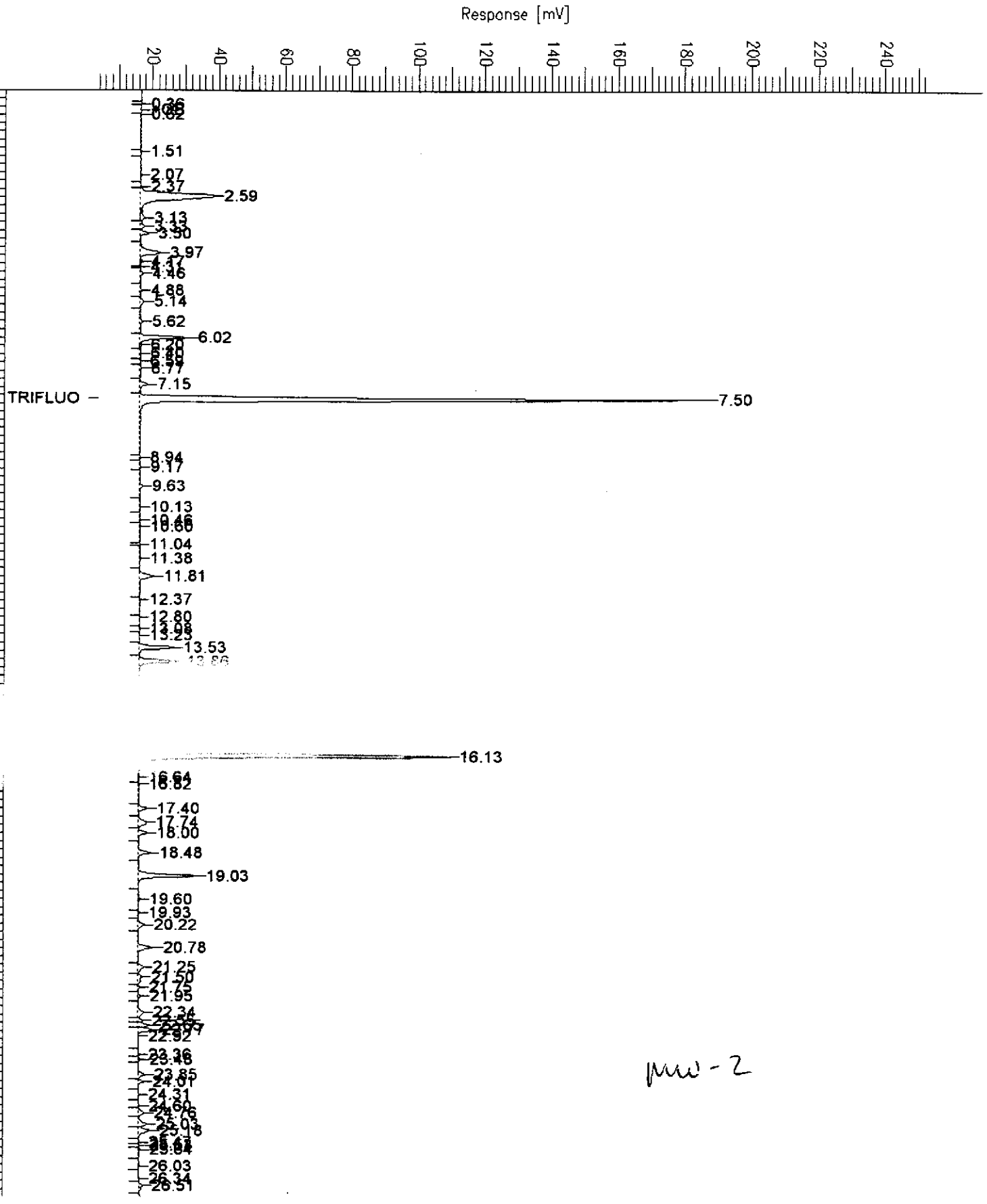
Analyte	Units	138787-002	138787-004	138787-007	138787-008
Diln Fac:		1	1	1	1
Gasoline C7-C12	ug/L	82	2900 H	2600 H	<50
Surrogate					
Trifluorotoluene	%REC	106	112	109	110
Bromofluorobenzene	%REC	102	154 *	146	106

* Values outside of QC limits
H: Heavier hydrocarbons than indicated standard

GC19 TVH 'X' Data File (FID)

Sample Name : 138787-002,47277
FileName : G:\GC19\DATA\097X009.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

Sample #: Page 1 of 1
Date : 4/7/99 08:58 PM
Time of Injection: 4/7/99 08:31 PM
Low Point : 3.90 mV High Point : 253.90 mV
Plot Scale: 250.0 mV

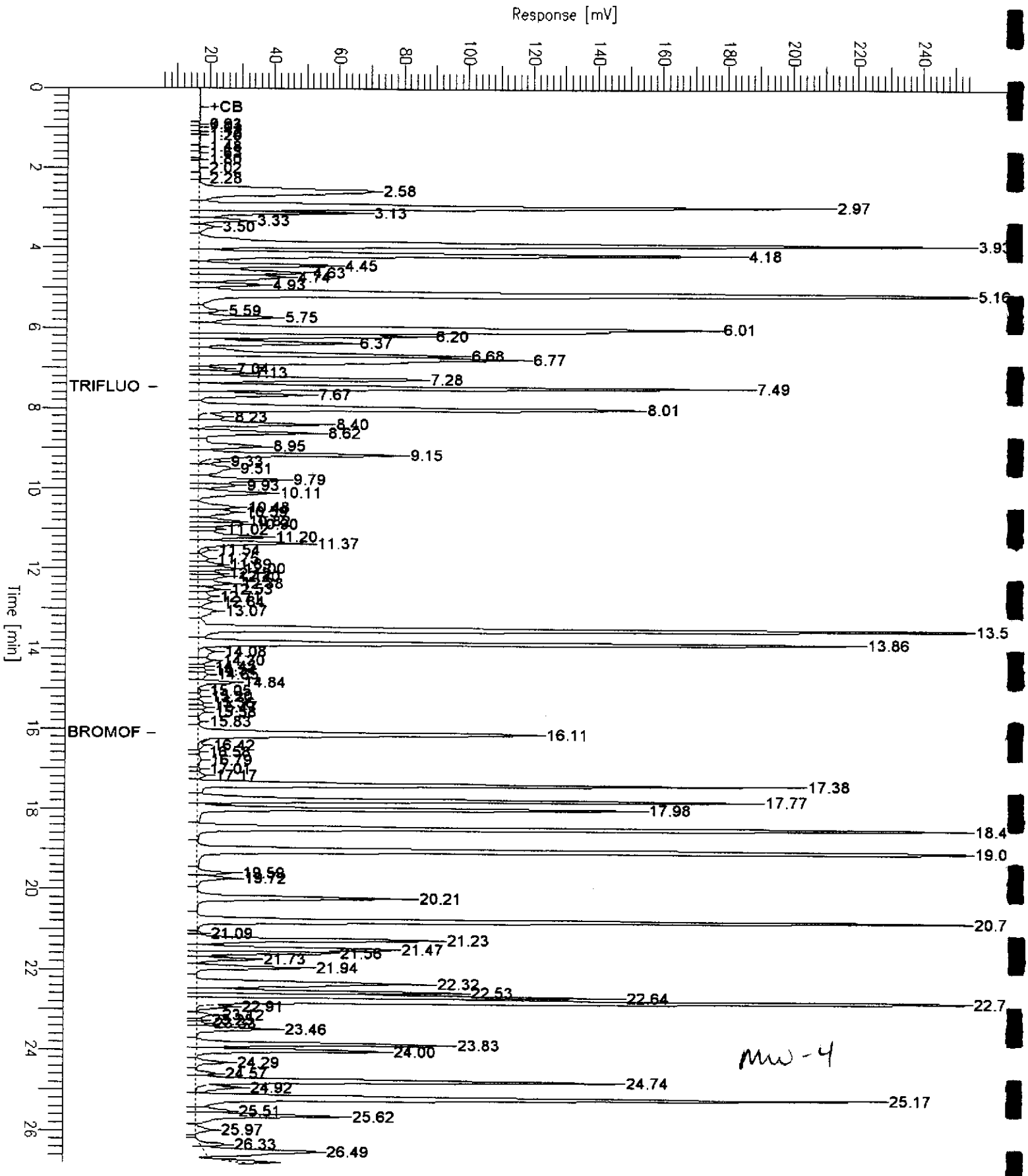


MW-2

GC19 TVH 'X' Data File (FID)

Sample Name : 138787-004,47277
FileName : G:\GC19\DATA\097X015.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

Sample #: Page 1 of 1
Date : 4/8/99 12:58 AM
Time of Injection: 4/8/99 12:31 AM
Low Point : 4.25 mV High Point : 254.25 mV
Plot Scale: 250.0 mV

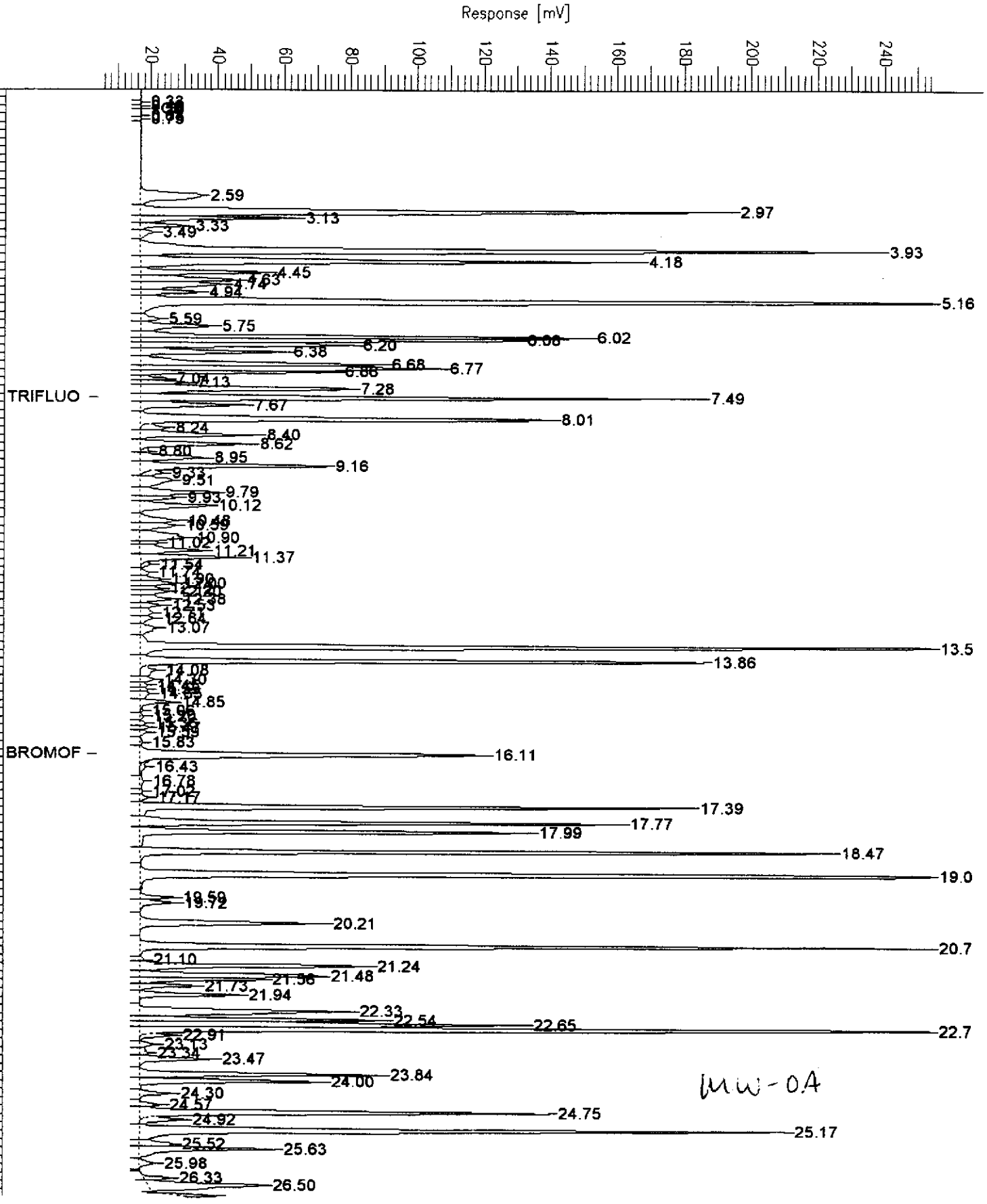


MW-4

GC19 TVH 'X' Data File (FID)

Sample Name : 138787-007,47277
FileName : G:\GC19\DATA\097X017.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

Sample #: Page 1 of 1
Date : 4/8/99 02:18 AM
Time of Injection: 4/8/99 01:51 AM
Low Point : 4.33 mV High Point : 254.33 mV
Plot Scale: 250.0 mV



MW-0A

TVH-Total Volatile Hydrocarbons

Client: Stellar Environmental Solutions
Location: Redwood Reg. Park
Analysis Method: EPA 8015M
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138787-009	SW-2	47277	04/06/99	04/07/99	04/07/99	
138787-010	SW-3	47277	04/06/99	04/07/99	04/07/99	

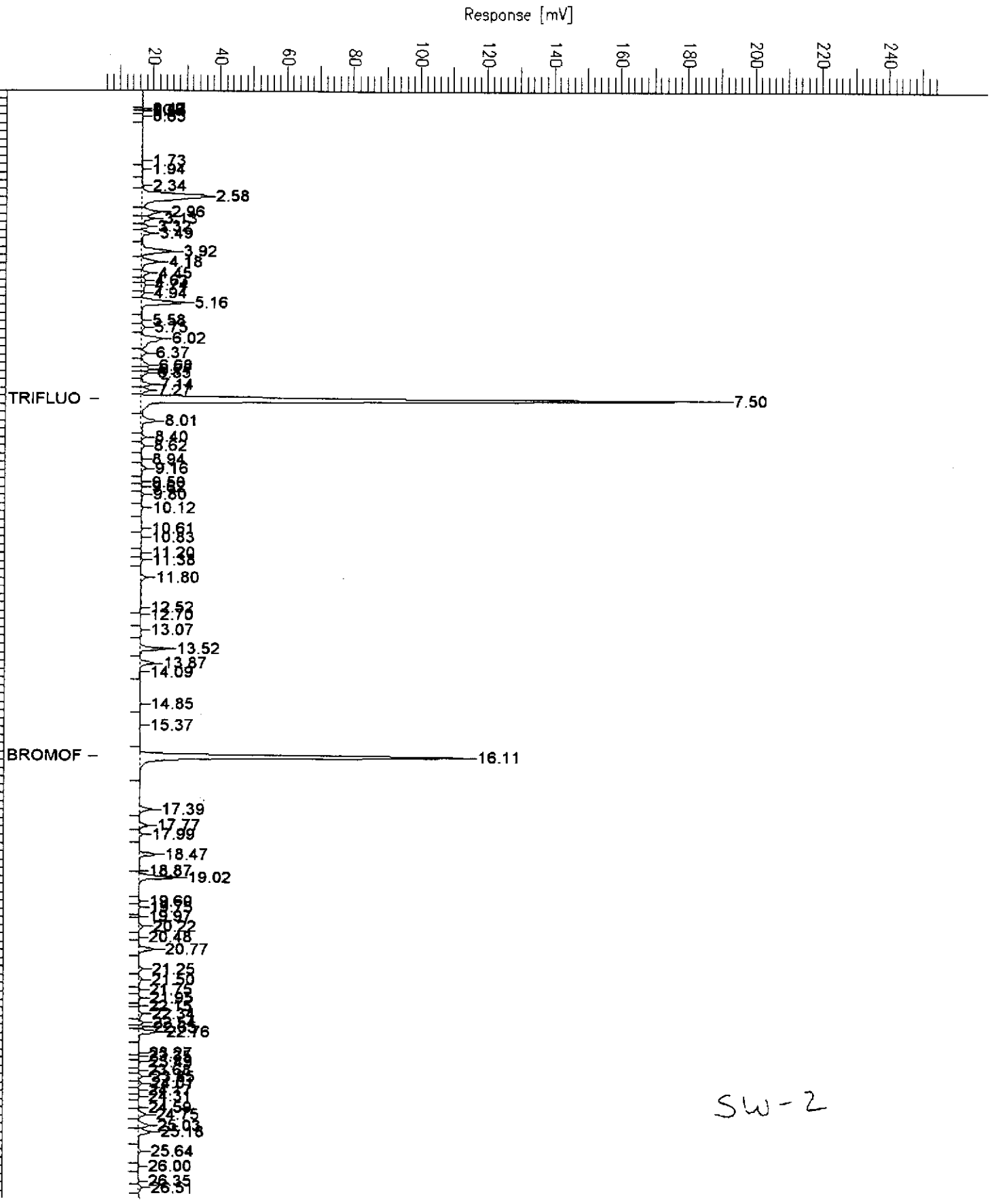
Matrix: Water

Analyte	Units	138787-009	138787-010
Diln Fac:		1	1
Gasoline C7-C12	ug/L	81	<50
Surrogate			
Trifluorotoluene	%REC	108	109
Bromofluorobenzene	%REC	106	106

GC19 TVH 'X' Data File (FID)

Sample Name : 138787-009,47277
FileName : G:\GC19\DATA\097X011.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

Sample #: Page 1 of 1
Date : 4/7/99 10:18 PM
Time of Injection: 4/7/99 09:51 PM
Low Point : 4.03 mV High Point : 254.03 mV
Plot Scale: 250.0 mV



SW-2

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Location:	Redwood Reg. Park	Prep Method:	EPA 5030

METHOD BLANK

Matrix:	Water	Prep Date:	04/07/99
Batch#:	47277	Analysis Date:	04/07/99
Units:	ug/L		
Diln Fac:	1		

MB Lab ID: QC94663

Analyte	Result
Gasoline C7-C12	<50

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	102	53-150
Bromofluorobenzene	100	53-149

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Location:	Redwood Reg. Park	Prep Method:	EPA 5030

LABORATORY CONTROL SAMPLE

Matrix:	Water	Prep Date:	04/07/99
Batch#:	47277	Analysis Date:	04/07/99
Units:	ug/L		
Diln Fac:	1		

LCS Lab ID: QC94661

Analyte	Result	Spike Added	%Rec #	Limits
Gasoline C7-C12	1708	2000	85	77-117

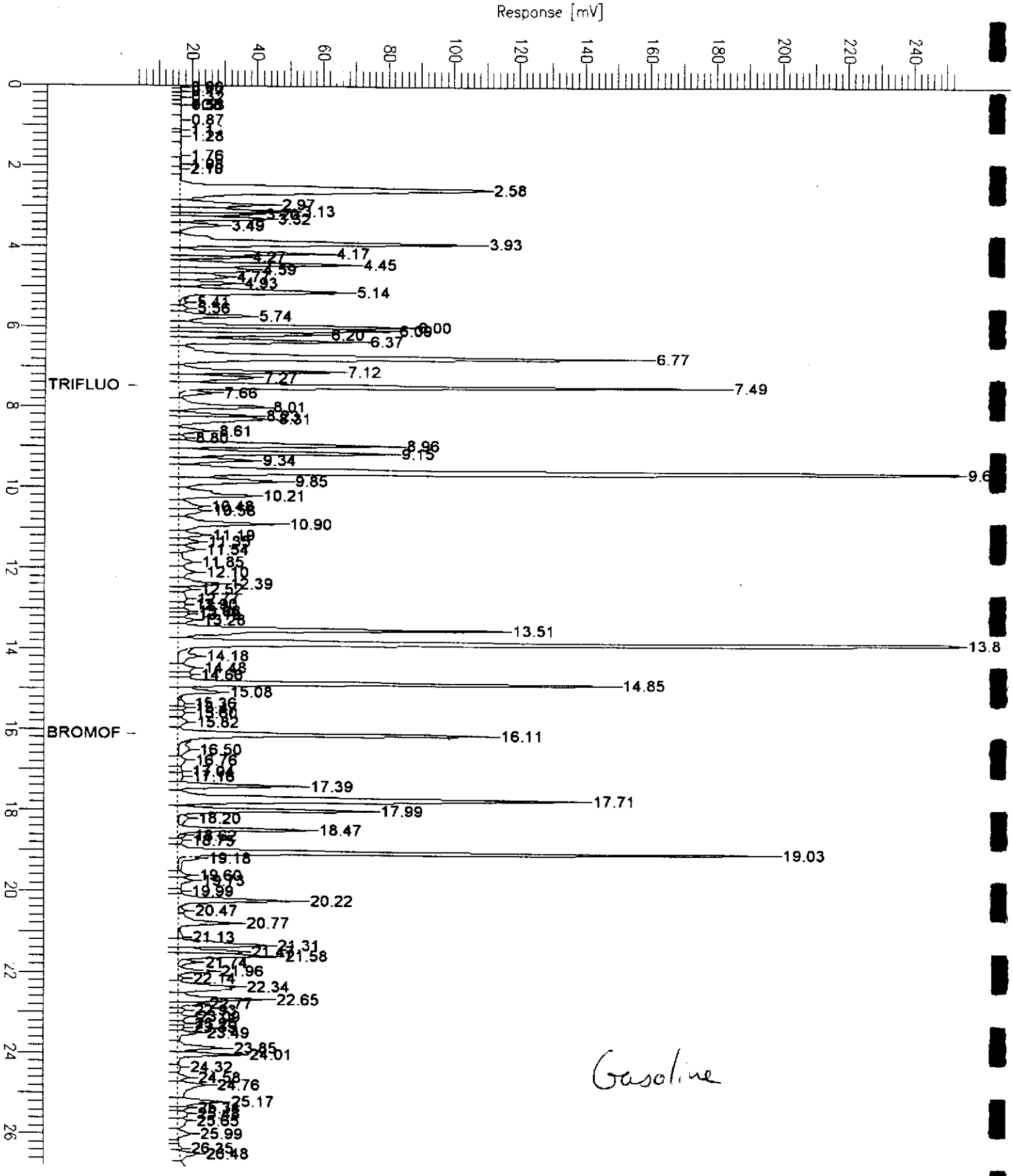
Surrogate	%Rec	Limits
Trifluorotoluene	106	53-150
Bromofluorobenzene	114	53-149

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

GC19 TVH 'X' Data File (FID)

Sample Name : CCV/LCS,QC94661,99WS7170,47277
FileName : G:\GC19\DATA\097X001.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

Sample #: GAS Page 1 of 1
Date : 4/7/99 12:33 PM
Time of Injection: 4/7/99 12:06 PM
Low Point : 3.98 mV High Point : 253.98 mV
Plot Scale: 250.0 mV



Gasoline

BTXE

Client: Stellar Environmental Solutions
Location: Redwood Reg. Park
Analysis Method: EPA 8021B
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138787-002	MW-2	47277	04/06/99	04/07/99	04/07/99	
138787-004	MW-4	47277	04/06/99	04/08/99	04/08/99	
138787-007	MW-OA	47277	04/06/99	04/08/99	04/08/99	
138787-008	SW-1	47277	04/06/99	04/07/99	04/07/99	

Matrix: Water

Analyte	Units	138787-002	138787-004	138787-007	138787-008
Diln Fac:		1	1	1	1
MTBE	ug/L	7.5	32	29	<2
Benzene	ug/L	4.2	61	50	<0.5
Toluene	ug/L	<0.5	1.2C	<0.5	<0.5
Ethylbenzene	ug/L	3.4	120	100	<0.5
m,p-Xylenes	ug/L	4	77	63	<0.5
o-Xylene	ug/L	<0.5	3.4	2.8	<0.5
Surrogate					
Trifluorotoluene	%REC	95	104	101	99
Bromofluorobenzene	%REC	97	114	110	100

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

BTXE

Client: Stellar Environmental Solutions
Location: Redwood Reg. Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138787-009	SW-2	47277	04/06/99	04/07/99	04/07/99	
138787-010	SW-3	47277	04/06/99	04/07/99	04/07/99	

Matrix: Water

Analyte	Units	138787-009	138787-010
Diln Fac:		1	1
MTBE	ug/L	2.3	<2
Benzene	ug/L	2	<0.5
Toluene	ug/L	<0.5	<0.5
Ethylbenzene	ug/L	2.5	<0.5
m,p-Xylenes	ug/L	1.3	<0.5
o-Xylene	ug/L	<0.5	<0.5
Surrogate			
Trifluorotoluene	%REC	100	99
Bromofluorobenzene	%REC	99	100

BTXE

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8021B
Location:	Redwood Reg. Park	Prep Method:	EPA 5030

METHOD BLANK

Matrix:	Water	Prep Date:	04/07/99
Batch#:	47277	Analysis Date:	04/07/99
Units:	ug/L		
Diln Fac:	1		

MB Lab ID: QC94663

Analyte	Result
MTBE	<2.0
Benzene	<0.5
Toluene	<0.5
Ethylbenzene	<0.5
m,p-Xylenes	<0.5
o-Xylene	<0.5

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	92	51-143
Bromofluorobenzene	92	37-146

Lab #: 138787

BATCH QC REPORT

Curtis & Tompkins, Ltd.

BTXE

Client: Stellar Environmental Solutions
Location: Redwood Reg. Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

LABORATORY CONTROL SAMPLE

Matrix: Water
Batch#: 47277
Units: ug/L
Diln Fac: 1

Prep Date: 04/07/99
Analysis Date: 04/07/99

LCS Lab ID: QC94662

Analyte	Result	Spike Added	%Rec #	Limits
MTBE	16.84	20	84	66-126
Benzene	17.6	20	88	65-111
Toluene	19.11	20	96	76-117
Ethylbenzene	19.27	20	96	71-121
m,p-Xylenes	40.23	40	101	80-123
o-Xylene	19.08	20	95	75-127

Surrogate	%Rec	Limits
Trifluorotoluene	91	51-143
Bromofluorobenzene	93	37-146

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits
Spike Recovery: 0 out of 6 outside limits

BTXE

Client: Stellar Environmental Solutions
Location: Redwood Reg. Park
Analysis Method: EPA 8021B
Prep Method: EPA 5030

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Field ID: SW-3
Lab ID: 138787-010
Matrix: Water
Batch#: 47277
Units: ug/L
Diln Fac: 1
Sample Date: 04/06/99
Received Date: 04/06/99
Prep Date: 04/07/99
Analysis Date: 04/07/99

MS Lab ID: QC94664

Analyte	Spike Added	Sample	MS	%Rec #	Limits
MTBE	20	<2	18.28	91	49-136
Benzene	20	<0.5	18.77	94	55-122
Toluene	20	<0.5	20.36	102	63-139
Ethylbenzene	20	<0.5	20.51	103	61-137
m,p-Xylenes	40	<0.5	42.56	106	57-148
o-Xylene	20	<0.5	20.11	101	70-141

Surrogate	%Rec	Limits
Trifluorotoluene	98	51-143
Bromofluorobenzene	100	37-146

MSD Lab ID: QC94665

Analyte	Spike Added	MSD	%Rec #	Limits	RPD #	Limit
MTBE	20	19.26	96	49-136	5	11
Benzene	20	19.11	96	55-122	2	10
Toluene	20	20.62	103	63-139	1	10
Ethylbenzene	20	20.92	105	61-137	2	10
m,p-Xylenes	40	43.38	108	57-148	2	10
o-Xylene	20	20.65	103	70-141	3	10

Surrogate	%Rec	Limits
Trifluorotoluene	98	51-143
Bromofluorobenzene	101	37-146

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits
RPD: 0 out of 6 outside limits
Spike Recovery: 0 out of 12 outside limits

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Location: Redwood Reg. Park
Analysis Method: EPA 8015M
Prep Method: EPA 3520

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138787-002	MW-2	47325	04/06/99	04/08/99	04/10/99	
138787-004	MW-4	47325	04/06/99	04/08/99	04/10/99	
138787-008	SW-1	47325	04/06/99	04/08/99	04/10/99	
138787-009	SW-2	47325	04/06/99	04/08/99	04/10/99	

Matrix: Water

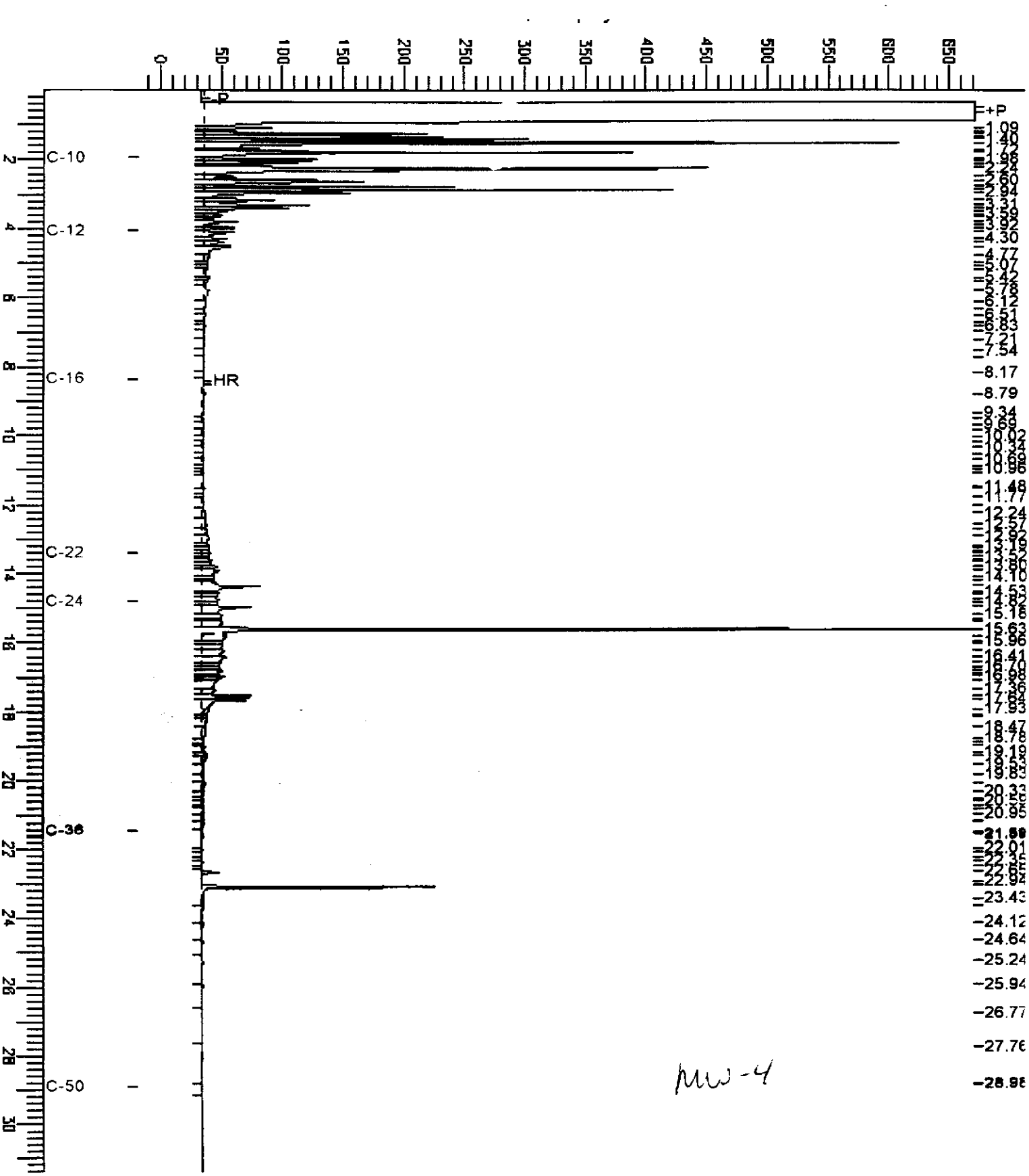
Analyte	Units	138787-002	138787-004	138787-008	138787-009
Diln Fac:		1	1	1	1
Diesel C10-C24	ug/L	<50	710 YLH	<50	<50
Surrogate					
Hexacosane	%REC	71	67	79	68

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

Chromatogram

Sample Name : 138787-004,47325
FileName : G:\GC11\CHA\098A057.RAW
Method : ATEH055.MTH
Start Time : 0.01 min End Time : 31.47 min
Scale Fact : 0.0 Plot Offset: -19 mV

Sample #: 47325 Page 1 of 1
Date : 4/12/99 08:03 PM
Time of Injection: 4/10/99 10:22 AM
Low Point : -19.10 mV High Point : 672.33 mV
Plot Scale: 691.4 mV



MW-4

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Location: Redwood Reg. Park
Analysis Method: EPA 8015M
Prep Method: EPA 3520

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138787-010	SW-3	47325	04/06/99	04/08/99	04/10/99	

Matrix: Water

Analyte	Units	138787-010
Diln Fac:		1
Diesel C10-C24	ug/L	<50
Surrogate		
Hexacosane	%REC	78

TEH-Tot Ext Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Location:	Redwood Reg. Park	Prep Method:	EPA 3520

METHOD BLANK

Matrix:	Water	Prep Date:	04/08/99
Batch#:	47325	Analysis Date:	04/10/99
Units:	ug/L		
Diln Fac:	1		

MB Lab ID: QC94868

Analyte	Result
Diesel C10-C24	<50

Surrogate	%Rec	Recovery Limits
Hexacosane	66	58-128

Lab #: 138787

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Location: Redwood Reg. Park
Analysis Method: EPA 8015M
Prep Method: EPA 3520

BLANK SPIKE/BLANK SPIKE DUPLICATE

Matrix: Water
Batch#: 47325
Units: ug/L
Diln Fac: 1
Prep Date: 04/08/99
Analysis Date: 04/11/99

BS Lab ID: QC94869

Analyte	Spike Added	BS	%Rec #	Limits
Diesel C10-C24	2475	1630	66	50-114

Surrogate	%Rec	Limits
Hexacosane	75	58-128

BSD Lab ID: QC94870

Analyte	Spike Added	BSD	%Rec #	Limits	RPD #	Limit
Diesel C10-C24	2475	1536	62	50-114	6	25

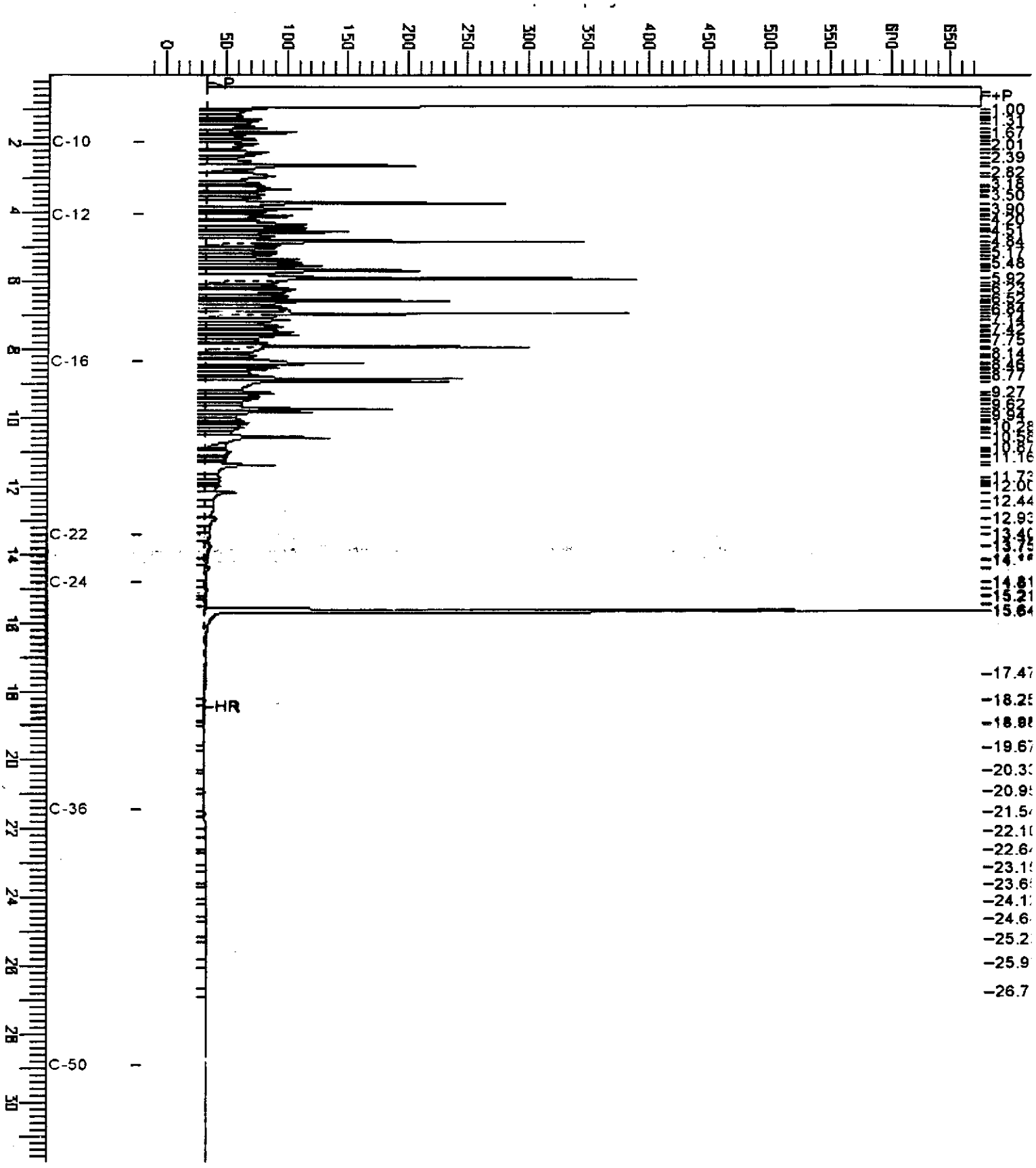
Surrogate	%Rec	Limits
Hexacosane	71	58-128

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

Chromatogram

Sample Name : ccv,99ws7346,dsl
FileName : G:\GC11\CHA\098A050.RAW
Method : ATEH055.MTH
Start Time : 0.01 min End Time : 31.79 min
Scale Factor: 0.0 Plot Offset: -19 mV

Sample #: 500mg/l
Date : 4/12/99 12:43 PM
Time of Injection: 4/10/99 05:40 AM
Low Point : -18.53 mV High Point : 676.44 mV
Plot Scale: 695.0 mV



DIESEL STANDARD

Curtis & Tompkins, Ltd.

Nitrogen,Nitrate

Client: Stellar Environmental Solutions
Location : Redwood Reg. Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
138787-001	MW-1	47246	06-APR-99	06-APR-99	-
138787-002	MW-2	47246	06-APR-99	06-APR-99	-
138787-003	MW-3	47246	06-APR-99	06-APR-99	-
138787-004	MW-4	47246	06-APR-99	06-APR-99	-
138787-005	MW-5	47246	06-APR-99	06-APR-99	-
138787-006	MW-6	47246	06-APR-99	06-APR-99	-
QC94562	Method Blank	47246	-	06-APR-99	-

Analyte: Nitrogen, Nitrate **Matrix:** Water **Units:** mg/L

Sample #	Client ID	Result	Reporting Limit	Dilution Factor
138787-001	MW-1	ND	1.0	20
138787-002	MW-2	ND	1.0	20
138787-003	MW-3	ND	1.0	20
138787-004	MW-4	ND	1.0	20
138787-005	MW-5	ND	1.0	20
138787-006	MW-6	ND	1.0	20
QC94562	Method Blank	ND	0.050	1

ND = None Detected at or above Reporting Limit

Curtis & Tompkins, Ltd.

Nitrogen,Nitrate

Client: Stellar Environmental Solutions
Location : Redwood Reg. Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
QC94563	Blank Spike	47246	-	06-APR-99	-
QC94564	Blank Spike Duplicate	47246	-	06-APR-99	-

Analyte: Nitrogen, Nitrate **Matrix:** Water **Units:** mg/L

Sample #	Sample Type	Spike Amt.	Result	%Rec	Limits	%RPD	Limit
QC94563	Blank Spike	2.260	2.280	101	80-120		
QC94564	Blank Spike Duplicate	2.260	2.270	100	80-120	1	25

Curtis & Tompkins, Ltd.

Nitrogen,Nitrate

Client: Stellar Environmental Solutions
Location : Redwood Reg. Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
QC94565	MS of 138761-001	47246	05-APR-99	06-APR-99	-
QC94566	MSD of 138761-001	47246	05-APR-99	06-APR-99	-

Analyte: Nitrogen, Nitrate **Matrix:** Water **Units:** mg/L

Sample #	Client ID	Spikeamt	Result	%Rec	Limits	%RPD	Limit
QC94565	MS of 138761-001	5.650	5.860	100	75-125		
QC94566	MSD of 138761-001	5.650	5.770	99	75-125	2	35
138761-001	ZZZZZZZZ		<0.2500				

Curtis & Tompkins, Ltd.

Sulfate

Client: Stellar Environmental Solutions
Location : Redwood Reg. Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
138787-001	MW-1	47246	06-APR-99	06-APR-99	-
138787-002	MW-2	47246	06-APR-99	06-APR-99	-
138787-003	MW-3	47246	06-APR-99	06-APR-99	-
138787-004	MW-4	47246	06-APR-99	06-APR-99	-
138787-005	MW-5	47246	06-APR-99	06-APR-99	-
138787-006	MW-6	47246	06-APR-99	06-APR-99	-
QC94562	Method Blank	47246	-	06-APR-99	-

Analyte: Sulfate **Matrix:** Water **Units:** mg/L

Sample #	Client ID	Result	Reporting Limit	Dilution Factor
138787-001	MW-1	150	10	20
138787-002	MW-2	100	10	20
138787-003	MW-3	42	10	20
138787-004	MW-4	19	10	20
138787-005	MW-5	24	10	20
138787-006	MW-6	86	10	20
QC94562	Method Blank	ND	0.50	1

ND = None Detected at or above Reporting Limit

Curtis & Tompkins, Ltd.

Sulfate

Client: Stellar Environmental Solutions
Location : Redwood Reg. Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
QC94563	Blank Spike	47246	-	06-APR-99	-
QC94564	Blank Spike Duplicate	47246	-	06-APR-99	-

Analyte: Sulfate **Matrix:** Water **Units:** mg/L

Sample #	Sample Type	Spike Amt.	Result	%Rec	Limits	%RPD	Limit
QC94563	Blank Spike	15.00	14.84	99	80-120		
QC94564	Blank Spike Duplicate	15.00	14.95	100	80-120	1	25

Curtis & Tompkins, Ltd.

Sulfate

Client: Stellar Environmental Solutions
Location : Redwood Reg. Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
QC94565	MS of 138761-001	47246	06-APR-99	06-APR-99	-
QC94566	MSD of 138761-001	47246	06-APR-99	06-APR-99	-

Analyte: Sulfate **Matrix:** Water **Units:** mg/L

Sample #	Client ID	Spikeamt	Result	%Rec	Limits	%RPD	Limit
QC94565	MS of 138761-001	37.50	39.76	97	75-125		
QC94566	MSD of 138761-001	37.50	40.14	98	75-125	1	35

ALAMEDA COUNTY PUBLIC WORKS AGENCY

WATER RESOURCES SECTION
951 TURNER COURT, SUITE 300, HAYWARD, CA 94545-2651
PHONE (510) 670-5575 ANDREAS GODFREY FAX (510) 670-5262
(510) 670-5248 ALVIN KAN

DRILLING PERMIT APPLICATION

FOR APPLICANT TO COMPLETE

LOCATION OF PROJECT Redwood Regional Park Service Yard
7867 Redwood Rd. Oakland CA

California Coordinates Source _____ ft. Accuracy ± ___ ft.
CCN _____ ft. CCE _____ ft.
APN _____

CLIENT
Name East Bay Regional Park District (Mr. Warren Gee)
Address P.O. Box 5381 Phone 635-0135
City Oakland CA Zip 94605

APPLICANT
Name Stellar Environmental Solutions
Mr. Bruce Rueker Fax 510/644-3859
Address 2110 Sixth Street Phone 510/644-3123
City Berkeley CA Zip 94710

TYPE OF PROJECT

Well Construction		Geotechnical Investigation	
Cathodic Protection	☐	General	☐
Water Supply	☐	Contamination	☒
Monitoring	☐	Well Destruction	☐

PROPOSED WATER SUPPLY WELL USE

New Domestic	☐	Replacement Domestic	☐
Municipal	☐	Irrigation	☐
Industrial	☐	Other _____	☐

DRILLING METHOD:

Mud Rotary	☐	Air Rotary	☐	Auger	☐
Cable	☐	Other	☒ Geoprobe		

DRILLER'S LICENSE NO. 683865

WELL PROJECTS
Drill Hole Diameter _____ in. Maximum
Casing Diameter _____ in. Depth _____ ft.
Surface Seal Depth _____ ft. Number _____

GEOTECHNICAL PROJECTS
Number of Borings 10 Maximum
Hole Diameter 2 in. Depth 25 ft.

ESTIMATED STARTING DATE 4/14/99
ESTIMATED COMPLETION DATE 4/15/99

I hereby agree to comply with all requirements of this permit and Alameda County Ordinance No. 73-68.

APPLICANT'S SIGNATURE Bruce M. Rueker DATE 4/13/99

FOR OFFICE USE

PERMIT NUMBER 99WR188
WELL NUMBER _____
APN _____

PERMIT CONDITIONS

Circled Permit Requirements Apply

A. GENERAL
1. A permit application should be submitted so as to arrive at the ACPWA office five days prior to proposed starting date.
2. Submit to ACPWA within 60 days after completion of permitted work the original Department of Water Resources Water Well Drillers Report or equivalent for well projects, or drilling logs and location sketch for geotechnical projects.
3. Permit is void if project not begun within 90 days of approval date.

B. WATER SUPPLY WELLS
1. Minimum surface seal thickness is two inches of cement grout placed by tremie.
2. Minimum seal depth is 50 feet for municipal and industrial wells or 20 feet for domestic and irrigation wells unless a lesser depth is specially approved.

C. GROUNDWATER MONITORING WELLS INCLUDING PIEZOMETERS
1. Minimum surface seal thickness is two inches of cement grout placed by tremie.
2. Minimum seal depth for monitoring wells is the maximum depth practicable or 20 feet.

D. GEOTECHNICAL
Backfill bore hole with compacted cuttings or heavy bentonite and upper two feet with compacted material. In areas of known or suspected contamination, tremied cement grout shall be used in place of compacted cuttings.

E. CATHODIC
Fill hole above anode zone with concrete placed by tremie.

F. WELL DESTRUCTION
See attached.

G. SPECIAL CONDITIONS

APPROVED [signature] DATE 5-3-99

Subject: GeoProbe rig at borehole HP-01, looking east.	
Site: Redwood Regional Park Service Yard Fuel Leak Site, Oakland California	
Date Taken: April 14 and 15, 1999	Project No.: SES99012
Photographer: B. Rucker	Photo No.: 01

Subject: GeoProbe rig at borehole HP-02, looking west.	
Site: Redwood Regional Park Service Yard Fuel Leak Site, Oakland California	
Date Taken: April 14 and 15, 1999	Project No.: SES99012
Photographer: B. Rucker	Photo No.: 02

Subject: GeoProbe rig at borehole HP-04, looking south, with monitoring well MW-5 in the background.	
Site: Redwood Regional Park Service Yard Fuel Leak Site, Oakland California	
Date Taken: April 14 and 15, 1999	Project No.: SES99012
Photographer: B. Rucker	Photo No.: 03

Subject: GeoProbe rig at borehole HP-07, looking north, showing locations HP-05 and HP-06 (marked by cones) in the foreground.	
Site: Redwood Regional Park Service Yard Fuel Leak Site, Oakland California	
Date Taken: April 14 and 15, 1999	Project No.: SES99012
Photographer: B. Rucker	Photo No.: 04

Subject: GeoProbe rig at borehole HP-09, looking north.	
Site: Redwood Regional Park Service Yard Fuel Leak Site, Oakland California	
Date Taken: April 14 and 15, 1999	Project No.: SES99012
Photographer: B. Rucker	Photo No.: 05

Subject: GeoProbe rig at borehole HP-10, looking north.	
Site: Redwood Regional Park Service Yard Fuel Leak Site, Oakland California	
Date Taken: April 14 and 15, 1999	Project No.: SES99012
Photographer: B. Rucker	Photo No.: 06

Subject: Temporary well point at HP-11, adjacent to Redwood Creek, prior to damming and purging pit to remove stream water	
Site: Redwood Regional Park Service Yard Fuel Leak Site, Oakland California	
Date Taken: May 22, 1999	Project No.: SES99012
Photographer: B. Rucker	Photo No.: 07

Subject: Borehole HP-11, adjacent to Redwood Creek – white bailer at right shows top of visibly contaminated soil ("smear zone")	
Site: Redwood Regional Park Service Yard Fuel Leak Site, Oakland California	
Date Taken: May 22, 1999	Project No.: SES99012
Photographer: B. Rucker	Photo No.: 08

Stellar Environmental Solutions
2110 Sixth Street, Berkeley, CA 94710
Geoscience & Engineering Consulting

Soil Boring Log

BORING NUMBER HP-01 Page 1 of 1

PROJECT Redwood Reg. Park Serv. Yard
OWNER East Bay Regional Park District
LOCATION Oakland, CA
PROJECT NUMBER 99012
TOTAL DEPTH 18 feet
BOREHOLE DIA. 2-inch
SURFACE ELEV. Unknown
WATER FIRST ENCOUNTERED ~16.5 feet
DRILLING COMPANY Fisch Environmental
DRILLING METHOD GeoProbe
DRILLER Flint
GEOLOGIST B. Rucker
DATE DRILLED 4/14/99

DEPTH (feet)	GRAPHIC LOG	SAMPLE INTERVAL/ RECOVERY	BLOW COUNTS	INSTRUMENT READING	DESCRIPTION/SOIL CLASSIFICATION	REMARKS
0				(PID)	Light brown clayey silt (ML), dry, sl. stiff	
2						
4					Color change to red brown, minor gravel, soft	
6						
8				0		
10				0	Becomes wet at 10-13′ (perched water zone)	
12				0		No odor or staining noted in samples
14				0	Becomes gravelly (small-medium) (30-40%) at 13′, sl. stiff, moist	
16				0	Silty clay (CL), same as above	
					Color change to green brown, gravel is small (10-20%), wet	Temporary well point screened from 16 to 20′
18		HP-01-17.5′		0	Bottom of soil core = 18′	
20						

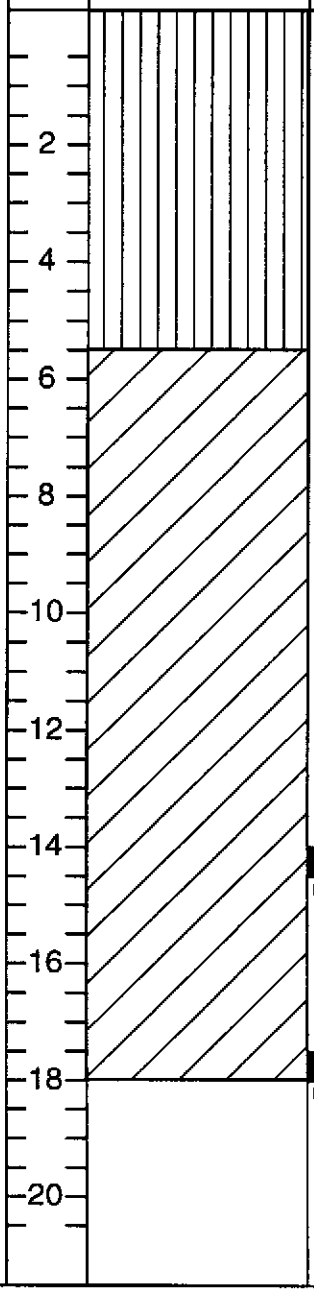
99012-1

Stellar Environmental Solutions
2110 Sixth Street, Berkeley, CA 94710
Geoscience & Engineering Consulting

Soil Boring Log

BORING NUMBER HP-02 Page 1 of 1

PROJECT Redwood Reg. Park Serv. Yard
OWNER East Bay Regional Park District
LOCATION Oakland, CA
PROJECT NUMBER 99012
TOTAL DEPTH 18 feet
BOREHOLE DIA. 2-inch
SURFACE ELEV. Unknown
WATER FIRST ENCOUNTERED ~15.5 feet
DRILLING COMPANY Fisch Environmental
DRILLING METHOD GeoProbe
DRILLER Flint
GEOLOGIST B. Rucker
DATE DRILLED 4/14/99



DEPTH (feet)	INSTRUMENT READING	DESCRIPTION/SOIL CLASSIFICATION	REMARKS
	(PID)	Light brown clayey silt (ML), dry, minor organics	
		Orange brown silty clay (CL), sl. stiff, sl. moist, sl. plastic	
	0		Petroleum odor noted beginning at approximately 12' bgs
	10	13' color change to blue-grey, slight mottling	Equilibrated water level = 9.8'
	41		
	2,200	14.5' becomes gravelly (small) (40-60%) stiff	
	2,914		
	1,293	15' becomes sandy (fine) and gravelly (20-30%)	
	164	15.5' becomes soft & wet	
	193		
		Orange brown weathered siltstone, friable, wet	
		18' Bottom of borehole	

99012-2

Stellar Environmental Solutions
2110 Sixth Street, Berkeley, CA 94710
Geoscience & Engineering Consulting

Soil Boring Log

BORING NUMBER HP-03 Page 1 of 1

PROJECT Redwood Reg. Park Serv. Yard
OWNER East Bay Regional Park District
LOCATION Oakland, CA
PROJECT NUMBER 99012
TOTAL DEPTH 16 feet
BOREHOLE DIA. 2-inch
SURFACE ELEV. Unknown
WATER FIRST ENCOUNTERED ~13.5 feet
DRILLING COMPANY Fisch Environmental
DRILLING METHOD GeoProbe
DRILLER Flint
GEOLOGIST B. Rucker
DATE DRILLED 4/14/99

DEPTH (feet)	GRAPHIC LOG	SAMPLE INTERVAL/ RECOVERY	BLOW COUNTS	INSTRUMENT READING	DESCRIPTION/SOIL CLASSIFICATION	REMARKS
0				(PID)	Light brown clayey silt (ML), dry, minor small gravel	
2						
4						Equilibrated water level = 11.0′
6						
8					Red brown silty clay (CH), soft, sl. moist, plastic, minor organics	
10						
12				4 28	12.5′ minor gravel	
14		HP-03-13′		13 294	13.5′ color change to blue grey, wet	
16				~~935~~ 915	14.5′ becomes sandy, silty clay, mod. stiff, moist	
18					16′ Bottom of borehole	
20						

99012-2

Stellar Environmental Solutions
2110 Sixth Street, Berkeley, CA 94710
Geoscience & Engineering Consulting

Soil Boring Log

BORING NUMBER HP-04 Page 1 of 1

PROJECT Redwood Reg. Park Serv. Yard
OWNER East Bay Regional Park District
LOCATION Oakland, CA
PROJECT NUMBER 99012
TOTAL DEPTH 19 feet
BOREHOLE DIA. 2-inch
SURFACE ELEV. Unknown
WATER FIRST ENCOUNTERED ~17.5 feet
DRILLING COMPANY Fisch Environmental
DRILLING METHOD GeoProbe
DRILLER Flint
GEOLOGIST B. Rucker
DATE DRILLED 4/14/99

DEPTH (feet)	GRAPHIC LOG	SAMPLE INTERVAL/ RECOVERY	BLOW COUNTS	INSTRUMENT READING	DESCRIPTION/SOIL CLASSIFICATION	REMARKS
0				(PID)	Light brown clayey silt (ML), dry, organics	Equilibrated water level = 11.9′
8					Red brown silty clay (CH), soft, plastic, sl. moist, minor small gravel Becomes wet from 9′-11′	
12	Siltstone			0 6 12	13-13.5′ lens of weathered siltstone	
14				0	Red brown silty clay (as above)	
16		HP-04-15′		0 0		
18				0 0	17.5′ becomes gravelly clay (small, 40-60%), wet	
20					19′ Bottom of borehole	

99012-4

Stellar Environmental Solutions
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Geoscience & Engineering Consulting

Soil Boring Log

BORING NUMBER HP-05 Page 1 of 1

PROJECT Redwood Reg. Park Serv. Yard
OWNER East Bay Regional Park District
LOCATION Oakland, CA
PROJECT NUMBER 99012
TOTAL DEPTH 20 feet
BOREHOLE DIA. 2-inch
SURFACE ELEV. Unknown
WATER FIRST ENCOUNTERED ~19 feet
DRILLING COMPANY Fisch Environmental
DRILLING METHOD GeoProbe
DRILLER Flint
GEOLOGIST B. Rucker
DATE DRILLED 4/14/99

DEPTH (feet)	GRAPHIC LOG	SAMPLE INTERVAL/ RECOVERY	BLOW COUNTS	INSTRUMENT READING	DESCRIPTION/SOIL CLASSIFICATION	REMARKS
0				(PID)	Light brown clayey silt (ML), dry	Equilibrated water level = 8.8′
6					Dark brown-black silty clay (CH), soft, v. moist, plastic	
10	Siltstone				Yellow brown weathered siltstone, dry, friable	
12				0	Dark brown silty clay (CH), soft, moist, plastic	
14				0	14.5′ 6-inch gravel lens	
16		HP-05-15′		0	15.5′ becomes sl. stiff, sl. moist	
18				0	18′ becomes gravelly (small-med) (20-30%)	
20				0	19′ becomes v. moist 20′ weathered siltstone, wet	
					20′ Bottom of borehole	

99012-5

Stellar Environmental Solutions
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Geoscience & Engineering Consulting

Soil Boring Log

BORING NUMBER HP-06 Page 1 of 1

PROJECT Redwood Reg. Park Serv. Yard
OWNER East Bay Regional Park District
LOCATION Oakland, CA
PROJECT NUMBER 99012
TOTAL DEPTH 12 feet
BOREHOLE DIA. 2-inch
SURFACE ELEV. Unknown
WATER FIRST ENCOUNTERED ~11.5 feet
DRILLING COMPANY Fisch Environmental
DRILLING METHOD GeoProbe
DRILLER Flint
GEOLOGIST B. Rucker
DATE DRILLED 4/14/99

DEPTH (feet)	GRAPHIC LOG	SAMPLE INTERVAL/ RECOVERY	BLOW COUNTS	INSTRUMENT READING	DESCRIPTION/SOIL CLASSIFICATION	REMARKS
0				(PID)	Light brown clayey silt (ML), dry	Equilibrated water level = 7.3′
8				0	Dark brown silty clay, sl. stiff, moist	
10				13	10′ becomes stiff, sl. moist	
				447	10.5′ color change to blue-grey, petroleum odor	
				679		
12		HP-06-11′ & HP-06-11.5′		618	11.5′ becomes wet	
					12′ Bottom of borehole	

99012-6

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Geoscience & Engineering Consulting

Soil Boring Log

BORING NUMBER HP-07 Page 1 of 1

PROJECT Redwood Reg. Park Serv. Yard
OWNER East Bay Regional Park District
LOCATION Oakland, CA
PROJECT NUMBER 99012
TOTAL DEPTH 16 feet
BOREHOLE DIA. 2-inch
SURFACE ELEV. Unknown
WATER FIRST ENCOUNTERED ~12.5 feet
DRILLING COMPANY Fisch Environmental
DRILLING METHOD GeoProbe
DRILLER Flint
GEOLOGIST B. Rucker
DATE DRILLED 4/14/99

DEPTH (feet)	GRAPHIC LOG	SAMPLE INTERVAL/ RECOVERY	BLOW COUNTS	INSTRUMENT READING	DESCRIPTION/SOIL CLASSIFICATION	REMARKS
0–10				(PID)	Brown clayey silt (ML), dry, minor organics	Equilibrated water level = 12′
10–16		HP-07-12′		0 499 1177 573 767	Dark brown-black silty clay (CH), soft, moist, plastic 10.5′ becomes sl. stiff 12′ becomes soft 12.5′ becomes wet, color change to blue-grey, petrol. odor 13′ minor, small gravel	
16					16′ Bottom of borehole	

99012-7

Stellar Environmental Solutions
2110 Sixth Street, Berkeley, CA 94710
Geoscience & Engineering Consulting

Soil Boring Log

BORING NUMBER HP-08 Page 1 of 1

PROJECT Redwood Reg. Park Serv. Yard
OWNER East Bay Regional Park District
LOCATION Oakland, CA
PROJECT NUMBER 99012
TOTAL DEPTH 16 feet
BOREHOLE DIA. 2-inch
SURFACE ELEV. Unknown
WATER FIRST ENCOUNTERED ~12.5 feet
DRILLING COMPANY Fisch Environmental
DRILLING METHOD GeoProbe
DRILLER Flint
GEOLOGIST B. Rucker
DATE DRILLED 4/14/99

DEPTH (feet)	GRAPHIC LOG	SAMPLE INTERVAL/ RECOVERY	BLOW COUNTS	INSTRUMENT READING	DESCRIPTION/SOIL CLASSIFICATION	REMARKS
0				(PID)	Dark brown clayey silt (ML), dry	
2						
4					Dark brown silty clay (CL), sl. stiff, sl. moist	Equilibrated water level = 9.9′
6						
8						
10				0	9.5′ becomes soft	
				0	11′ becomes stiff	
12				16	11.5′ becomes soft	
				5	12.5′ becomes wet and gravelly (medium, 50%)	
14				78		
				313		
16		HP-08-15.5′		404	16′ Bottom of borehole	
18						
20						

99012-8

Stellar Environmental Solutions
2110 Sixth Street, Berkeley, CA 94710
Geoscience & Engineering Consulting

Soil Boring Log

BORING NUMBER HP-09 Page 1 of 1

PROJECT Redwood Reg. Park Serv. Yard
OWNER East Bay Regional Park District
LOCATION Oakland, CA
PROJECT NUMBER 99012
TOTAL DEPTH 16 feet
BOREHOLE DIA. 2-inch
SURFACE ELEV. Unknown
WATER FIRST ENCOUNTERED 15.5 feet
DRILLING COMPANY Fisch Environmental
DRILLING METHOD GeoProbe
DRILLER Flint
GEOLOGIST B. Rucker
DATE DRILLED 4/15/99

DEPTH (feet)	GRAPHIC LOG	SAMPLE INTERVAL/ RECOVERY	BLOW COUNTS	INSTRUMENT READING	DESCRIPTION/SOIL CLASSIFICATION	REMARKS
2				(PID)	Light brown clayey silt (ML), dry	
4						
6					Dark brown silty clay (CL), sl. stiff, sl. moist	Equilibrated water level = 11.1′
8						
10				0		
				0	11′ becomes soft	
12				0	12′ becomes moist	
				492	12.5′ becomes blue-grey, stiff, dry	
14				1,076	13′ becomes brown with sl. blue-grey mottling	
				1,103		
		HP-09-15′		1,556	15.5′ becomes sandy and wet	
16					16′ Bottom of borehole	
18						
20						

99012-9

Stellar Environmental Solutions
2110 Sixth Street, Berkeley, CA 94710
Geoscience & Engineering Consulting

Soil Boring Log

BORING NUMBER HP-10 Page 1 of 1

PROJECT Redwood Reg. Park Serv. Yard
OWNER East Bay Regional Park District
LOCATION Oakland, CA
PROJECT NUMBER 99012
TOTAL DEPTH 16 feet
BOREHOLE DIA. 2-inch
SURFACE ELEV. Unknown
WATER FIRST ENCOUNTERED 14.5 feet
DRILLING COMPANY Fisch Environmental
DRILLING METHOD GeoProbe
DRILLER Flint
GEOLOGIST B. Rucker
DATE DRILLED 4/15/99

DEPTH (feet)	GRAPHIC LOG	SAMPLE INTERVAL/ RECOVERY	BLOW COUNTS	INSTRUMENT READING	DESCRIPTION/SOIL CLASSIFICATION	REMARKS
0				(PID)	Light brown clayey silt (ML)	Equilibrated water level = 7.9′
6					Brown silty clay (CL), dry	
8					8′ becomes stiff, minor small gravel	
10					10′ becomes soft, plastic (CH)	
12				0 13 527 1,350 1,401	11.5′ becomes sl. stiff (CL) 12′ color change to blue-grey	
14		HP-10-14′		1,360 1,386	14.5′ becomes wet sandy clay 15.5′ becomes gravelly (small-med) (30-50%), wet	
16				53	16′ Bottom of borehole	
18						
20						

99012-10

Curtis & Tompkins, Ltd., Analytical Laboratories, Since 1878
2323 Fifth Street, Berkeley, CA 94710, Phone (510) 486-0900, Fax (510) 486-0532

ANALYTICAL REPORT

Prepared for:

Stellar Environmental Solutions
2198 6th Street
Suite 201
Berkeley, CA 94710

Date: 14-MAY-99
Lab Job Number: 138934
Project ID: 99012
Location: Redwood Regional Park

Reviewed by: _____

Reviewed by: _____

STELLAR ENVIRONMENTAL SOLUTIONS

Chain of Custody Record

138934

Lab Job no.: _____
Date _____
Page 1 of 2

Laboratory Curtis + Tompkins, Ltd.
Address 2323 Fifth Street
Berkeley CA 94710

Client Stellar Environmental Solutions
Address _____

Project Name Redwood Regional Park, Oakland, CA
Project Number 99012

Method of Shipment hand delivery
Shipment No. —
Airbill No. —
Cooler No. —
Project Manager Bruce Rucker
Telephone No. 510/644-3123
Fax. No. 510/644-3859
Samplers: (Signature) B.M. Rucker

	Field Sample Number	Location/ Depth	Date	Time	Sample Type	Type/Size of Container	Preservation: Temp.	Preservation: Chemical	Filtered?	No. of Containers	TVH+BTEX+MTBE (8015 Mod./8030)	TEH (8015 Mod.)	Nitrate + Sulfate (353.2+375)	Total organic carbon (Walkley-Black Method)	Remarks
1	HP-01-17.5'	HP-01	4/14/99	845	Soil	acetate sleeve	4°	—	No	1	X	X			Double set of
2	HP-01-GW	HP-01		915	H2O	multiple		various		4	X	X	X		HP-02-GW
3	HP-02-14'	HP-02		1010	Soil	acetate sleeve		—		1	X	X			Samples collected
4	HP-02-17.5'	HP-02		1025	Soil	" "		—		1	X (No)	X	X		for TVH, BTEX
5	HP-02-GW	HP-02		1040	H_2O	multiple		various		7	X	X	X		MTBE + TEH.
6	HP-03-13'	HP-03		1130	Soil	acetate sleeve		—		1	X	X			Run one set
7	HP-03-GW	HP-03		1140	H_2O	multiple		various		4	X	X	X		unfiltered. For
8	HP-04-15'	HP-04		1210	Soil	acetate sleeve		—		1	X	X			other set, filter
9	HP-04-GW	HP-04		1230	H_2O	multiple		various		4	X	X	X		(0.45 micron)
10	HP-05-15'	HP-05		1355	Soil	acetate sleeve		—		1	X	X			before analysis.
11	HP-05-GW	HP-05		1405	H_2O	multiple		various		4	X	X	X		ID on lab report
															(filtered) + (unfiltered)

23

Relinquished by:	Date	Received by:	Date
Signature B.M. Rucker	4/15/99	Signature [illegible]	4/15/99
Printed Bruce M. Rucker	Time 1507	Printed TRAVERS	Time 1507
Company Stellar Env.		Company C&T	
Reason lab drop off			

Relinquished by:	Date	Received by:	Date
Signature		Signature	
Printed	Time	Printed	Time
Company		Company	
Reason			

Relinquished by:	Date	Received by:	Date
Signature		Signature	
Printed	Time	Printed	Time
Company		Company	
Reason			

Comments:
Volatile samples (water) in 40-ml VOA vials w/ HCl
TPH-d (water) samples in 1-liter amber glass, no preservative
Nitrate + Sulfate (water) in 500 ml poly, unpreserved

STELLAR ENVIRONMENTAL SOLUTIONS

Chain of Custody Record

1389 94

Lab Job no.: _____

Date _____

Page 2 of 2

Laboratory Curtis + Tompkins, Ltd.
Address 2323 Fifth Street
Berkeley CA 94710

Client Stellar Environmental Solutions
Address _____

Project Name Redwood Regional Park, Oakland CA
Project Number 99012

Method of Shipment hand delivery
Shipment No. —
Airbill No. —
Cooler No. —
Project Manager Bruce Rucker
Telephone No. 510/644-3123
Fax. No. 510/644-3859
Samplers: (Signature) B.M. Rucker

	Field Sample Number	Location/ Depth	Date	Time	Sample Type	Type/Size of Container	Preservation: Temp.	Preservation: Chemical	Filtered Y	No. of Containers	Analysis Required: TVH+BTEX+MTBE (8015 Mod + 8020)	TEH (8015 Mod.)	Nitrate + Sulfate (353.2 + 375)	Total Organic Carbon (Walkley-Black Method)	Remarks
12	HP-06-11'	HP-06	4/14/99	1430	Soil	acetate sleeve	4°	—	NO	1	X	X			
13	HP-06-11.5'	HP-06		1440	Soil	" "		—		1			X		
14	HP-06-GW	HP-06		1500	H2O	multiple		various		4	X	X			
15	HP-07-12'	HP-07		1520	Soil	acetate sleeve		—		1	X	X			
16	HP-07-GW	HP-07		1550	H2O	multiple		various		4	X	X			
17	HP-08-15.5'	HP-08		1630	Soil	acetate sleeve		—		1	X	X			
18	HP-08-GW	HP-08		1720	H2O	multiple		various		4	X	X			
19	HP-09-15'	HP-09	4/15/99	820	Soil	acetate sleeve		—		1	X	X			
20	HP-09-GW	HP-09		850	water	multiple		various		4	X	X			
21	HP-10-14'	HP-10		935	Soil	acetate sleeve		—		1	X	X			
22	HP-10-GW	HP-10		950	H2O	multiple		various		3	X	X			

Relinquished by: Signature B M Rucker; Printed Bruce M. Rucker; Company Stellar Env.; Reason lab drop off. — Date 4/15/99 — Time 1507

Received by: Signature Travers; Printed TRAVERS; Company CT — Date 4/15/99 — Time 1507

Relinquished by: Signature _____; Printed _____; Company _____; Reason _____ — Date _____ — Time _____

Received by: Signature _____; Printed _____; Company _____ — Date _____ — Time _____

Relinquished by: Signature _____; Printed _____; Company _____; Reason _____ — Date _____ — Time _____

Received by: Signature _____; Printed _____; Company _____ — Date _____ — Time _____

Comments:
Volatile H_2O samples collected in 40 ml VOA vials w/ HCl
TEH samples (H_2O) collected in 1 L amber glass
Nitrate + Sulfate samples (H_2O) collected in 500 ml poly, unpreserved

TVH-Total Volatile Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-001	HP-01-17.5'	47551	04/14/99	04/21/99	04/21/99	
138934-003	HP-02-14'	47633	04/14/99	04/25/99	04/25/99	
138934-006	HP-03-13'	47551	04/14/99	04/21/99	04/21/99	
138934-008	HP-04-15'	47551	04/14/99	04/21/99	04/21/99	

Matrix: Soil

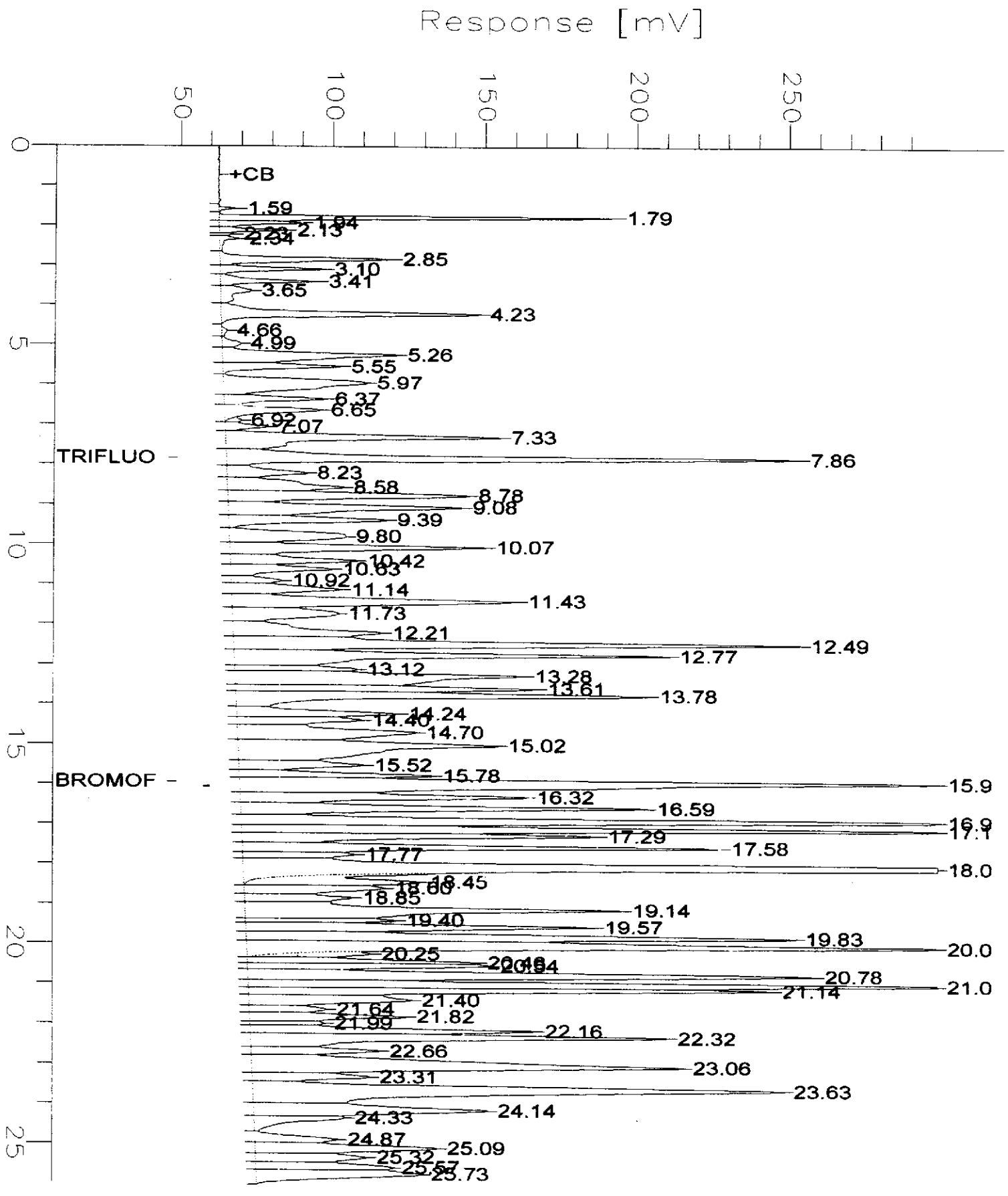
Analyte	Units	138934-001	138934-003		138934-006	138934-008
Diln Fac:		1	25		1	1
Gasoline C7-C12	mg/Kg	<1	970	H	<1	<1
Surrogate						
Trifluorotoluene	%REC	101	110		104	101
Bromofluorobenzene	%REC	99	273	*	103	108

* Values outside of QC limits
H: Heavier hydrocarbons than indicated standard

GC04 TVH 'J' Data File Rtx1FID

Sample Name : RD,138934-003,47633,TVH ONLY
FileName : G:\GC04\DATA\114J023.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.00 min
Scale Factor: -1.0 Plot Offset: 50 mV

Sample #: 25X Page 1 of 1
Date : 4/25/99 04:10 AM
Time of Injection: 4/25/99 03:43 AM
Low Point : 49.61 mV High Point : 299.61 mV
Plot Scale: 250.0 mV



BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-001	HP-01-17.5'	47551	04/14/99	04/21/99	04/21/99	
138934-003	HP-02-14'	47551	04/14/99	04/22/99	04/22/99	
138934-006	HP-03-13'	47551	04/14/99	04/21/99	04/21/99	
138934-008	HP-04-15'	47551	04/14/99	04/21/99	04/21/99	

Matrix: Soil

Analyte	Units	138934-001	138934-003	138934-006	138934-008
Diln Fac:		1	20	1	1
MTBE	ug/Kg	<20	1000	<20	<20
Benzene	ug/Kg	<5	1300 C	<5	<5
Toluene	ug/Kg	<5	1300	<5	<5
Ethylbenzene	ug/Kg	<5	5500	<5	<5
m,p-Xylenes	ug/Kg	<5	7400	<5	<5
o-Xylene	ug/Kg	<5	1300	<5	<5
Surrogate					
Trifluorotoluene	%REC	89	107	93	89
Bromofluorobenzene	%REC	89	142	93	97

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: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-010	HP-05-15'	47551	04/14/99	04/21/99	04/21/99	
138934-012	HP-06-11'	47660	04/14/99	04/26/99	04/26/99	
138934-015	HP-07-12'	47551	04/14/99	04/21/99	04/21/99	
138934-017	HP-08-15.5'	47633	04/14/99	04/25/99	04/25/99	

Matrix: Soil

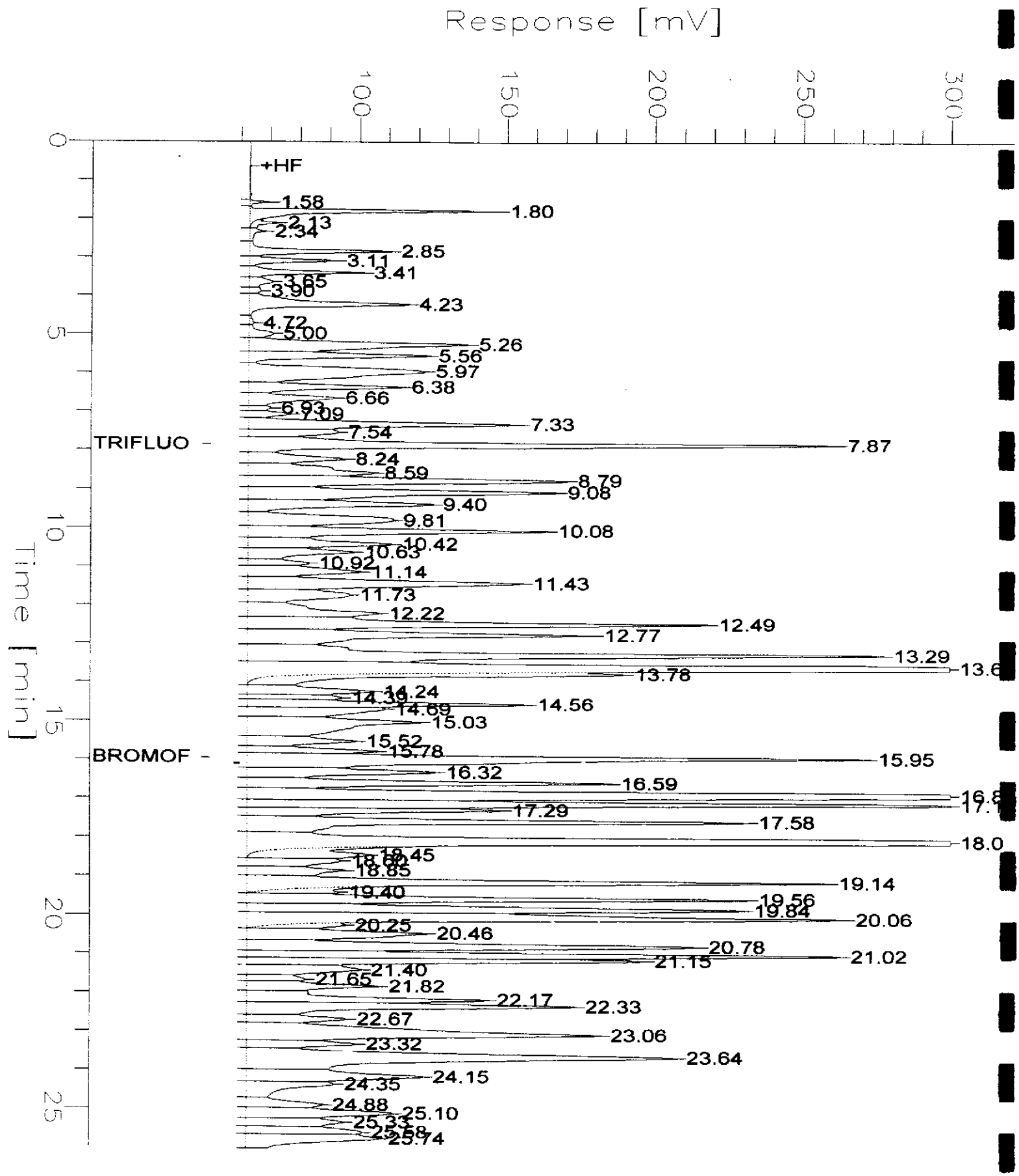
Analyte	Units	138934-010	138934-012		138934-015	138934-017	
Diln Fac:		1	40		1	20	
Gasoline C7-C12	mg/Kg	<1	1700	H	2.9	580	H
Surrogate							
Trifluorotoluene	%REC	102	120		108	126	
Bromofluorobenzene	%REC	111	217	*	121	207	*

* Values outside of QC limits
H: Heavier hydrocarbons than indicated standard

GC04 TVH 'J' Data File Rtx1FID

Sample Name : r,138934-012,47660
FileName : G:\GC04\DATA\116J012.raw
Method : TVHBTXF
Start Time : 0.00 min End Time : 26.00 min
Scale Factor: -1.0 Plot Offset: 50 mV

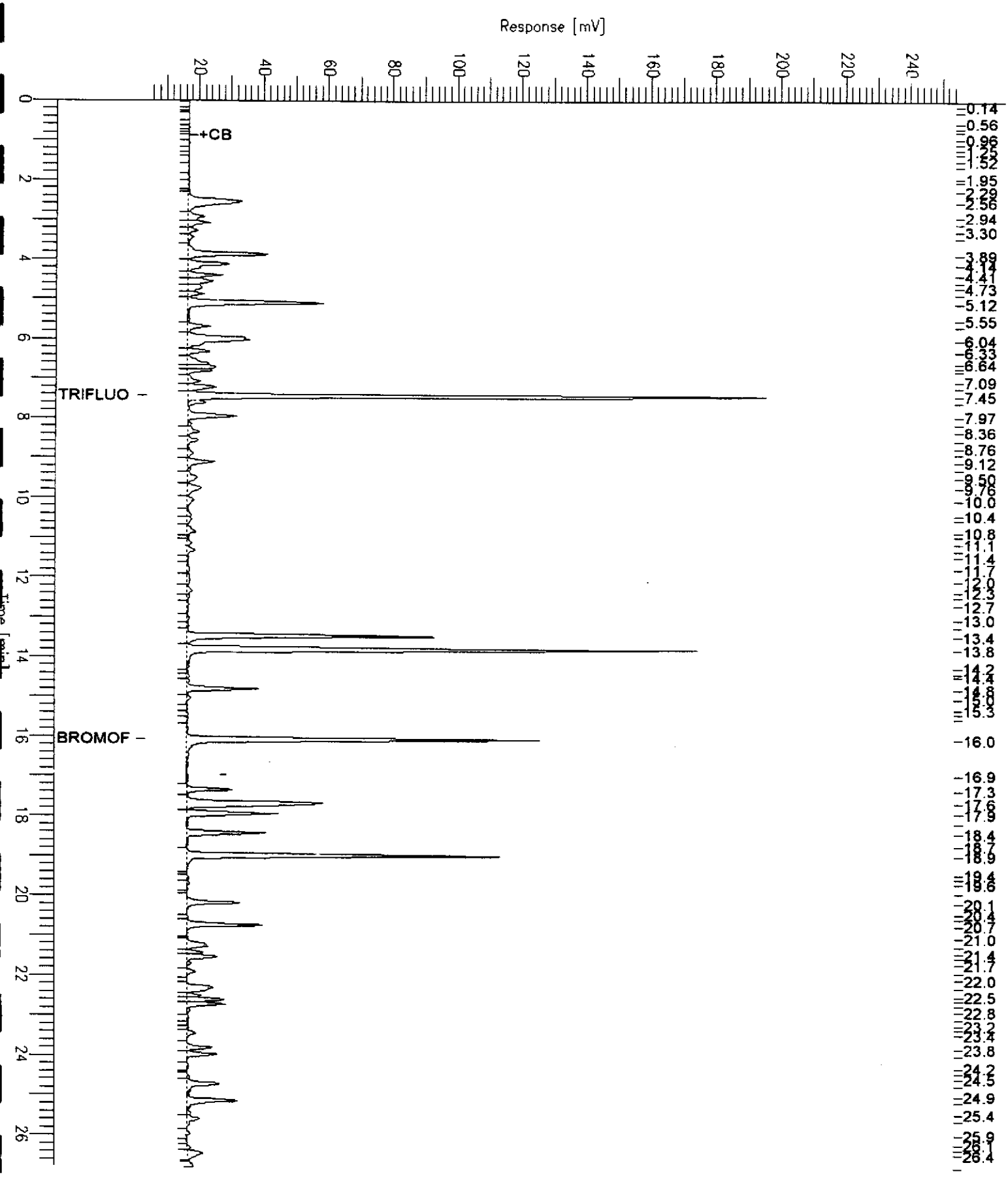
Sample #: 40x Page 1 of 1
Date : 4/27/99 12:27 PM
Time of Injection: 4/26/99 09:56 PM
Low Point : 50.22 mV High Point : 300.22 mV
Plot Scale: 250.0 mV



GC19 TVH 'X' Data File (FID)

Sample Name : 138934-015,4755
FileName : G:\GC19\DATA\111X019.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

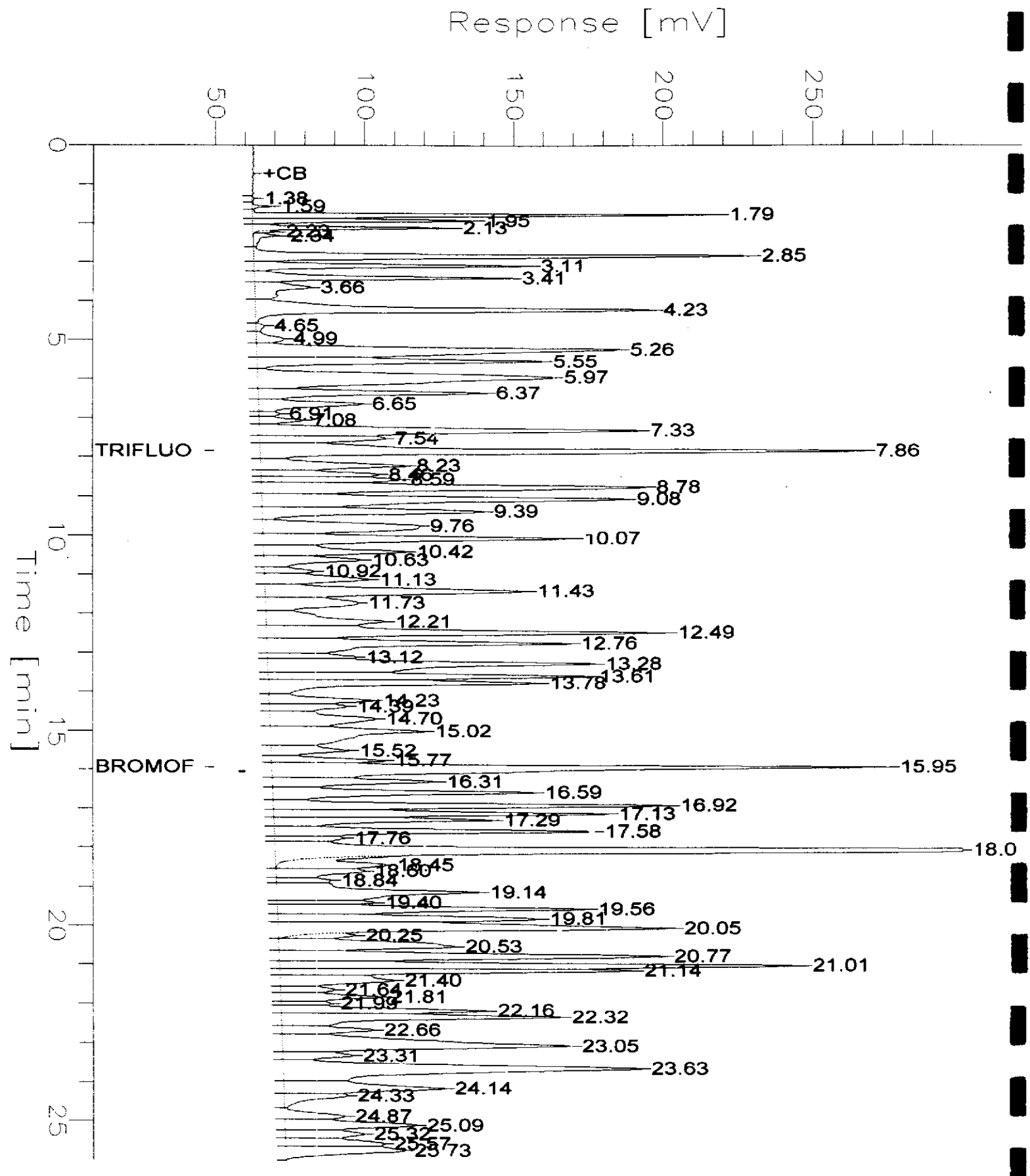
Sample #: Page 1 of 1
Date : 4/21/99 11:21 PM
Time of Injection: 4/21/99 10:53 PM
Low Point : 4.14 mV High Point : 254.14 mV
Plot Scale: 250.0 mV



GC04 TVH 'J' Data File Rtx1FID

Sample Name : RD,138934-017,47633
FileName : G:\GC04\DATA\114J020.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.00 min
Scale Factor: -1.0 Plot Offset: 50 mV

Sample #: 20X Page 1 of 1
Date : 4/25/99 02:25 AM
Time of injection: 4/25/99 01:58 AM
Low Point : 49.80 mV High Point : 299.80 mV
Plot Scale: 250.0 mV



BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-010	HP-05-15'	47551	04/14/99	04/21/99	04/21/99	
138934-012	HP-06-11'	47660	04/14/99	04/26/99	04/26/99	
138934-015	HP-07-12'	47551	04/14/99	04/21/99	04/21/99	
138934-017	HP-08-15.5'	47633	04/14/99	04/25/99	04/25/99	

Matrix: Soil

Analyte Diln Fac:	Units	138934-010 1	138934-012 40	138934-015 1	138934-017 20
MTBE	ug/Kg	<20	<800	20	<400
Benzene	ug/Kg	<5	1400 C	28	<100
Toluene	ug/Kg	<5	2700	<5	1000
Ethylbenzene	ug/Kg	<5	21000	130	4700
m,p-Xylenes	ug/Kg	<5	70000	310	4700
o-Xylene	ug/Kg	<5	11000	37	<100
Surrogate					
Trifluorotoluene	%REC	89	107	97	100
Bromofluorobenzene	%REC	98	115	106	104

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: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-019	HP-09-15'	47660	04/14/99	04/27/99	04/27/99	
138934-021	HP-10-14'	47633	04/14/99	04/24/99	04/24/99	

Matrix: Soil

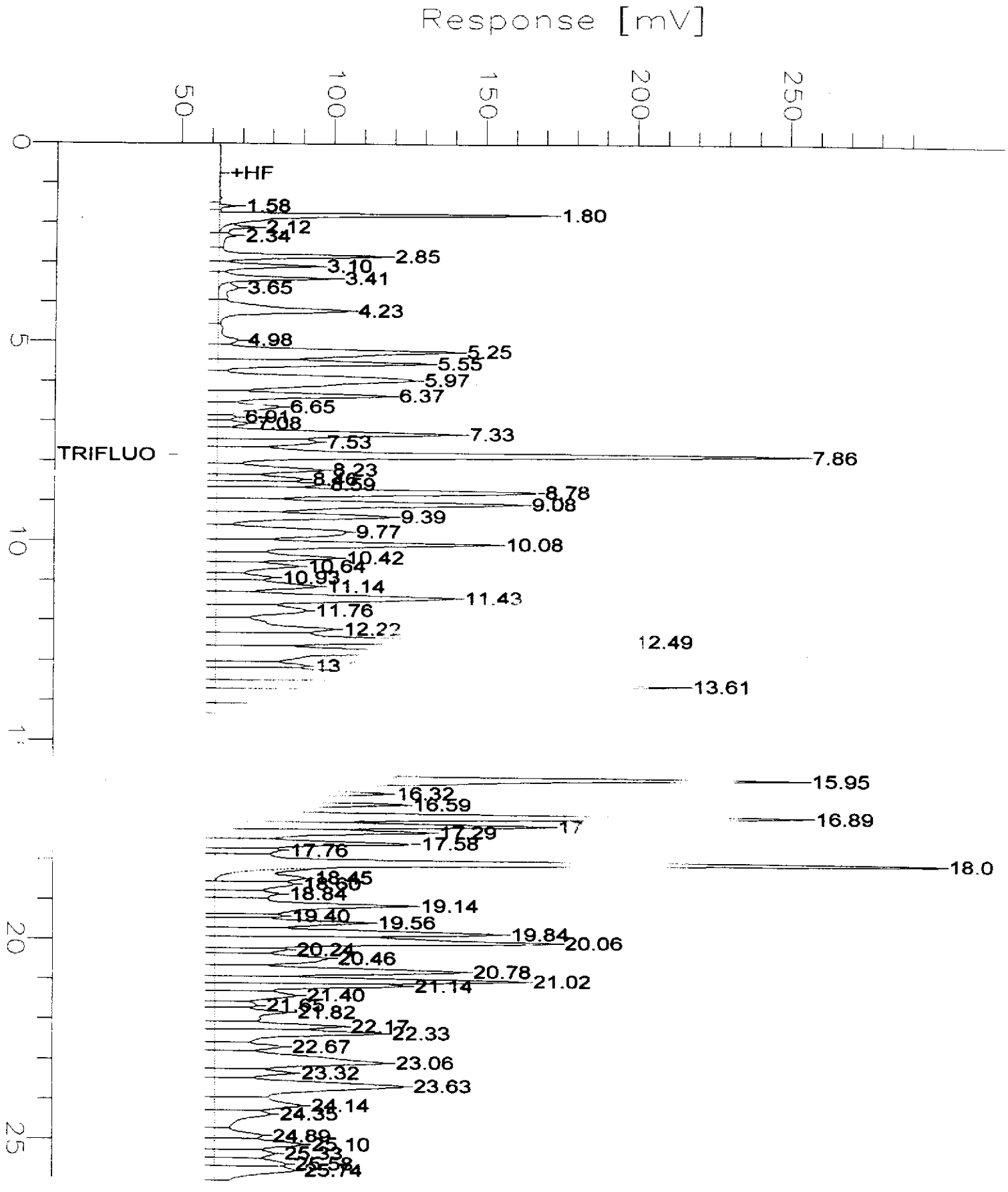
Analyte	Units	138934-019		138934-021	
Diln Fac:		25		20	
Gasoline C7-C12	mg/Kg	610	H	500	H
Surrogate					
Trifluorotoluene	%REC	116		128	
Bromofluorobenzene	%REC	201	*	200	*

* Values outside of QC limits
H: Heavier hydrocarbons than indicated standard

GC04 TVH 'J' Data File Rtx1FID

Sample Name : RD,138934-019,47660
FileName. : G:\GC04\DATA\116J034.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.00 min
Scale Factor: -1.0 Plot Offset: 50 mV

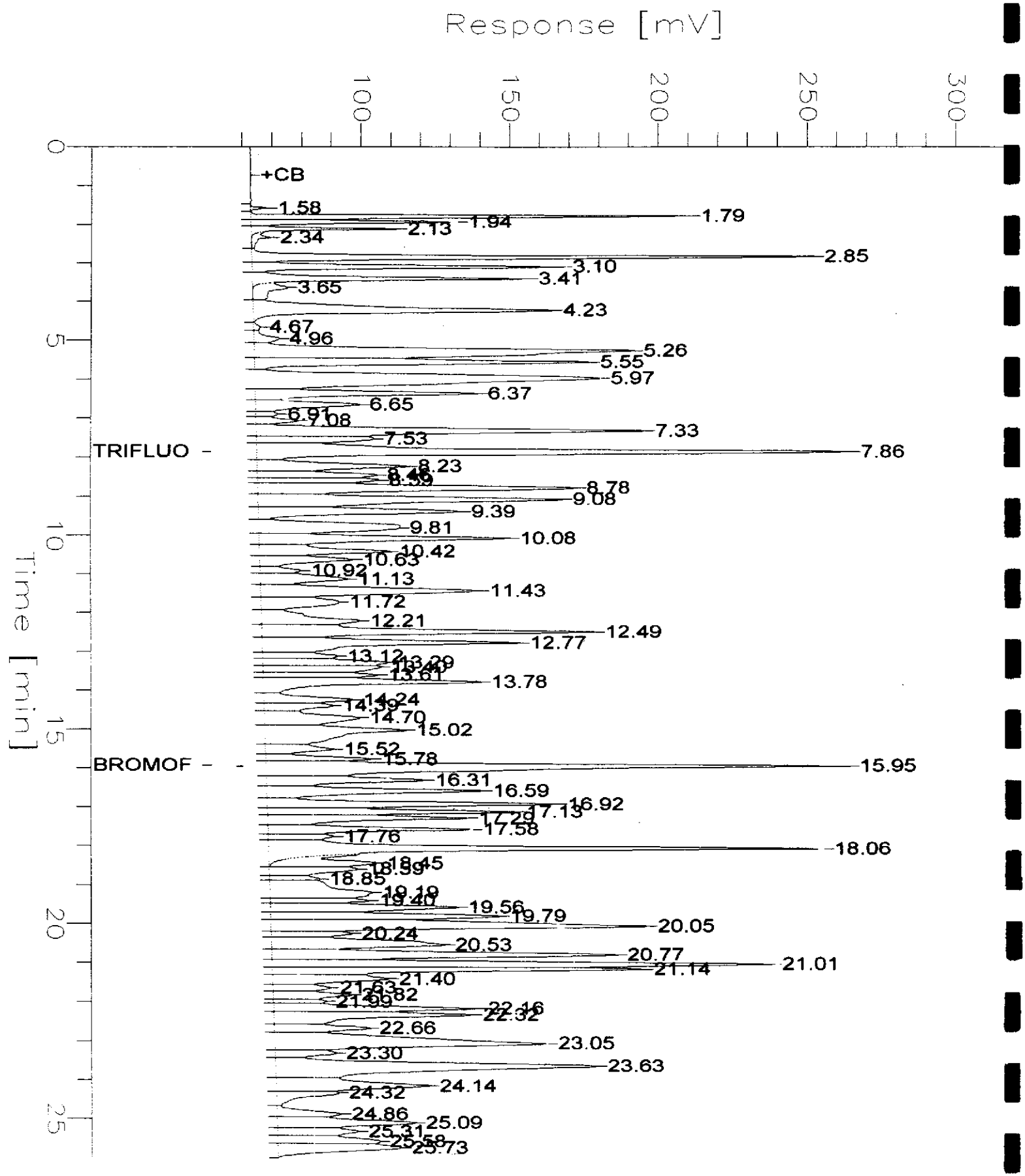
Sample #: 25X Page 1 of 1
Date : 4/27/99 01:53 PM
Time of Injection: 4/27/99 12:40 PM
Low Point : 49.64 mV High Point : 299.64 mV
Plot Scale: 250.0 mV



GC04 TVH 'J' Data File Rtx1FID

Sample Name : RD,138934-021,47633,TVH ONLY
FileName : G:\GC04\DATA\114J021.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.00 min
Scale Factor: -1.0 Plot Offset: 50 mV

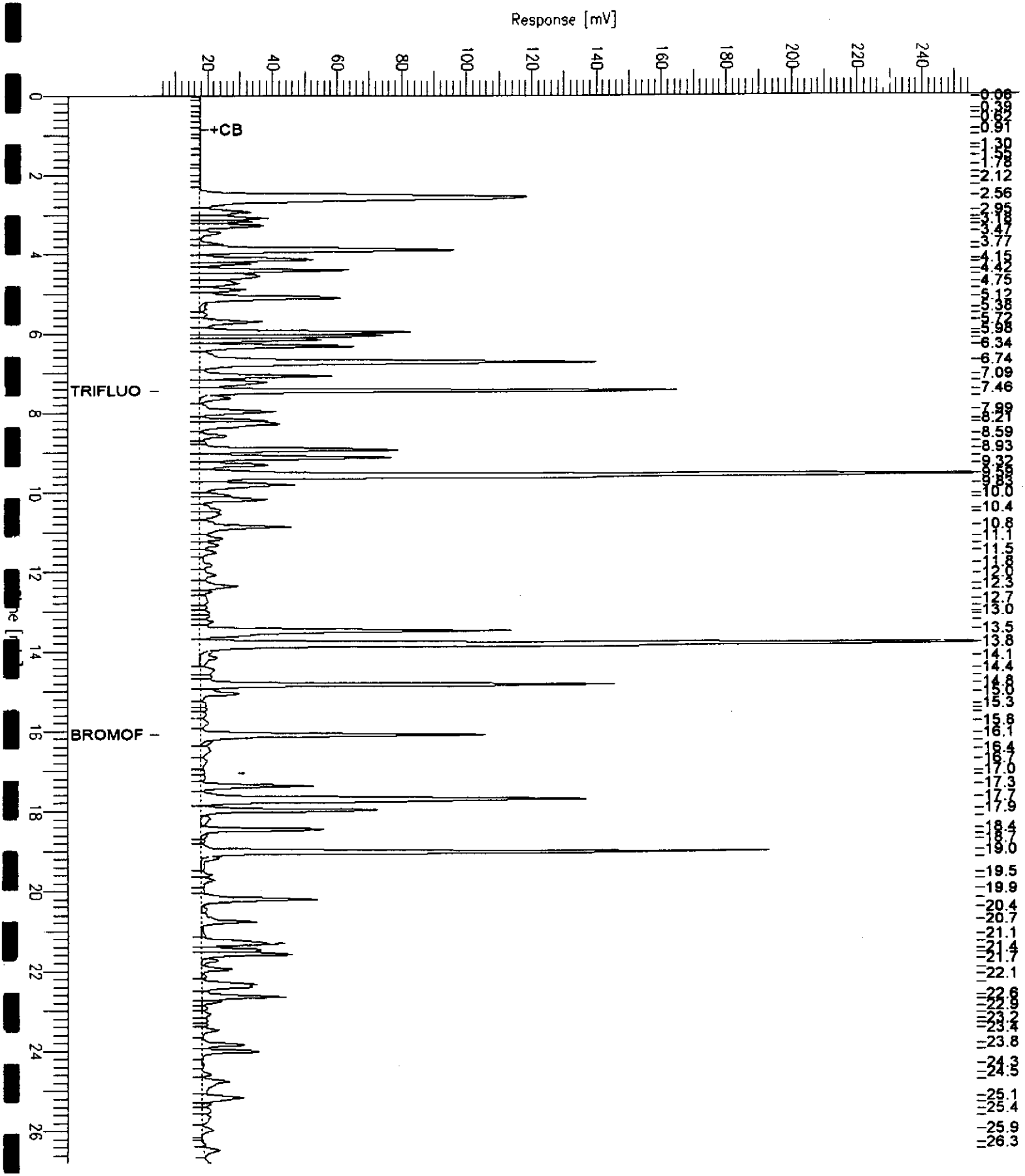
Sample #: 20X Page 1 of 1
Date : 4/25/99 03:00 AM
Time of Injection: 4/25/99 02:33 AM
Low Point : 50.01 mV High Point : 300.01 mV
Plot Scale: 250.0 mV



GC19 TVH 'X' Data File (FID)

Sample Name : CCV/LCS,QC95711,99WS7368,47551
FileName : G:\GC19\DATA\111X001.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 5 mV

Sample #: GAS
Date : 4/21/99 10:47 AM
Time of Injection: 4/21/99 10:20 AM
Low Point : 5.02 mV High Point : 255.02 mV
Plot Scale: 250.0 mV



BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-019	HP-09-15'	47660	04/14/99	04/27/99	04/27/99	
138934-021	HP-10-14'	47551	04/14/99	04/22/99	04/22/99	

Matrix: Soil

Analyte	Units	138934-019	138934-021	
Diln Fac:		25	5	
MTBE	ug/Kg	<500	2300	
Benzene	ug/Kg	1500	190	
Toluene	ug/Kg	1500	1600	
Ethylbenzene	ug/Kg	3800	2000	
m,p-Xylenes	ug/Kg	9800	2500	
o-Xylene	ug/Kg	1400	710	
Surrogate				
Trifluorotoluene	%REC	105	151	*
Bromofluorobenzene	%REC	112	180	*

* Values outside of QC limits

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

METHOD BLANK

Matrix:	Soil	Prep Date:	04/21/99
Batch#:	47551	Analysis Date:	04/21/99
Units:	mg/Kg		
Diln Fac:	1		

MB Lab ID: QC95713

Analyte	Result
Gasoline C7-C12	<1.0

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	102	62-143
Bromofluorobenzene	98	59-150

BTXE

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8021B
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

METHOD BLANK

Matrix:	Soil	Prep Date:	04/21/99
Batch#:	47551	Analysis Date:	04/21/99
Units:	ug/Kg		
Diln Fac:	1		

MB Lab ID: QC95713

Analyte	Result
MTBE	<20
Benzene	<5.0
Toluene	<5.0
Ethylbenzene	<5.0
m,p-Xylenes	<5.0
o-Xylene	<5.0

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	89	59-134
Bromofluorobenzene	88	38-150

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

LABORATORY CONTROL SAMPLE

Matrix:	Soil	Prep Date:	04/21/99
Batch#:	47551	Analysis Date:	04/21/99
Units:	mg/Kg		
Diln Fac:	1		

LCS Lab ID: QC95711

Analyte	Result	Spike Added	%Rec #	Limits
Gasoline C7-C12	9.04	10	90	77-122

Surrogate	%Rec	Limits
Trifluorotoluene	94	62-143
Bromofluorobenzene	102	59-150

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 #: 138934 BATCH QC REPORT Curtis & Tompkins, Ltd. Page 1 of 1

TVH-Total Volatile Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park
Analysis Method: EPA 8015M
Prep Method: EPA 5030

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Field ID: HP-03-13'
Lab ID: 138934-006
Matrix: Soil
Batch#: 47551
Units: mg/Kg
Diln Fac: 1
Sample Date: 04/14/99
Received Date: 04/15/99
Prep Date: 04/21/99
Analysis Date: 04/21/99

MS Lab ID: QC95714

Analyte	Spike Added	Sample	MS	%Rec #	Limits
Gasoline C7-C12	10	<1	8.53	85	55-134

Surrogate	%Rec	Limits
Trifluorotoluene	114	62-143
Bromofluorobenzene	121	59-150

MSD Lab ID: QC95715

Analyte	Spike Added	MSD	%Rec #	Limits	RPD #	Limit
Gasoline C7-C12	10	8.48	85	55-134	1	30

Surrogate	%Rec	Limits
Trifluorotoluene	43*	62-143
Bromofluorobenzene	56*	59-150

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

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

LABORATORY CONTROL SAMPLE

Matrix: Soil
Batch#: 47551
Units: ug/Kg
Diln Fac: 1

Prep Date: 04/21/99
Analysis Date: 04/21/99

LCS Lab ID: QC95712

Analyte	Result	Spike Added	%Rec #	Limits
MTBE	78.55	100	79	65-135
Benzene	84.31	100	84	67-116
Toluene	89.6	100	90	77-122
Ethylbenzene	89.73	100	90	70-124
m,p-Xylenes	187.4	200	94	75-125
o-Xylene	87.4	100	87	75-126

Surrogate	%Rec	Limits
Trifluorotoluene	87	59-134
Bromofluorobenzene	88	38-150

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits
Spike Recovery: 0 out of 6 outside limits

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

METHOD BLANK

Matrix:	Soil	Prep Date:	04/26/99
Batch#:	47660	Analysis Date:	04/26/99
Units:	mg/Kg		
Diln Fac:	1		

MB Lab ID: QC96102

Analyte	Result
Gasoline C7-C12	<1.0

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	96	62-143
Bromofluorobenzene	90	59-150

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

LABORATORY CONTROL SAMPLE

Matrix:	Soil	Prep Date:	04/26/99
Batch#:	47660	Analysis Date:	04/26/99
Units:	mg/Kg		
Diln Fac:	1		

LCS Lab ID: QC96103

Analyte	Result	Spike Added	%Rec #	Limits
Gasoline C7-C12	9.88	10	99	77-122
Surrogate	**%Rec**	**Limits**		
Trifluorotoluene	95	62-143		
Bromofluorobenzene	108	59-150		

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

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

TVH-Total Volatile Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Field ID: ZZZZZZ
Lab ID: 139092-001
Matrix: Soil
Batch#: 47660
Units: mg/Kg
Diln Fac: 1

Sample Date: 04/23/99
Received Date: 04/26/99
Prep Date: 04/26/99
Analysis Date: 04/26/99

MS Lab ID: QC96106

Analyte	Spike Added	Sample	MS	%Rec #	Limits
Gasoline C7-C12	10	<1	9.79	98	55-134

Surrogate	%Rec	Limits
Trifluorotoluene	96	62-143
Bromofluorobenzene	111	59-150

MSD Lab ID: QC96107

Analyte	Spike Added	MSD	%Rec #	Limits	RPD #	Limit
Gasoline C7-C12	10	10.47	105	55-134	7	30

Surrogate	%Rec	Limits
Trifluorotoluene	98	62-143
Bromofluorobenzene	110	59-150

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

Lab #: 138934

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

METHOD BLANK

Matrix:	Soil	Prep Date:	04/24/99
Batch#:	47633	Analysis Date:	04/24/99
Units:	mg/Kg		
Diln Fac:	1		

MB Lab ID: QC96005

Analyte	Result	
Gasoline C7-C12	<1.0	
Surrogate	**%Rec**	**Recovery Limits**
Trifluorotoluene	97	62-143
Bromofluorobenzene	87	59-150

Lab #: 138934

BATCH QC REPORT

Curtis & Tompkins, Ltd.

BTXE

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8021B
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

METHOD BLANK

Matrix:	Soil	Prep Date:	04/24/99
Batch#:	47633	Analysis Date:	04/24/99
Units:	ug/Kg		
Diln Fac:	1		

MB Lab ID: QC96005

Analyte	Result
MTBE	<20
Benzene	<5.0
Toluene	<5.0
Ethylbenzene	<5.0
m,p-Xylenes	<5.0
o-Xylene	<5.0

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	99	59-134
Bromofluorobenzene	90	38-150

Lab #: 138934

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

LABORATORY CONTROL SAMPLE

Matrix:	Soil	Prep Date:	04/24/99
Batch#:	47633	Analysis Date:	04/24/99
Units:	mg/Kg		
Diln Fac:	1		

LCS Lab ID: QC94003

Analyte	Result	Spike Added	%Rec #	Limits
Gasoline C7-C12	10.38	10	104	77-122
Surrogate				
Trifluorotoluene				
Bromofluorobenzene	11[illegible]	[illegible]		

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 #: 138934

BATCH QC REPORT

Curtis & Tompkins, Ltd.

BTXE

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8021B
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

LABORATORY CONTROL SAMPLE

Matrix:	Soil	Prep Date:	04/24/99
Batch#:	47633	Analysis Date:	04/24/99
Units:	ug/Kg		
Diln Fac:	1		

LCS Lab ID: QC96004

Analyte	Result	Spike Added	%Rec #	Limits
MTBE	84.57	100	85	65-135
Benzene	92.13	100	92	67-116
Toluene	96.85	100	97	77-122
Ethylbenzene	89.9	100	90	70-124
m,p-Xylenes	189.7	200	95	75-125
o-Xylene	93.04	100	93	75-126

Surrogate	%Rec	Limits
Trifluorotoluene	97	59-134
Bromofluorobenzene	92	38-150

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits
Spike Recovery: 0 out of 6 outside limits

Lab #: 138934

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Field ID:	ZZZZZZ	Sample Date:	04/21/99
Lab ID:	139031-004	Received Date:	04/21/99
Matrix:	Soil	Prep Date:	04/25/99
Batch#:	47633	Analysis Date:	04/25/99
Units:	mg/Kg		
Diln Fac:	1		

MS Lab ID: QC96006

Analyte	Spike Added	Sample	MS	%Rec #	Limits
Gasoline C7-C12	10	46.15	30.74	-154 *	55-134

Surrogate	%Rec	Limits
Trifluorotoluene	95	62-143
Bromofluorobenzene	140	59-150

MSD Lab ID: QC96007

Analyte	Spike Added	MSD	%Rec #	Limits	RPD #	Limit
Gasoline C7-C12	10	36.8	-94 *	55-134	18	30

Surrogate	%Rec	Limits
Trifluorotoluene	96	62-143
Bromofluorobenzene	155*	59-150

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: 2 out of 2 outside limits

TVH-Total Volatile Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-002	HP-01-GW	47584	04/14/99	04/22/99	04/22/99	
138934-005	**HP-02-GW UNFILTERED**	47584	04/14/99	04/23/99	04/23/99	
138934-007	HP-03-GW	47584	04/14/99	04/22/99	04/22/99	
138934-009	HP-04-GW	47584	04/14/99	04/22/99	04/22/99	

Matrix: Water

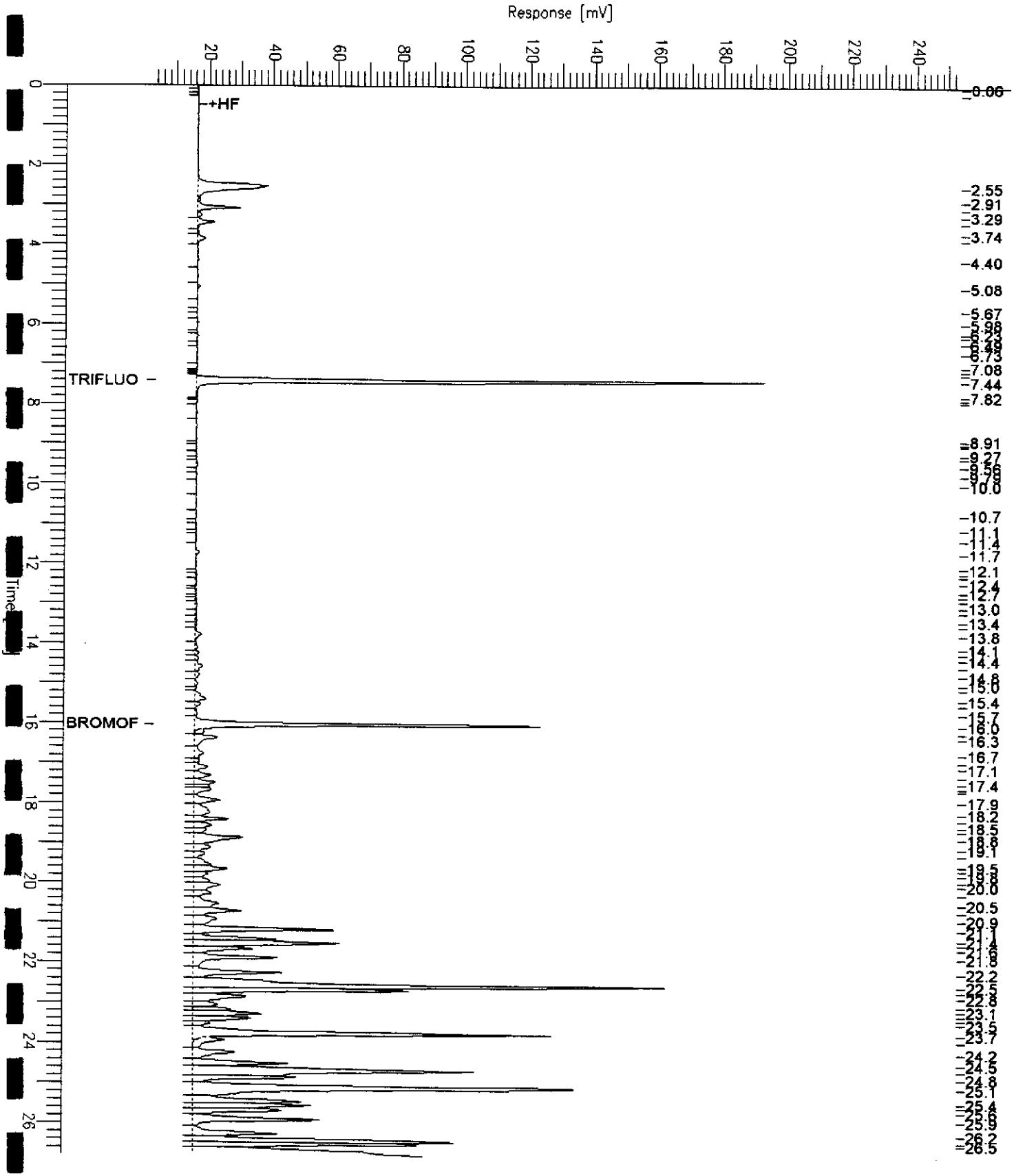
Analyte	Units	138934-002	**138934-005**	138934-007	138934-009
Diln Fac:		1	10	1	1
Gasoline C7-C12	ug/L	1300 YH	**31000 H**	3700 H	67 Z
Surrogate					
Trifluorotoluene	%REC	108	122	113	108
Bromofluorobenzene	%REC	113	147	169 *	107

* Values outside of QC limits
Y: Sample exhibits fuel pattern which does not resemble standard
Z: Sample exhibits unknown single peak or peaks
H: Heavier hydrocarbons than indicated standard

GC19 TVH 'X' Data File (FID)

mple Name : 138934-002,47584
FileName : G:\GC19\DATA\112X011.raw
Method : TVHBTXE
art Time : 0.00 min End Time : 26.80 min
ale Factor: -1.0 Plot Offset: 4 mV

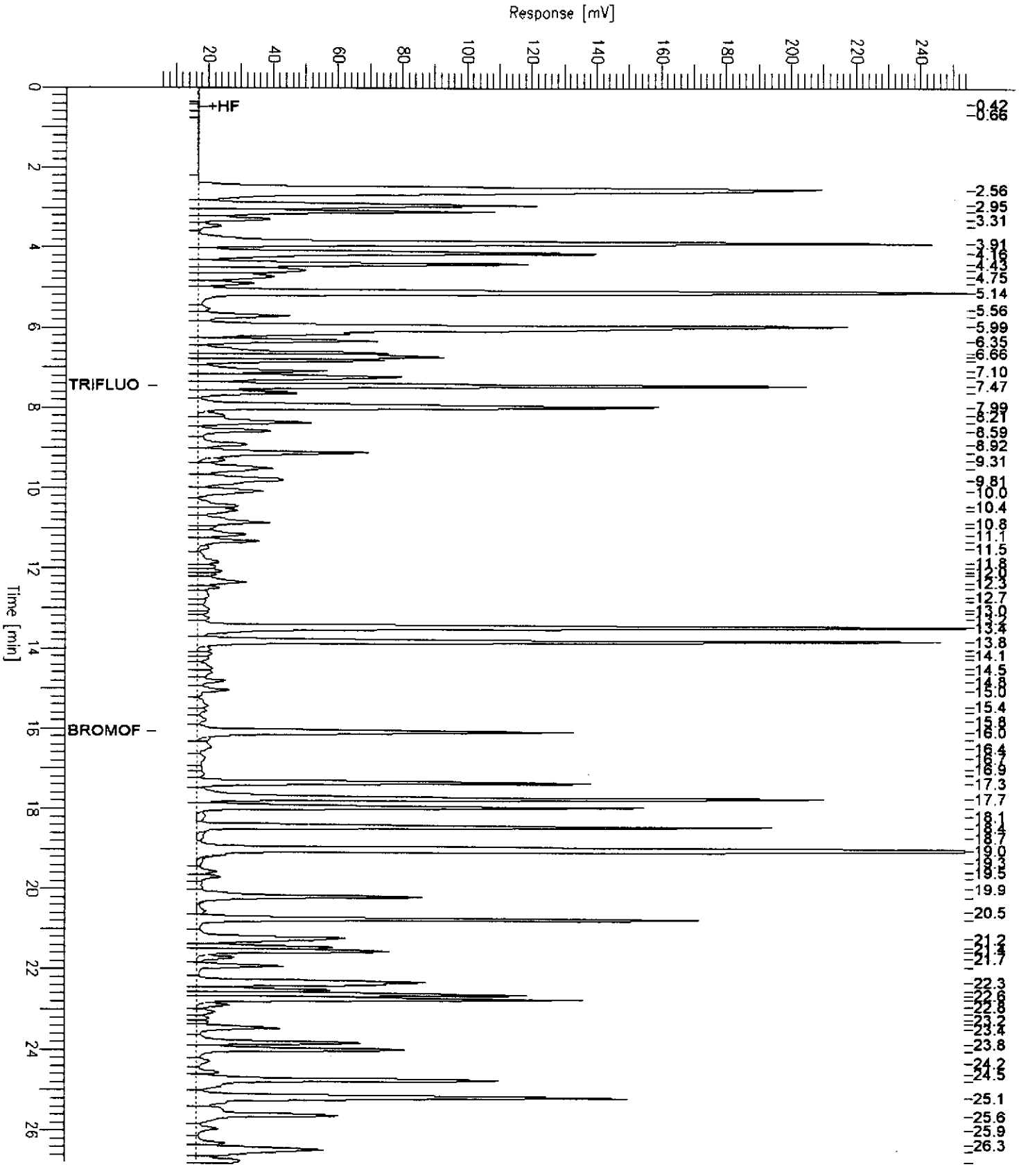
Sample #: Page 1 of 1
Date : 4/23/99 12:50 PM
Time of Injection: 4/22/99 05:33 PM
Low Point : 3.73 mV High Point : 253.73 mV
Plot Scale: 250.0 mV



GC19 TVH 'X' Data File (FID)

Sample Name : 138934-005,47584
FileName : G:\GC19\DATA\112X024.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

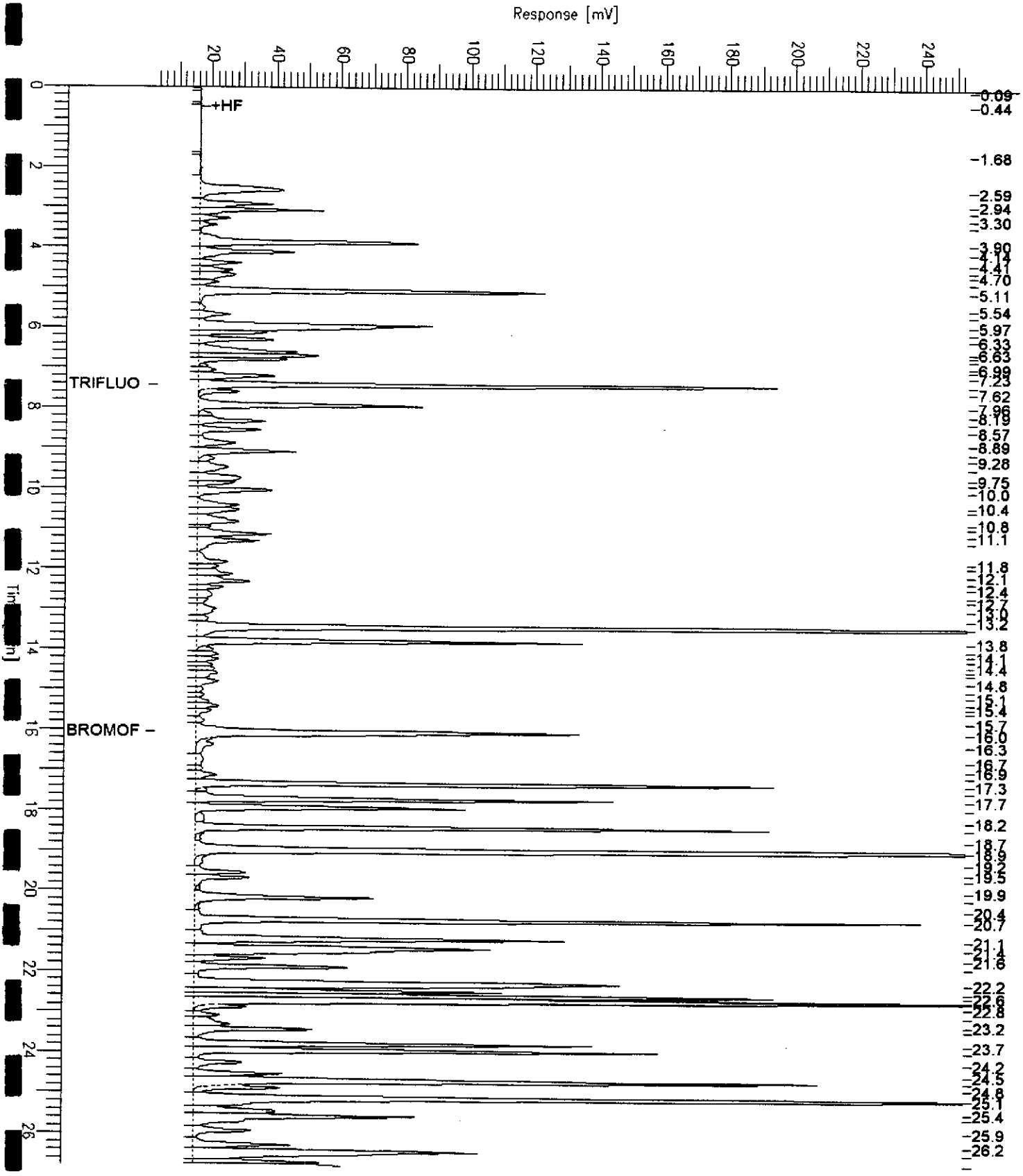
Sample #: Page 1 of 1
Date : 4/23/99 12:50 PM
Time of Injection: 4/23/99 02:14 AM
Low Point : 4.14 mV High Point : 254.14 mV
Plot Scale: 250.0 mV



GC19 TVH 'X' Data File (FID)

Sample Name : MSS,138934-007,47584
FileName : G:\GC19\DATA\112X012.raw
thod : TVHBTXE
art Time : 0.00 min End Time : 26.80 min
ale Factor: -1.0 Plot Offset: 4 mV

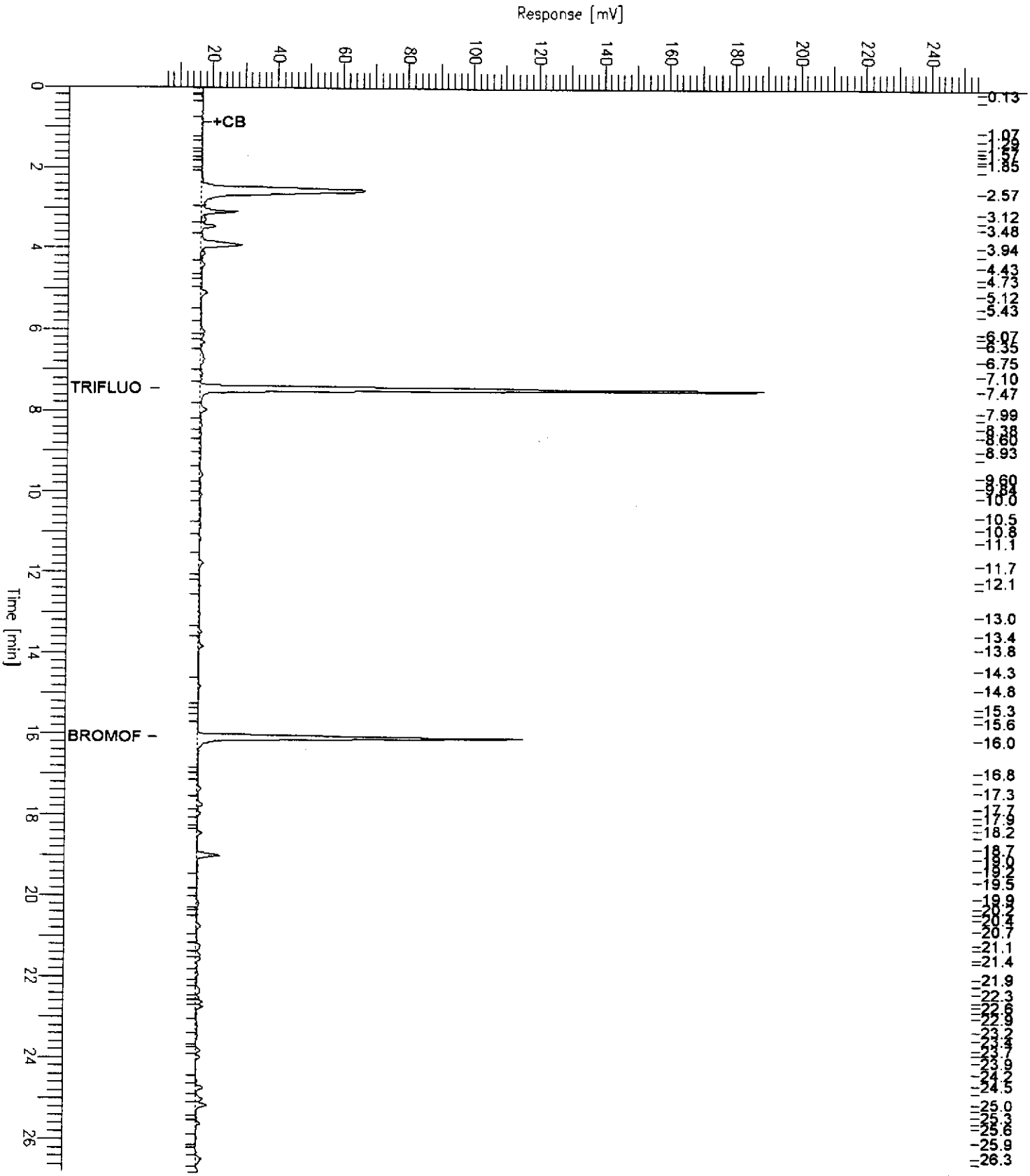
Sample #: Page 1 of 1
Date : 4/23/99 12:50 PM
Time of Injection: 4/22/99 06:14 PM
Low Point : 3.64 mV High Point : 253.64 mV
Plot Scale: 250.0 mV



GC19 TVH 'X' Data File (FID)

Sample Name : 138934-009,47584
FileName : G:\GC19\DATA\112X017.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

Sample #: Page 1 of 1
Date : 4/22/99 10:01 PM
Time of Injection: 4/22/99 09:34 PM
Low Point : 4.04 mV High Point : 254.04 mV
Plot Scale: 250.0 mV



Curtis & Tompkins, Ltd.

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-002	HP-01-GW	47584	04/14/99	04/22/99	04/22/99	
138934-005	HP-02-GW UNFILTERED	47584	04/14/99	04/23/99	04/23/99	
138934-007	HP-03-GW	47584	04/14/99	04/22/99	04/22/99	
138934-009	HP-04-GW	47584	04/14/99	04/22/99	04/22/99	

Matrix: Water

Analyte	Units	138934-002	138934-005	138934-007	138934-009
Diln Fac:		1	10	1	1
MTBE	ug/L	<2	260	31	15
Benzene	ug/L	<0.5	760	25	<0.5
Toluene	ug/L	<0.5	12 C	0.71C	<0.5
Ethylbenzene	ug/L	<0.5	1100	130	<0.5
m,p-Xylenes	ug/L	0.67C	810	39	<0.5
o-Xylene	ug/L	<0.5	23	1.5	<0.5
Surrogate					
Trifluorotoluene	%REC	96	113	103	95
Bromofluorobenzene	%REC	100	115	119	97

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: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-011	HP-05-GW	47584	04/14/99	04/22/99	04/22/99	
138934-014	HP-06-GW	47584	04/14/99	04/23/99	04/23/99	
138934-016	HP-07-GW	47584	04/14/99	04/23/99	04/23/99	
138934-018	HP-08-GW	47637	04/14/99	04/26/99	04/26/99	

Matrix: Water

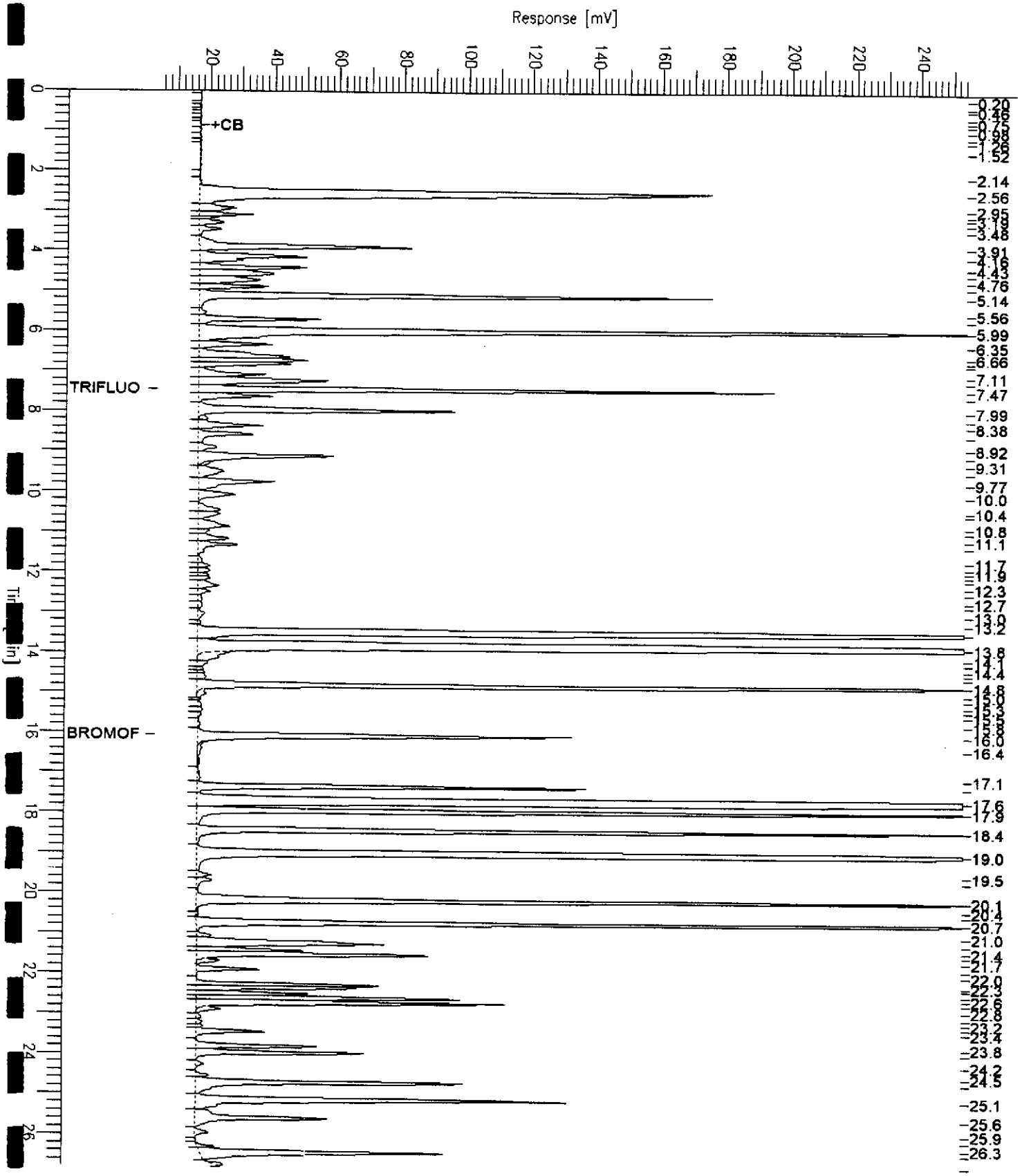
Analyte	Units	138934-011	138934-014	138934-016	138934-018
Diln Fac:		1	10	10	5
Gasoline C7-C12	ug/L	<50	54000 H	42000 H	13000 H
Surrogate					
Trifluorotoluene	%REC	109	115	118	107
Bromofluorobenzene	%REC	107	142	144	125

H: Heavier hydrocarbons than indicated standard

GC19 TVH 'X' Data File (FID)

Sample Name : 138934-014,47584
FileName : G:\GC19\DATA\112X022.raw
thod : TVHBTXE
art Time : 0.00 min End Time : 26.80 min
ale Factor: -1.0 Plot Offset: 4 mV

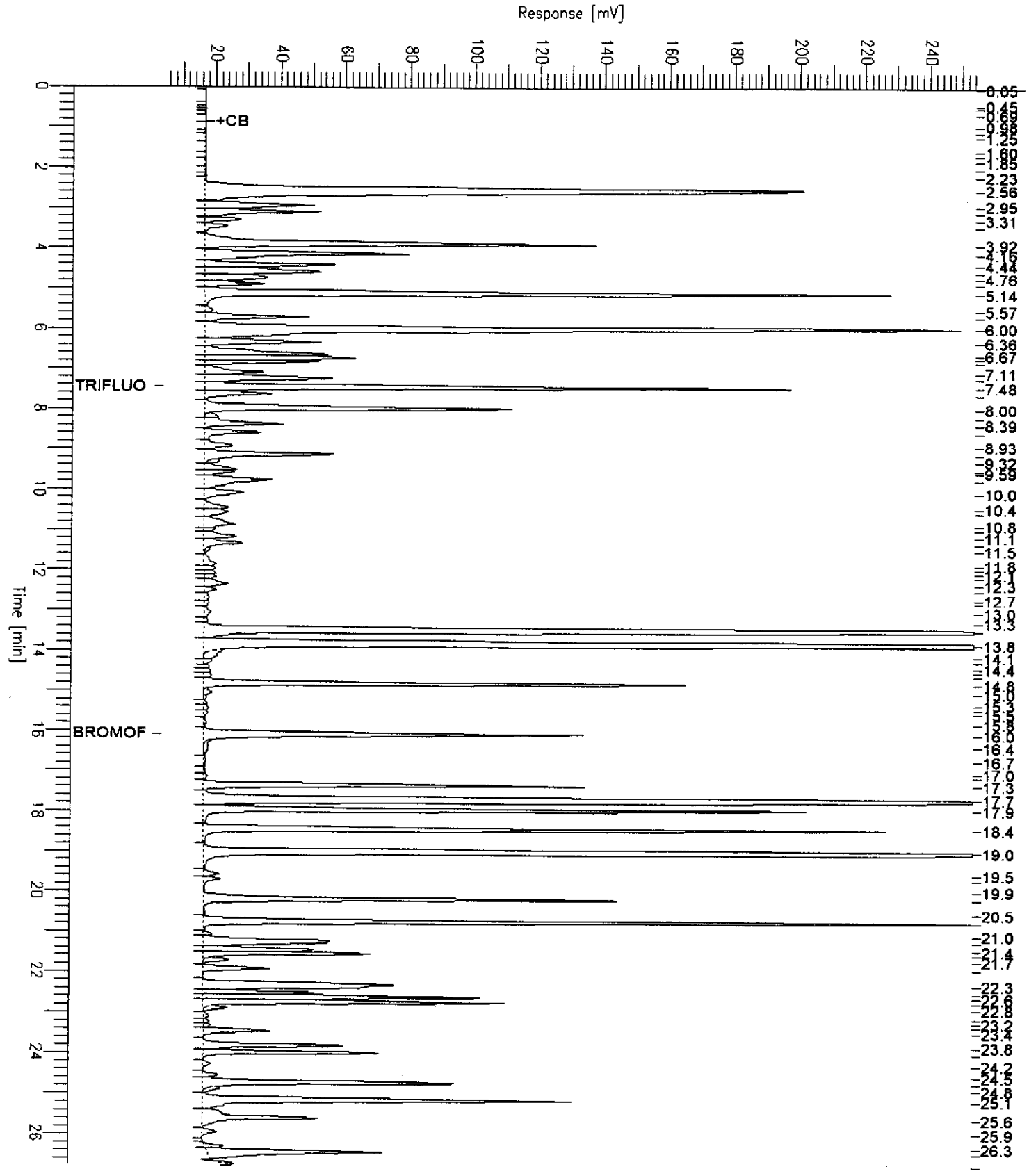
Sample #: Page 1 of 1
Date : 4/23/99 01:21 AM
Time of Injection: 4/23/99 12:54 AM
Low Point : 4.16 mV High Point : 254.16 mV
Plot Scale: 250.0 mV



GC19 TVH 'X' Data File (FID)

Sample Name : 138934-016,47584
FileName : G:\GC19\DATA\112X023.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

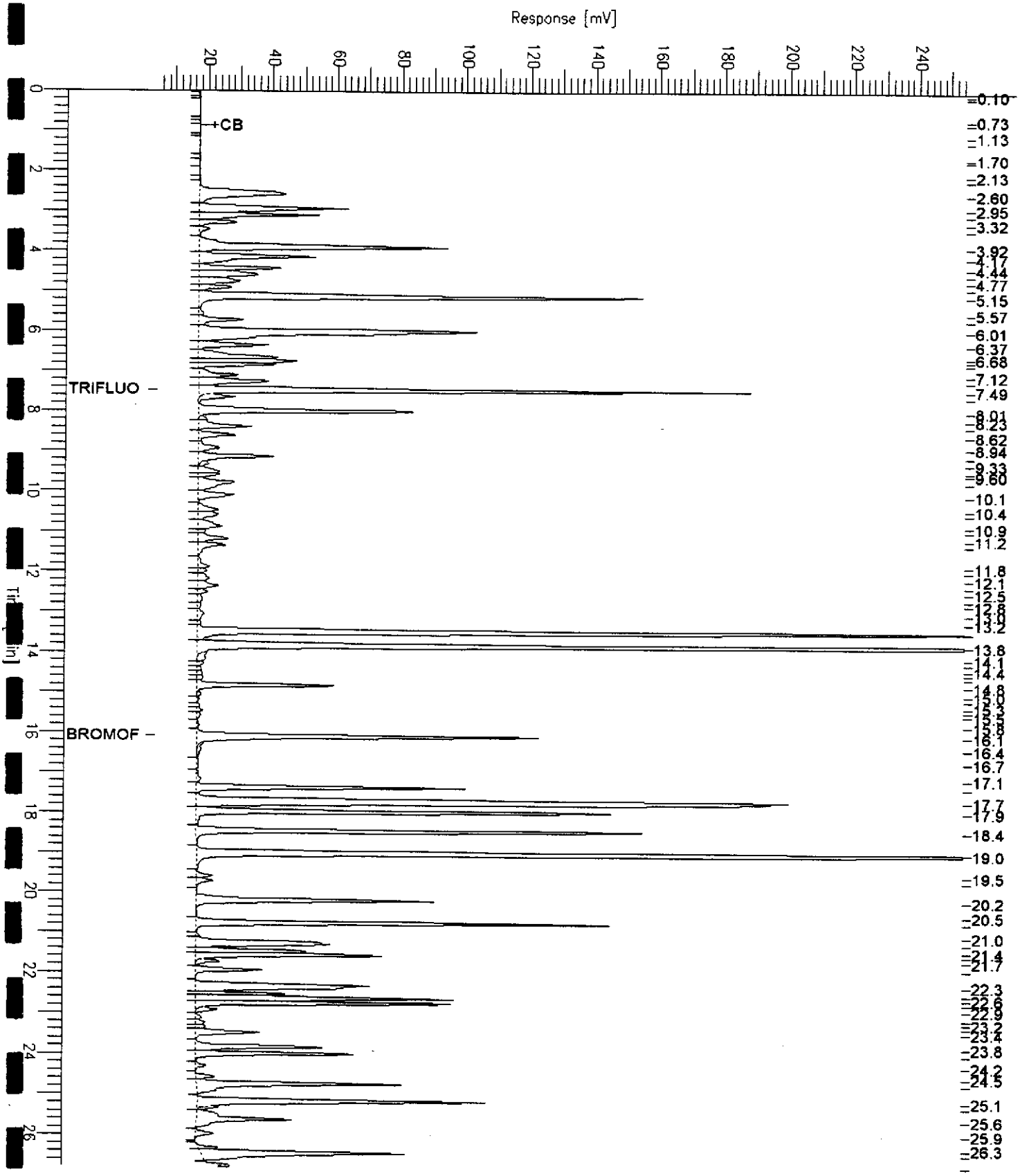
Sample #: Page 1 of 1
Date : 4/23/99 02:02 AM
Time of Injection: 4/23/99 01:34 AM
Low Point : 4.11 mV High Point : 254.11 mV
Plot Scale: 250.0 mV



GC19 TVH 'X' Data File (FID)

Sample Name : RR,138934-018,47637
FileName : G:\GC19\DATA\115X020.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

Sample #: Page 1 of 1
Date : 4/26/99 04:59 AM
Time of Injection: 4/26/99 04:32 AM
Low Point : 4.49 mV High Point : 254.49 mV
Plot Scale: 250.0 mV



BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-011	HP-05-GW	47584	04/14/99	04/22/99	04/22/99	
138934-014	HP-06-GW	47637	04/14/99	04/26/99	04/26/99	
138934-016	HP-07-GW	47637	04/14/99	04/26/99	04/26/99	
138934-018	HP-08-GW	47637	04/14/99	04/26/99	04/26/99	

Matrix: Water

Analyte Diln Fac:	Units	138934-011 1	138934-014 25	138934-016 25	138934-018 5
MTBE	ug/L	18	190	230	120
Benzene	ug/L	<0.5	830	750	150
Toluene	ug/L	<0.5	<13	49	5.4C
Ethylbenzene	ug/L	<0.5	2800	2500	570
m,p-Xylenes	ug/L	<0.5	10000	4800	860
o-Xylene	ug/L	<0.5	1000	490	71
Surrogate					
Trifluorotoluene	%REC	96	96	96	97
Bromofluorobenzene	%REC	98	100	100	103

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: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-020	HP-09-GW	47637	04/14/99	04/26/99	04/26/99	
138934-022	HP-10-GW	47637	04/14/99	04/26/99	04/26/99	

Matrix: Water

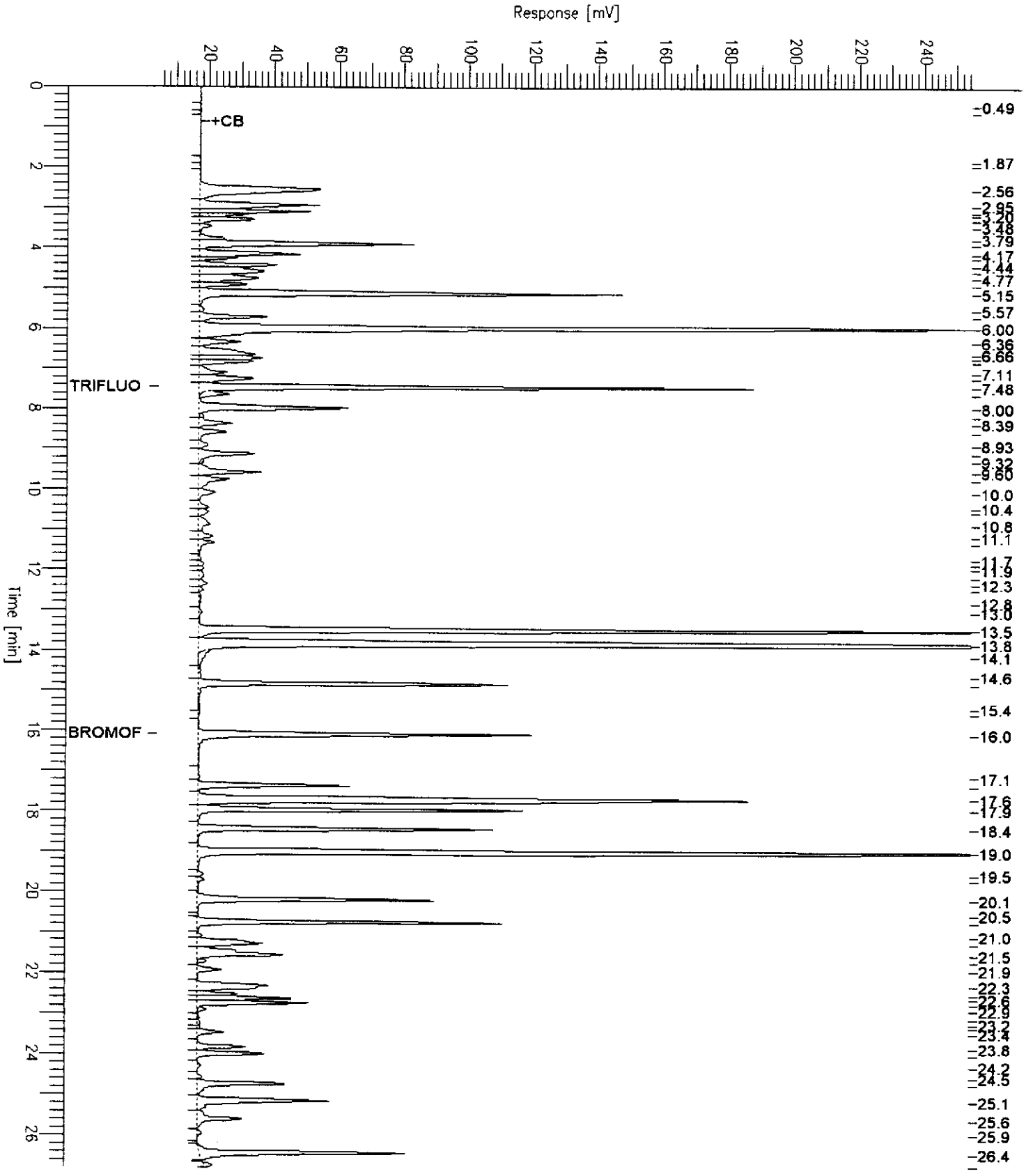
Analyte	Units	138934-020	138934-022
Diln Fac:		20	5
Gasoline C7-C12	ug/L	40000 H	23000 H
Surrogate			
Trifluorotoluene	%REC	108	108
Bromofluorobenzene	%REC	119	146

H: Heavier hydrocarbons than indicated standard

GC19 TVH 'X' Data File (FID)

Sample Name : RR,138934-020,47637
FileName : G:\GC19\DATA\115X019.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 5 mV

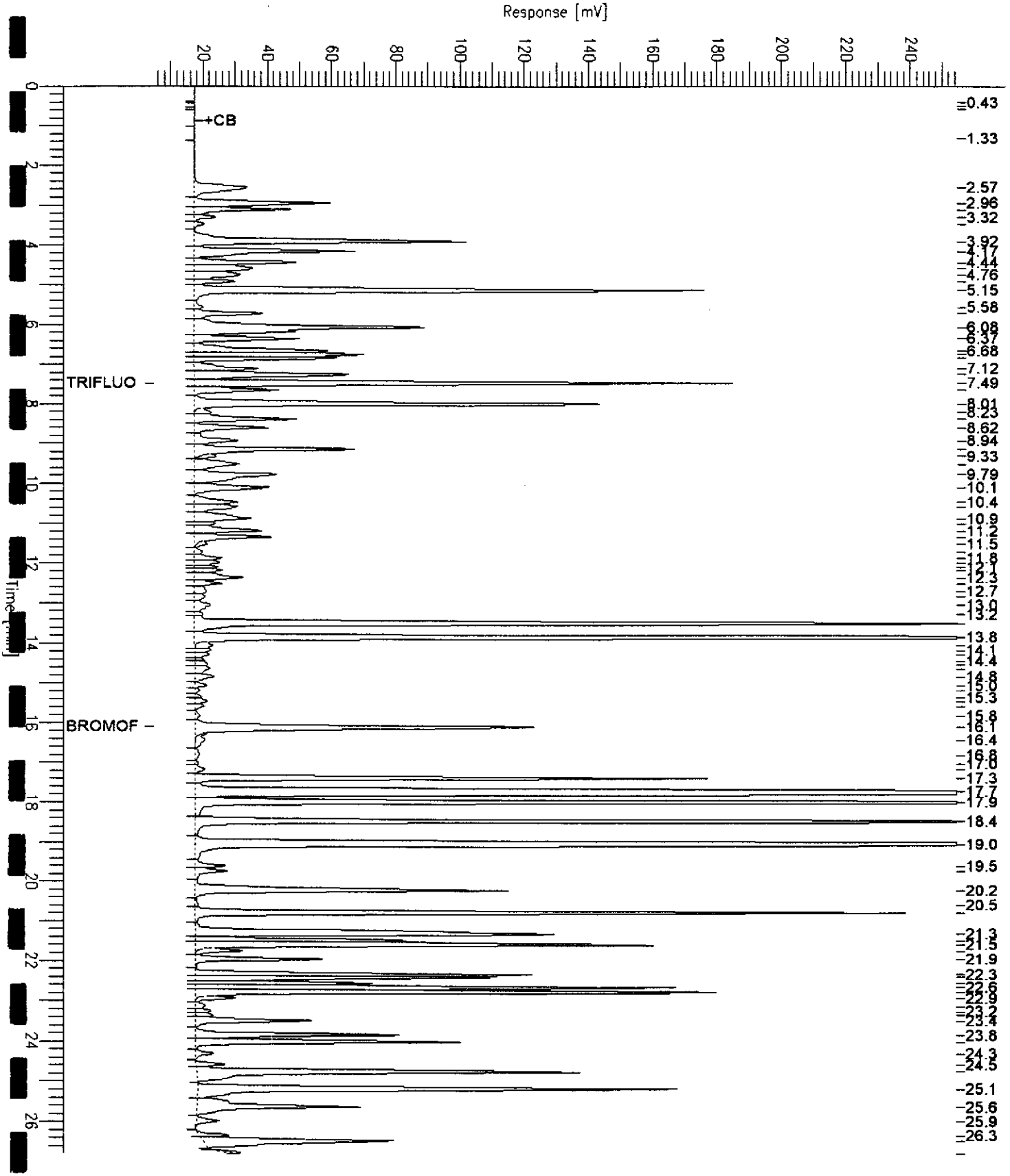
Sample #: Page 1 of 1
Date : 4/26/99 04:18 AM
Time of Injection: 4/26/99 03:51 AM
Low Point : 4.57 mV High Point : 254.57 mV
Plot Scale: 250.0 mV



GC19 TVH 'X' Data File (FID)

Sample Name : RR,138934-022,47637
FileName : G:\GC19\DATA\115X021.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 5 mV

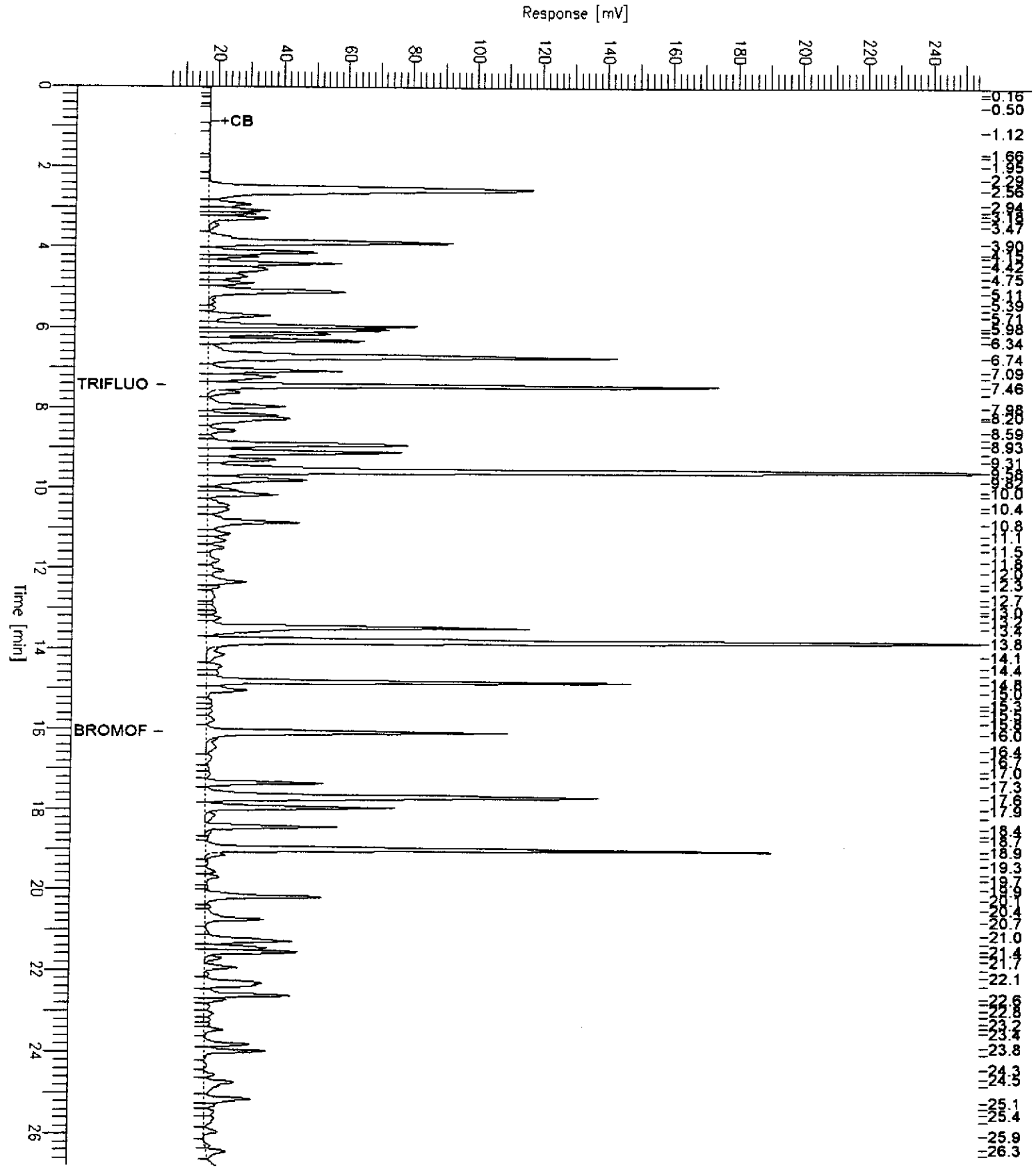
Sample #: Page 1 of 1
Date : 4/26/99 08:00 AM
Time of Injection: 4/26/99 05:12 AM
Low Point : 4.70 mV High Point : 254.70 mV
Plot Scale: 250.0 mV



GC19 TVH 'X' Data File (FID)

Sample Name : CCV/LCS,QC95815,99WS7368,47584
FileName : G:\GC19\DATA\112X001.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 5 mV

Sample #: GAS Page 1 of 1
Date : 4/22/99 11:02 AM
Time of Injection: 4/22/99 10:35 AM
Low Point : 4.63 mV High Point : 254.63 mV
Plot Scale: 250.0 mV



BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-020	HP-09-GW	47637	04/14/99	04/26/99	04/26/99	
138934-022	HP-10-GW	47637	04/14/99	04/26/99	04/26/99	

Matrix: Water

Analyte	Units	138934-020	138934-022
Diln Fac:		20	5
MTBE	ug/L	200	57
Benzene	ug/L	1700	53
Toluene	ug/L	110	3.2C
Ethylbenzene	ug/L	2100	600
m,p-Xylenes	ug/L	6200	920
o-Xylene	ug/L	690	8
Surrogate			
Trifluorotoluene	%REC	99	99
Bromofluorobenzene	%REC	102	108

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

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

METHOD BLANK

Matrix:	Water	Prep Date:	04/22/99
Batch#:	47584	Analysis Date:	04/22/99
Units:	ug/L		
Diln Fac:	1		

MB Lab ID: QC95817

Analyte	Result
Gasoline C7-C12	<50

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	96	53-150
Bromofluorobenzene	94	53-149

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

METHOD BLANK

Matrix: Water
Batch#: 47584
Units: ug/L
Diln Fac: 1

Prep Date: 04/22/99
Analysis Date: 04/22/99

MB Lab ID: QC95817

Analyte	Result
MTBE	<2.0
Benzene	<0.5
Toluene	<0.5
Ethylbenzene	<0.5
m,p-Xylenes	<0.5
o-Xylene	<0.5

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	83	51-143
Bromofluorobenzene	84	37-146

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

METHOD BLANK

Matrix:	Water	Prep Date:	04/25/99
Batch#:	47637	Analysis Date:	04/25/99
Units:	ug/L		
Diln Fac:	1		

MB Lab ID: QC96024

Analyte	Result
Gasoline C7-C12	<50

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	93	53-150
Bromofluorobenzene	92	53-149

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

METHOD BLANK

Matrix: Water
Batch#: 47637
Units: ug/L
Diln Fac: 1

Prep Date: 04/25/99
Analysis Date: 04/25/99

MB Lab ID: QC96024

Analyte	Result
MTBE	<2.0
Benzene	<0.5
Toluene	<0.5
Ethylbenzene	<0.5
m,p-Xylenes	<0.5
o-Xylene	<0.5

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	81	51-143
Bromofluorobenzene	83	37-146

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

TVH-Total Volatile Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

LABORATORY CONTROL SAMPLE

Matrix: Water
Batch#: 47584
Units: ug/L
Diln Fac: 1

Prep Date: 04/22/99
Analysis Date: 04/22/99

LCS Lab ID: QC95815

Analyte	Result	Spike Added	%Rec #	Limits
Gasoline C7-C12	1838	2000	92	77-117

Surrogate	%Rec	Limits
Trifluorotoluene	100	53-150
Bromofluorobenzene	109	53-149

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

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

LABORATORY CONTROL SAMPLE

Matrix: Water
Batch#: 47584
Units: ug/L
Diln Fac: 1

Prep Date: 04/22/99
Analysis Date: 04/22/99

LCS Lab ID: QC95816

Analyte	Result	Spike Added	%Rec #	Limits
MTBE	15.5	20	78	66-126
Benzene	16.64	20	83	65-111
Toluene	17.32	20	87	76-117
Ethylbenzene	17.26	20	86	71-121
m,p-Xylenes	36.08	40	90	80-123
o-Xylene	16.74	20	84	75-127

Surrogate	%Rec	Limits
Trifluorotoluene	86	51-143
Bromofluorobenzene	87	37-146

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits
Spike Recovery: 0 out of 6 outside limits

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

LABORATORY CONTROL SAMPLE

Matrix:	Water	Prep Date:	04/25/99
Batch#:	47637	Analysis Date:	04/25/99
Units:	ug/L		
Diln Fac:	1		

LCS Lab ID: QC96022

Analyte	Result	Spike Added	%Rec #	Limits
Gasoline C7-C12	1879	2000	94	77-117

Surrogate	%Rec	Limits
Trifluorotoluene	100	53-150
Bromofluorobenzene	115	53-149

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

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

LABORATORY CONTROL SAMPLE

Matrix: Water
Batch#: 47637
Units: ug/L
Diln Fac: 1

Prep Date: 04/25/99
Analysis Date: 04/25/99

LCS Lab ID: QC96023

Analyte	Result	Spike Added	%Rec #	Limits
MTBE	15.56	20	78	66-126
Benzene	16.98	20	85	65-111
Toluene	18.33	20	92	76-117
Ethylbenzene	18.28	20	91	71-121
m,p-Xylenes	38.36	40	96	80-123
o-Xylene	17.81	20	89	75-127

Surrogate	%Rec	Limits
Trifluorotoluene	88	51-143
Bromofluorobenzene	92	37-146

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits
Spike Recovery: 0 out of 6 outside limits

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Field ID: HP-03-GW
Lab ID: 138934-007
Matrix: Water
Batch#: 47584
Units: ug/L
Diln Fac: 1

Sample Date: 04/14/99
Received Date: 04/15/99
Prep Date: 04/22/99
Analysis Date: 04/22/99

MS Lab ID: QC95818

Analyte	Spike Added	Sample	MS	%Rec	#	Limits
MTBE	20	30.9	45.69	74		49-136
Benzene	20	24.85	42.44	88		55-122
Toluene	20	0.71	21.97	106		63-139
Ethylbenzene	20	133.6	142.8	46	*	61-137
m,p-Xylenes	40	38.83	79.53	102		57-148
o-Xylene	20	1.53	21.2	98		70-141

Surrogate	%Rec	Limits
Trifluorotoluene	105	51-143
Bromofluorobenzene	121	37-146

MSD Lab ID: QC95819

Analyte	Spike Added	MSD	%Rec	#	Limits	RPD	#	Limit
MTBE	20	46.93	80		49-136	3		11
Benzene	20	42.12	86		55-122	1		10
Toluene	20	20.82	101		63-139	5		10
Ethylbenzene	20	138.4	24	*	61-137	3		10
m,p-Xylenes	40	78.93	100		57-148	1		10
o-Xylene	20	21.63	101		70-141	2		10

Surrogate	%Rec	Limits
Trifluorotoluene	104	51-143
Bromofluorobenzene	119	37-146

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits
RPD: 0 out of 6 outside limits
Spike Recovery: 2 out of 12 outside limits

Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Field ID: ZZZZZZ
Lab ID: 138932-003
Matrix: Water
Batch#: 47637
Units: ug/L
Diln Fac: 1

Sample Date: 04/14/99
Received Date: 04/14/99
Prep Date: 04/25/99
Analysis Date: 04/25/99

MS Lab ID: QC96025

Analyte	Spike Added	Sample	MS	%Rec #	Limits
MTBE	20	<2	17.84	89	49-136
Benzene	20	<0.5	17.69	88	55-122
Toluene	20	<0.5	18.93	95	63-139
Ethylbenzene	20	<0.5	18.86	94	61-137
m,p-Xylenes	40	<0.5	39.64	99	57-148
o-Xylene	20	<0.5	18.53	93	70-141

Surrogate	%Rec	Limits
Trifluorotoluene	100	51-143
Bromofluorobenzene	101	37-146

MSD Lab ID: QC96026

Analyte	Spike Added	MSD	%Rec #	Limits	RPD #	Limit
MTBE	20	18.03	90	49-136	1	11
Benzene	20	17.97	90	55-122	2	10
Toluene	20	19.28	96	63-139	2	10
Ethylbenzene	20	19.21	96	61-137	2	10
m,p-Xylenes	40	40.36	101	57-148	2	10
o-Xylene	20	18.84	94	70-141	2	10

Surrogate	%Rec	Limits
Trifluorotoluene	94	51-143
Bromofluorobenzene	97	37-146

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits
RPD: 0 out of 6 outside limits
Spike Recovery: 0 out of 12 outside limits

Curtis & Tompkins, Ltd.

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: CA LUFT

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-001	HP-01-17.5'	47503	04/14/99	04/19/99	04/22/99	
138934-003	HP-02-14'	47503	04/14/99	04/19/99	04/24/99	
138934-006	HP-03-13'	47503	04/14/99	04/19/99	04/22/99	
138934-008	HP-04-15'	47503	04/14/99	04/19/99	04/22/99	

Matrix: Soil

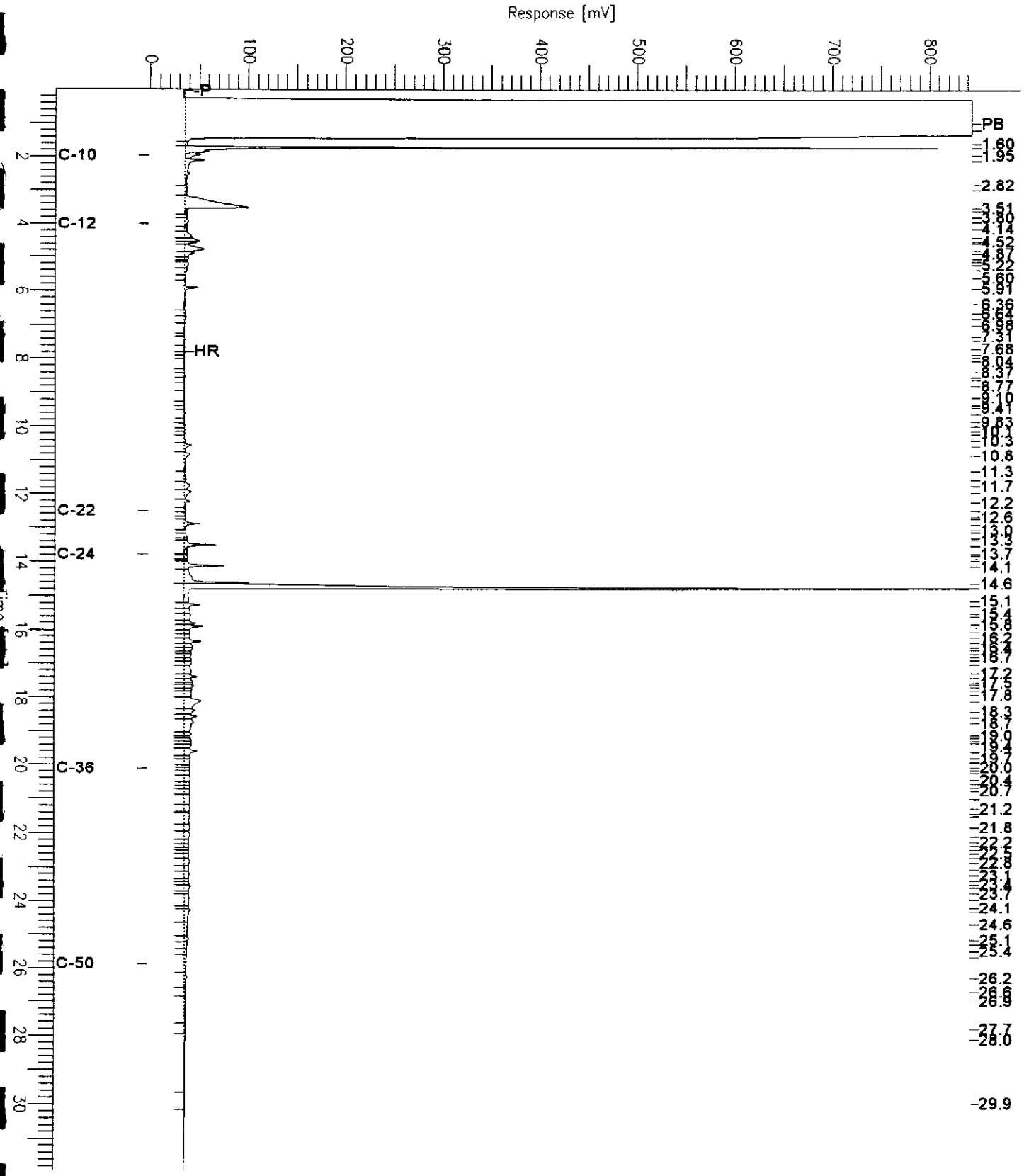
Analyte	Units	138934-001	138934-003	138934-006	138934-008
Diln Fac:		1	50	1	1
Diesel C10-C24	mg/Kg	3.8YLZ	640 YL	5.8YLZ	1.7YLZ
Surrogate					
Hexacosane	%REC	106	DO	99	104

DO: Surrogate diluted out
Y: Sample exhibits fuel pattern which does not resemble standard
Z: Sample exhibits unknown single peak or peaks
L: Lighter hydrocarbons than indicated standard

Chromatogram

Sample Name : 138934-001,47503
FileName : C:\GC15\CHB\110B048.RAW
Method : B082TEH.MTH
Start Time : 0.01 min End Time : 31.91 min
Scale Factor: 0.0 Plot Offset: -2 mV

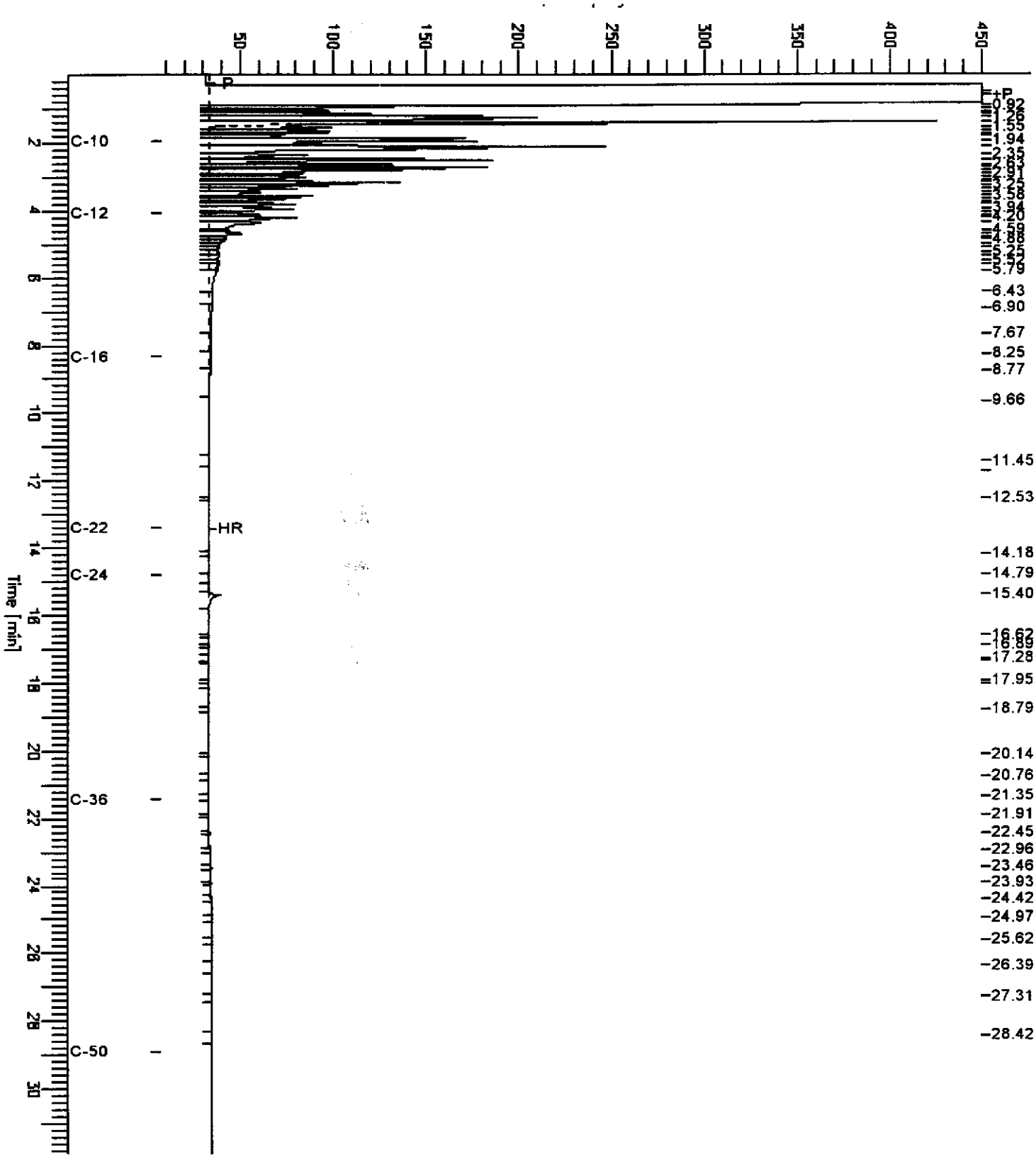
Sample #: 47503 Page 1 of 1
Date : 4/22/99 01:51 PM
Time of Injection: 4/22/99 01:18 PM
Low Point : -1.98 mV High Point : 844.11 mV
Plot Scale: 846.1 mV



Chromatogram

Sample Name : 138934-003,47503
FileName : G:\GC11\CHA\112A054.RAW
Method : ATEH055.MTH
Start Time : 0.01 min End Time : 31.91 min
Scale Factor: 0.0 Plot Offset: 7 mV

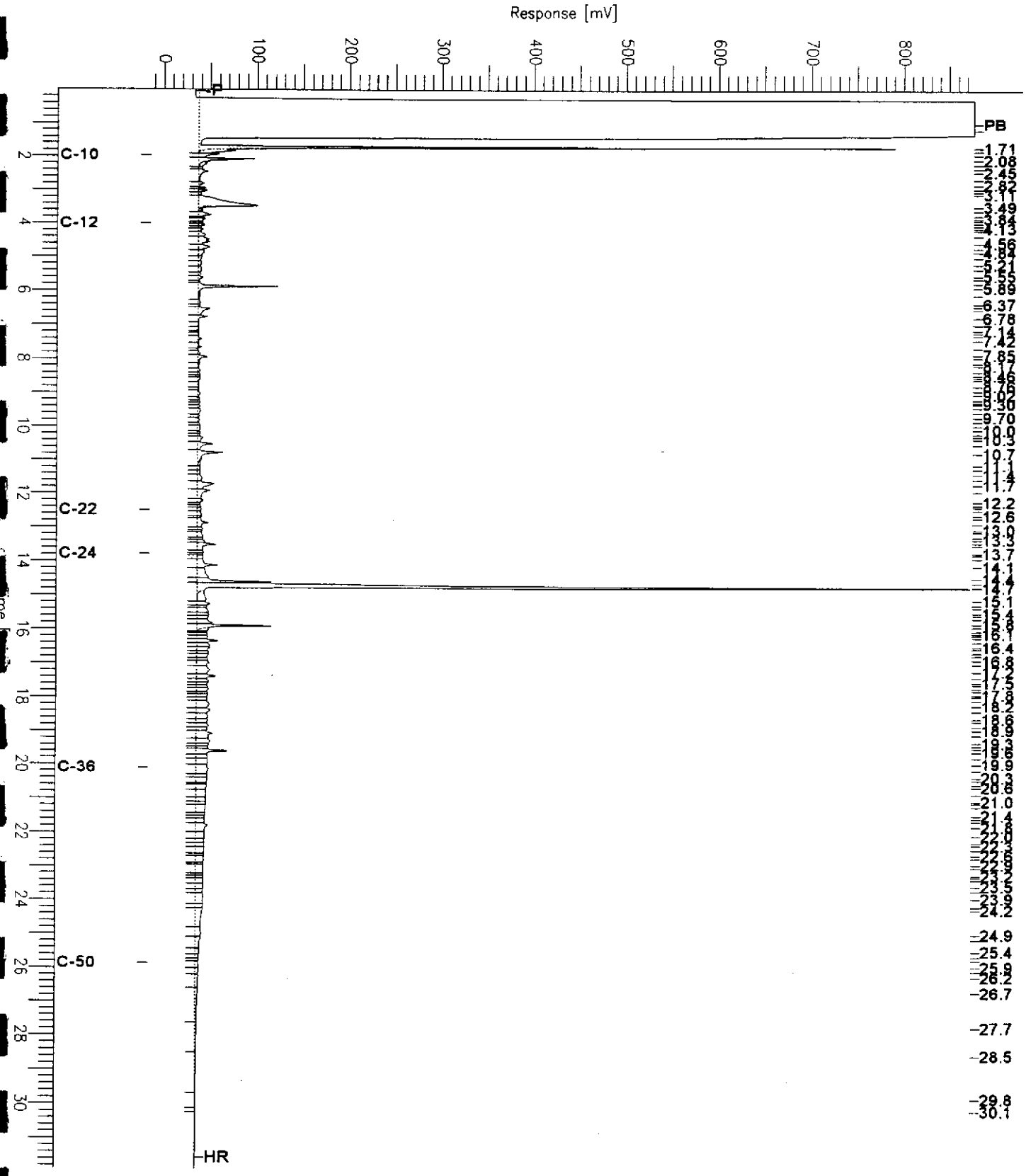
Sample #: 47503 Page 1 of 1
Date : 4/24/99 04:12 PM
Time of Injection: 4/24/99 05:33 AM
Low Point : 7.38 mV High Point : 450.31 mV
Plot Scale: 442.9 mV



Chromatogram

Sample Name : 138934-006,47503
FileName : C:\GC15\CHB\110B050.RAW
Method : B082TEH.MTH
Start Time : 0.01 min End Time : 31.91 min
Scale Factor: 0.0 Plot Offset: -15 mV

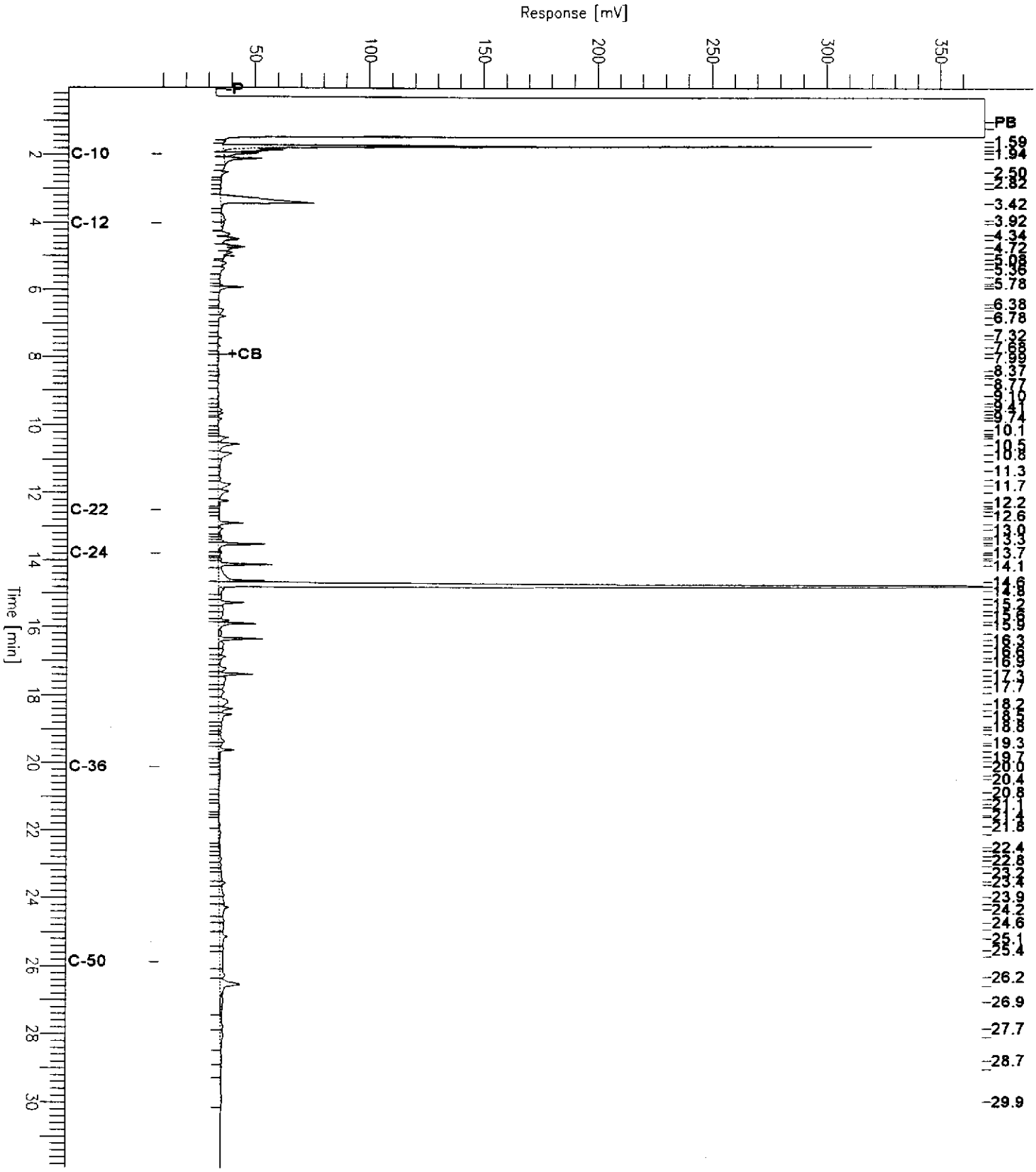
Sample #: 47503 Page 1 of 1
Date : 4/22/99 04:02 PM
Time of Injection: 4/22/99 02:43 PM
Low Point : -14.76 mV High Point : 876.75 mV
Plot Scale: 891.5 mV



Chromatogram

Sample Name : 138934-00847503
FileName : C:\GC15\CHB\110B051.RAW
Method : B082TEH.MTH
Start Time : 0.01 min End Time : 31.91 min
Scale Factor: 0.0 Plot Offset: 9 mV

Sample #: 47503 Page 1 of 1
Date : 4/22/99 04:03 PM
Time of Injection: 4/22/99 03:26 PM
Low Point : 9.33 mV High Point : 369.49 mV
Plot Scale: 360.2 mV



TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: CA LUFT

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-010	HP-05-15'	47503	04/14/99	04/19/99	04/22/99	
138934-012	HP-06-11'	47503	04/14/99	04/19/99	04/23/99	
138934-015	HP-07-12'	47503	04/14/99	04/19/99	04/23/99	
138934-017	HP-08-15.5'	47503	04/14/99	04/19/99	04/22/99	

Matrix: Soil

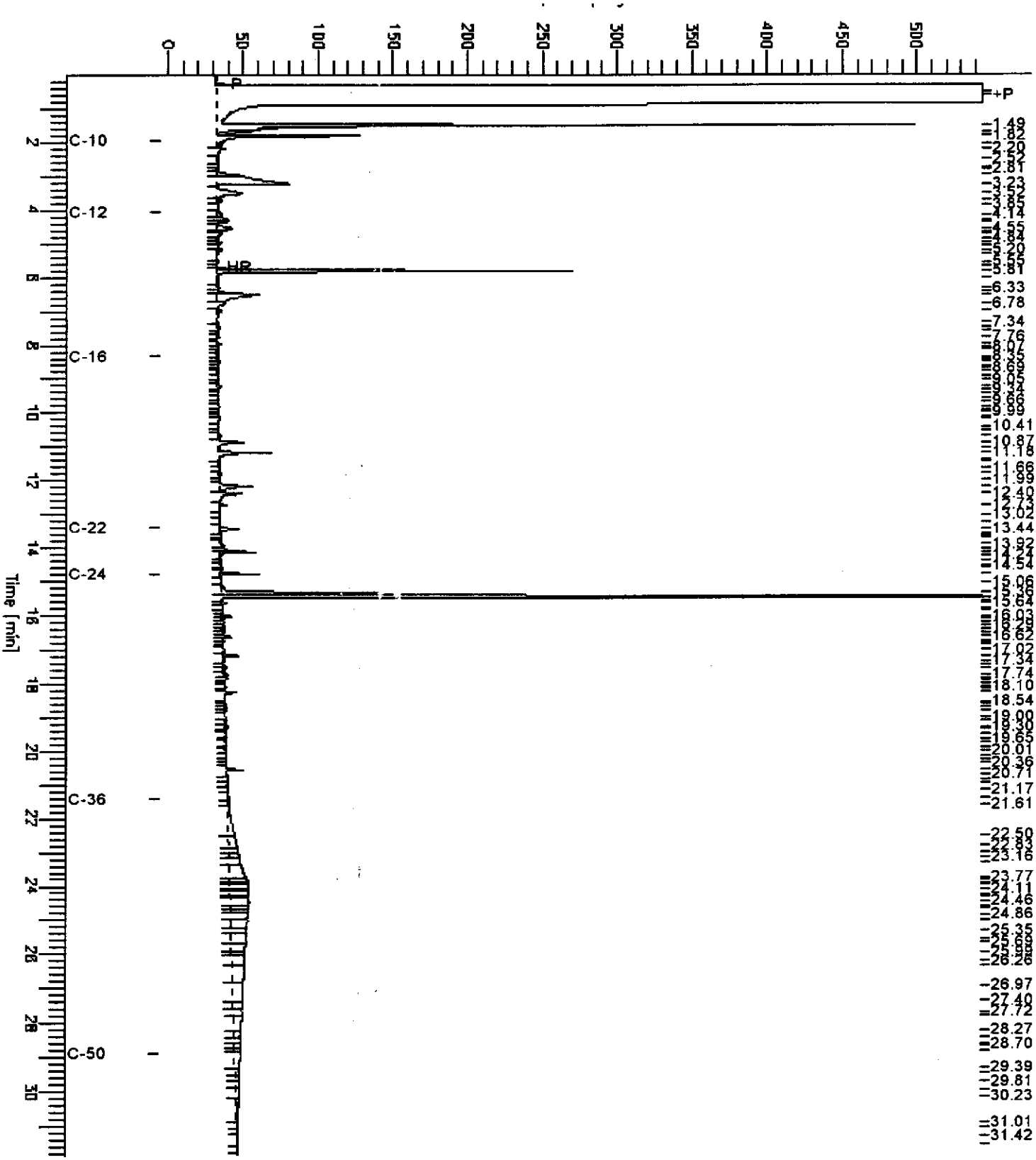
Analyte	Units	138934-010	138934-012	138934-015	138934-017
Diln Fac:		1	5	5	1
Diesel C10-C24	mg/Kg	4.3YL	360 YL	340 YL	83 YL
Surrogate					
Hexacosane	%REC	105	98	106	101

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

Chromatogram

Sample Name : 138934-010,47503
FileName : G:\GC11\CHA\112A007.RAW
Method : ATEH055.MTH
Start Time : 0.01 min End Time : 31.42 min
Scale Factor: 0.0 Plot Offset: -6 mV

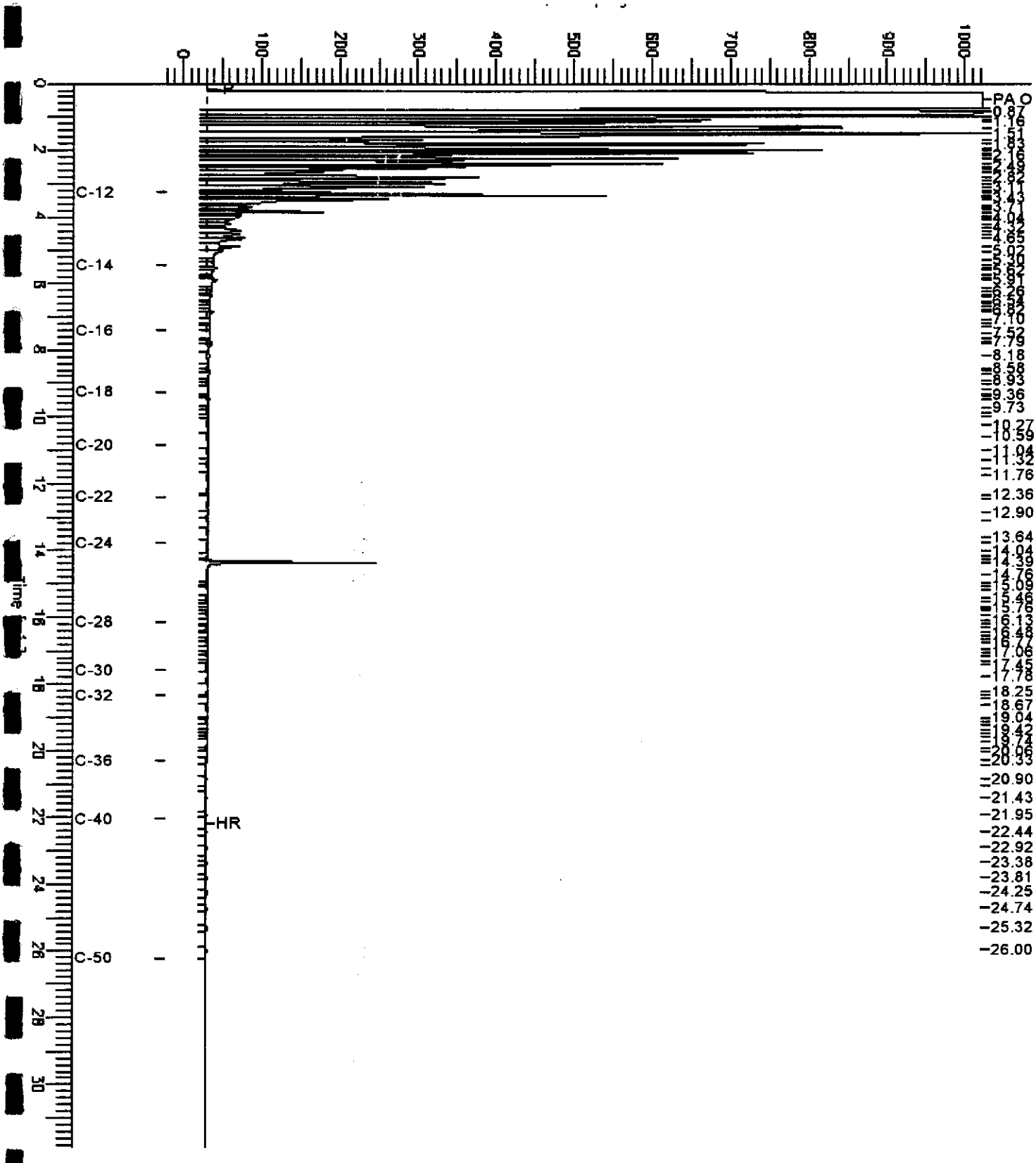
Sample #: 47503 Page 1 of 1
Date : 4/23/99 09:17 AM
Time of Injection: 4/22/99 06:03 PM
Low Point : -5.73 mV High Point : 544.72 mV
Plot Scale: 550.5 mV



Chromatogram

Sample Name : 138934-012,47503
FileName : G:\GC13\CHB\112B048.RAW
Method : BTEH015X.MTH
Start Time : 0.00 min End Time : 31.30 min
Scale Factor: 0.0 Plot Offset: -22 mV

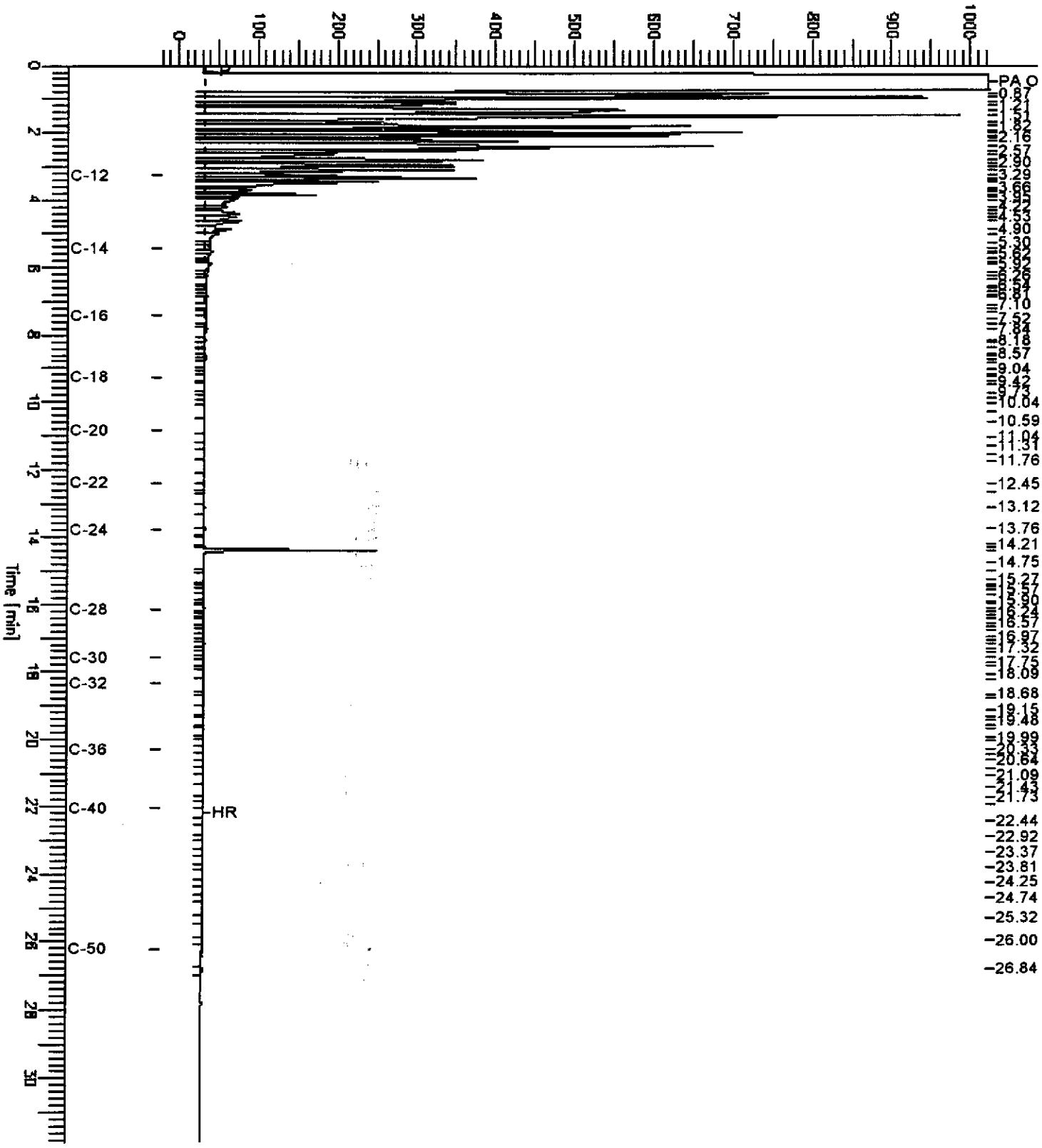
Sample #: 47503 Page 1 of 1
Date : 4/24/99 01:47 PM
Time of Injection: 4/23/99 11:11 PM
Low Point : -22.06 mV High Point : 1024.00 mV
Plot Scale: 1046.1 mV



Chromatogram

Sample Name : 138934-015,47503
FileName : G:\GC13\CHB\112B049.RAW
Method : BTEH015X.MTH
Start Time : 0.00 min End Time : 31.90 min
Scale Factor: 0.0 Plot Offset: -22 mV

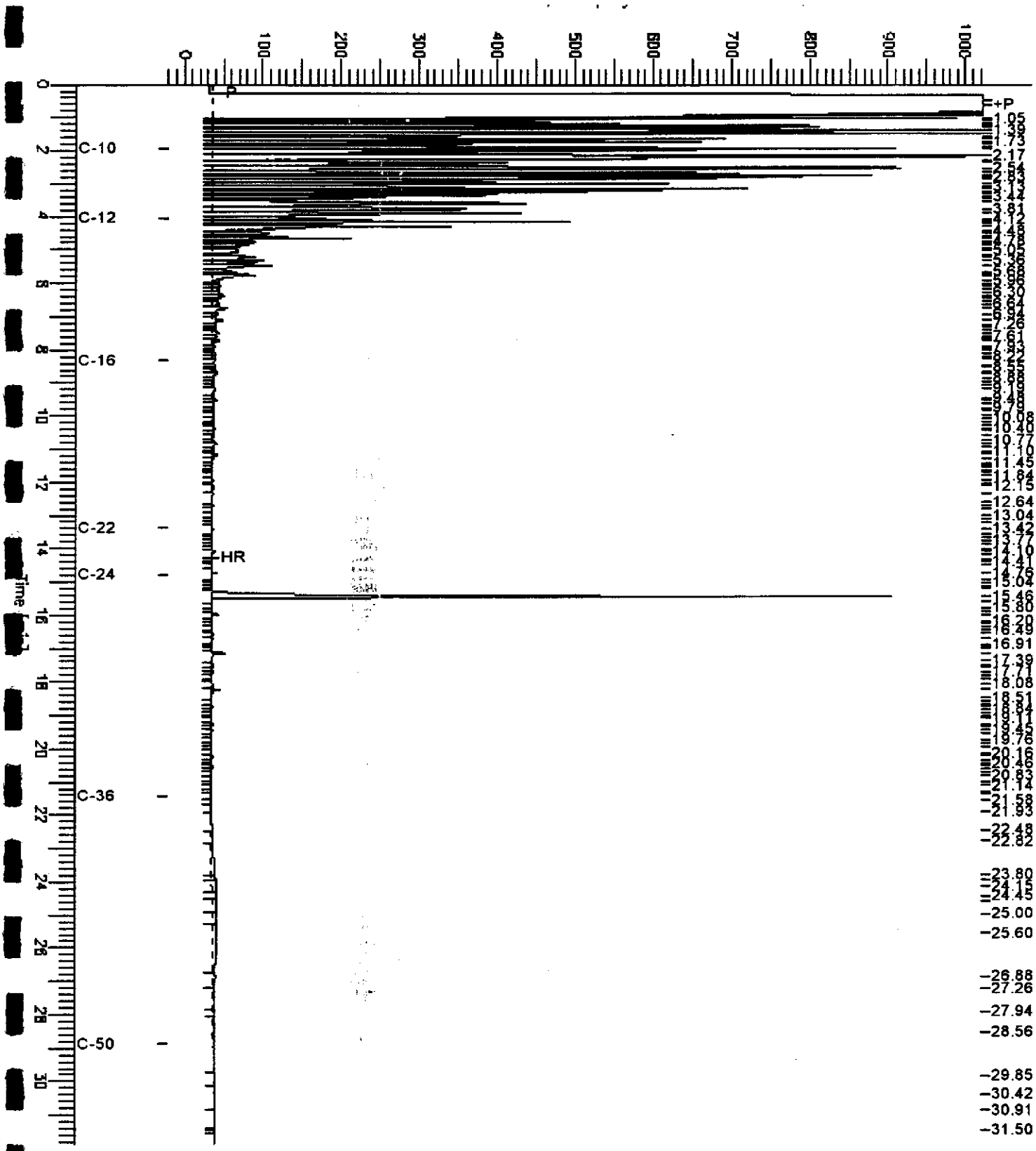
Sample #: 47503 Page 1 of 1
Date : 4/24/99 01:48 PM
Time of Injection: 4/23/99 11:53 PM
Low Point : -22.01 mV High Point : 1024.00 mV
Plot Scale: 1046.0 mV



Chromatogram

Sample Name : mss,138934-017,47503
FileName : G:\GC11\CHA\112A010.RAW
Method : ATEH055.MTH
Start Time : 0.00 min End Time : 31.90 min
Scale Factor: 0.0 Plot Offset: -21 mV

Sample #: 47503 Page 1 of 1
Date : 4/23/99 09:59 AM
Time of Injection: 4/22/99 08:03 PM
Low Point : -21.27 mV High Point : 1024.00 mV
Plot Scale: 1045.3 mV



TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: CA LUFT

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-019	HP-09-15'	47503	04/14/99	04/19/99	04/24/99	
138934-021	HP-10-14'	47503	04/14/99	04/19/99	04/22/99	

Matrix: Soil

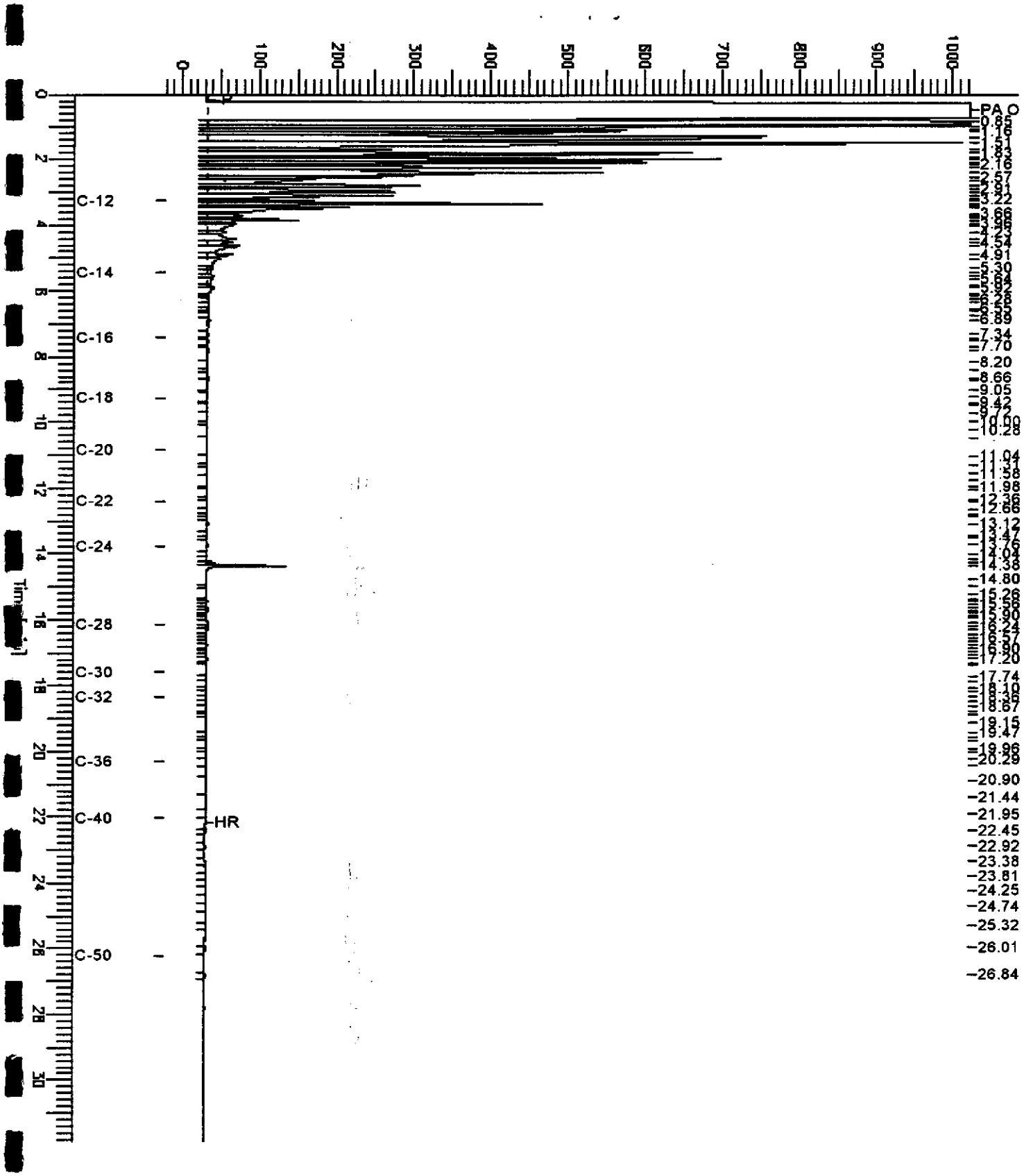
Analyte	Units	138934-019	138934-021
Diln Fac:		10	1
Diesel C10-C24	mg/Kg	630 YL	76 YL
Surrogate			
Hexacosane	%REC	DO	104

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

Chromatogram

Sample Name : 138934-019,47503
FileName : G:\GC13\CHB\112B050.RAW
Method : BTEH015X.MTH
Start Time : 0.00 min End Time : 31.90 min
Scale Factor: 0.0 Plot Offset: -22 mV

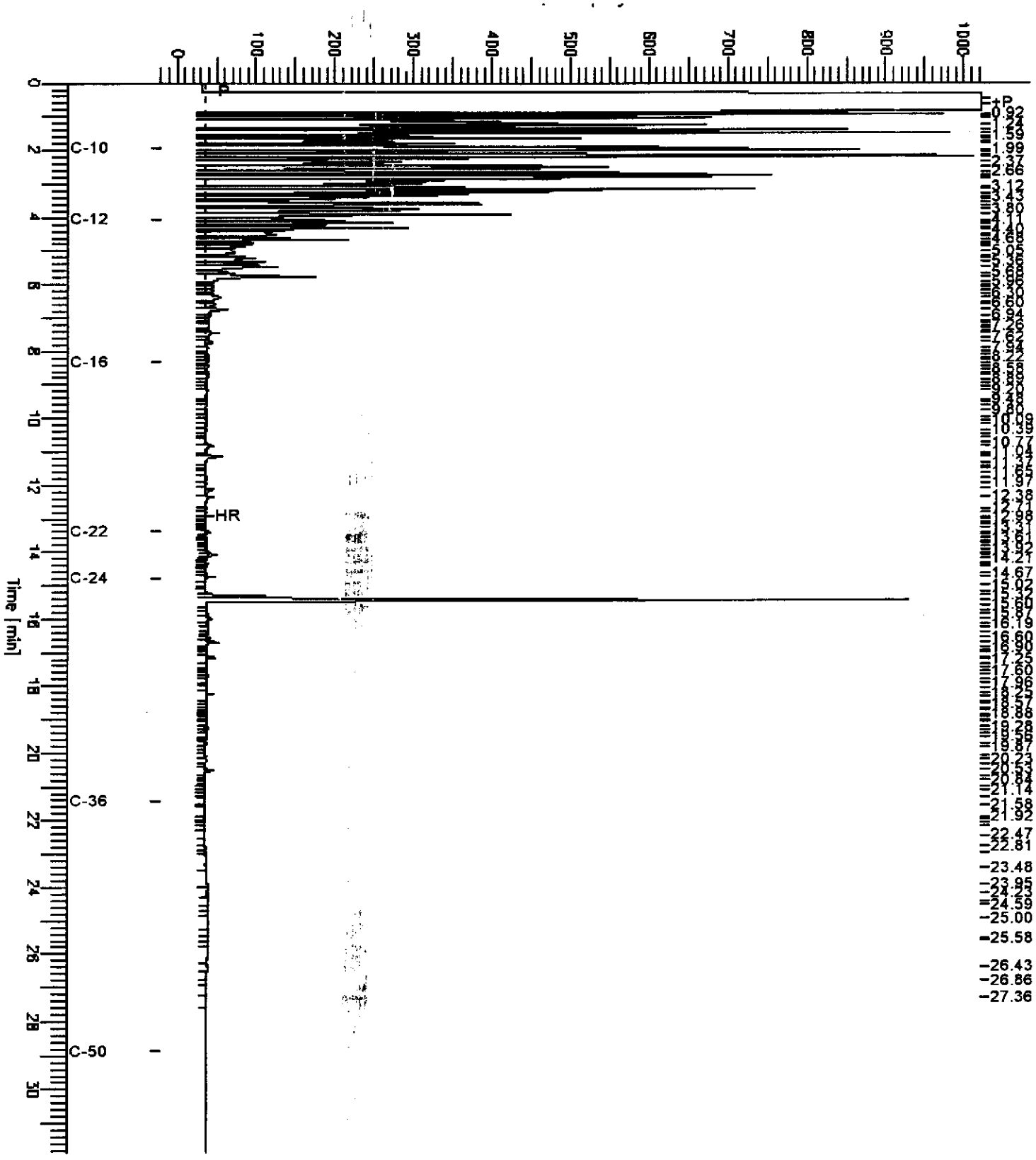
Sample #: 47503 Page 1 of 1
Date : 4/24/99 01:49 PM
Time of Injection: 4/24/99 12:35 AM
Low Point : -21.93 mV High Point : 1024.00 mV
Plot Scale: 1045.9 mV



Chromatogram

Sample Name : 138934-021,47503
FileName : G:\GC11\CHA\112A012.RAW
Method : ATEH055.MTH
Start Time : 0.00 min End Time : 31.90 min
Scale Factor: 0.0 Plot Offset: -21 mV

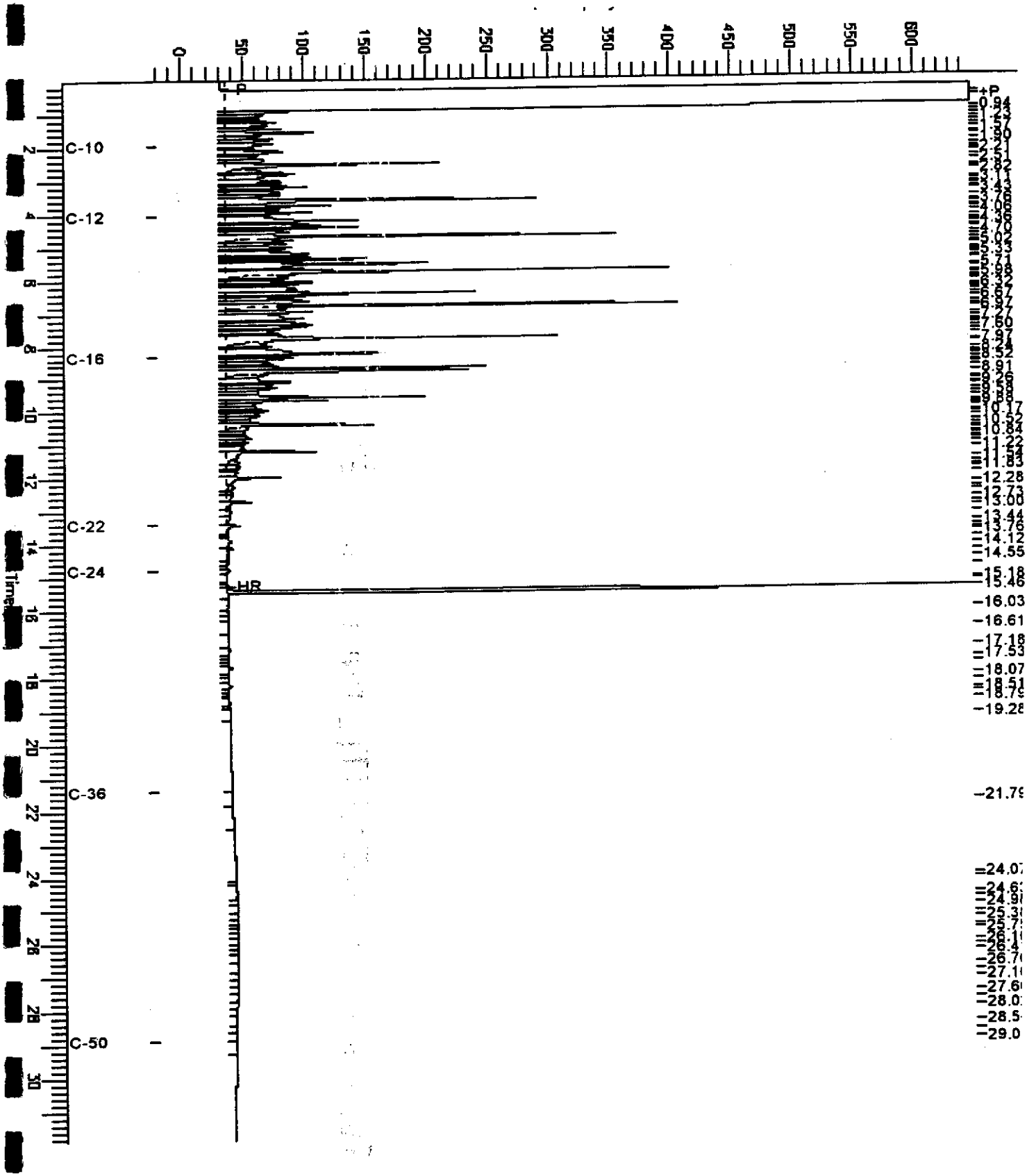
Sample #: 47503 Page 1 of 1
Date : 4/23/99 09:38 AM
Time of Injection: 4/22/99 09:24 PM
Low Point : -21.32 mV High Point : 1024.00 mV
Plot Scale: 1045.3 mV



Chromatogram

Sample Name : x,ccv,99ws7346,dsl
FileName : G:\GC11\CHA\999A001.RAW
Method : ATEH055.MTH
Start Time : 0.01 min
Sample Factor: 0.0
End Time : 31.91 min
Plot Offset: -20 mV

Sample #: 500mg/l
Date : 4/22/99 01:00 PM
Time of Injection: 4/22/99 12:14 PM
Low Point : -20.16 mV
High Point : 648.19 mV
Plot Scale: 668.4 mV



Curtis & Tompkins, Ltd.

Lab #: 138934 BATCH QC REPORT

TEH-Tot Ext Hydrocarbons			
Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	CA LUFT
Location:	Redwood Regional Park		

METHOD BLANK			
Matrix:	Soil	Prep Date:	04/19/99
Batch#:	47503	Analysis Date:	04/21/99
Units:	mg/Kg		
Diln Fac:	1		

MB Lab ID: QC95527

Analyte	Result
Diesel C10-C24	<1.0

Surrogate	%Rec	Recovery Limits
Hexacosane	90	52-137

Lab #: 138934

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TEH-Tot Ext Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	CA LUFT
Location:	Redwood Regional Park		

LABORATORY CONTROL SAMPLE

Matrix:	Soil	Prep Date:	04/19/99
Batch#:	47503	Analysis Date:	04/21/99
Units:	mg/Kg		
Diln Fac:	1		

LCS Lab ID: QC95528

Analyte	Result	Spike Added	%Rec #	Limits
Diesel C10-C24	41.59	49.5	84	52-117
Surrogate	**%Rec**	**Limits**		
Hexacosane	93	52-137		

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 #: 138934

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TEH-Tot Ext Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	CA LUFT
Location:	Redwood Regional Park		

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Field ID:	HP-08-15.5'	Sample Date:	04/14/99
Lab ID:	138934-017	Received Date:	04/15/99
Matrix:	Soil	Prep Date:	04/19/99
Batch#:	47503	Analysis Date:	04/23/99
Units:	mg/Kg		
Diln Fac:	1		

MS Lab ID: QC95529

Analyte	Spike Added	Sample	MS	%Rec #	Limits
Diesel C10-C24	49.5	82.65	128.3	92	41-135

Surrogate	%Rec	Limits
Hexacosane	100	52-137

MSD Lab ID: QC95530

Analyte	Spike Added	MSD	%Rec #	Limits	RPD #	Limit
Diesel C10-C24	49.5	143.4	123	41-135	11	37

Surrogate	%Rec	Limits
Hexacosane	96	52-137

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

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 3520

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-002	HP-01-GW	47490	04/14/99	04/16/99	04/22/99	
138934-005	HP-02-GW UNFILTERED	47490	04/14/99	04/16/99	04/28/99	
138934-009	HP-04-GW	47490	04/14/99	04/16/99	04/23/99	
138934-011	HP-05-GW	47490	04/14/99	04/16/99	04/23/99	

Matrix: Water

Analyte	Units	138934-002		138934-005		138934-009	138934-011
Diln Fac:		1		50		1	1
Diesel C10-C24	ug/L	850	LY	270000	YL	<50	<50
Surrogate							
Hexacosane	%REC	98			DO	95	99

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

Curtis & Tompkins, Ltd.

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 3520

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
139452-001	HP-03-GW	48109	04/14/99	05/17/99	05/18/99	

Matrix: Water

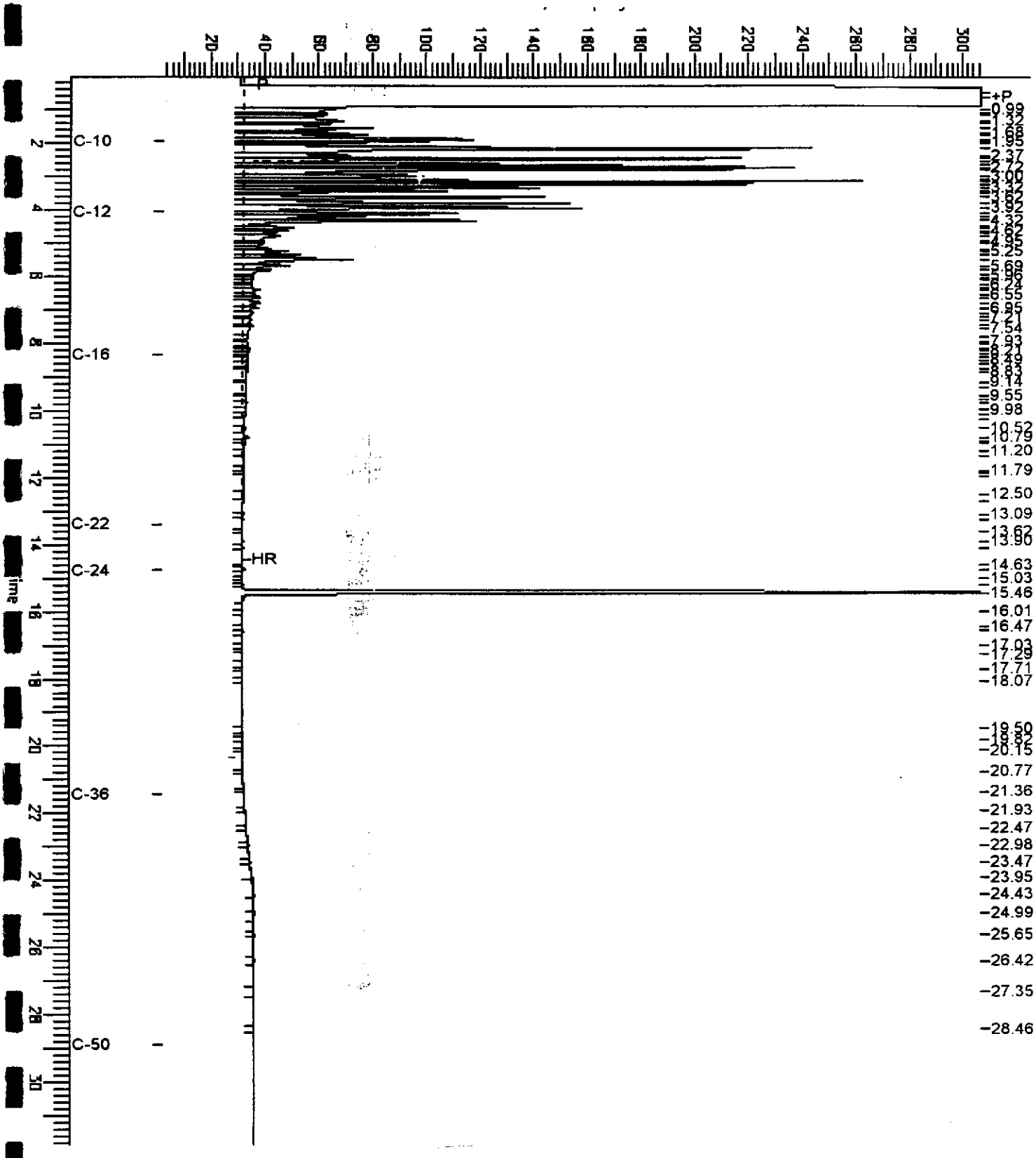
Analyte	Units	139452-001
Dilu Fac:		1
Diesel C10-C24	ug/L	1400 YL
Surrogate		
Hexacosane	%REC	73

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

Chromatogram

Sample Name : 138934-002,47490
FileName : G:\GC11\CHA\112A015.RAW
Method : ATEH055.MTH
Start Time : 0.05 min End Time : 31.91 min
Scale Factor: 0.0 Plot Offset: 2 mV

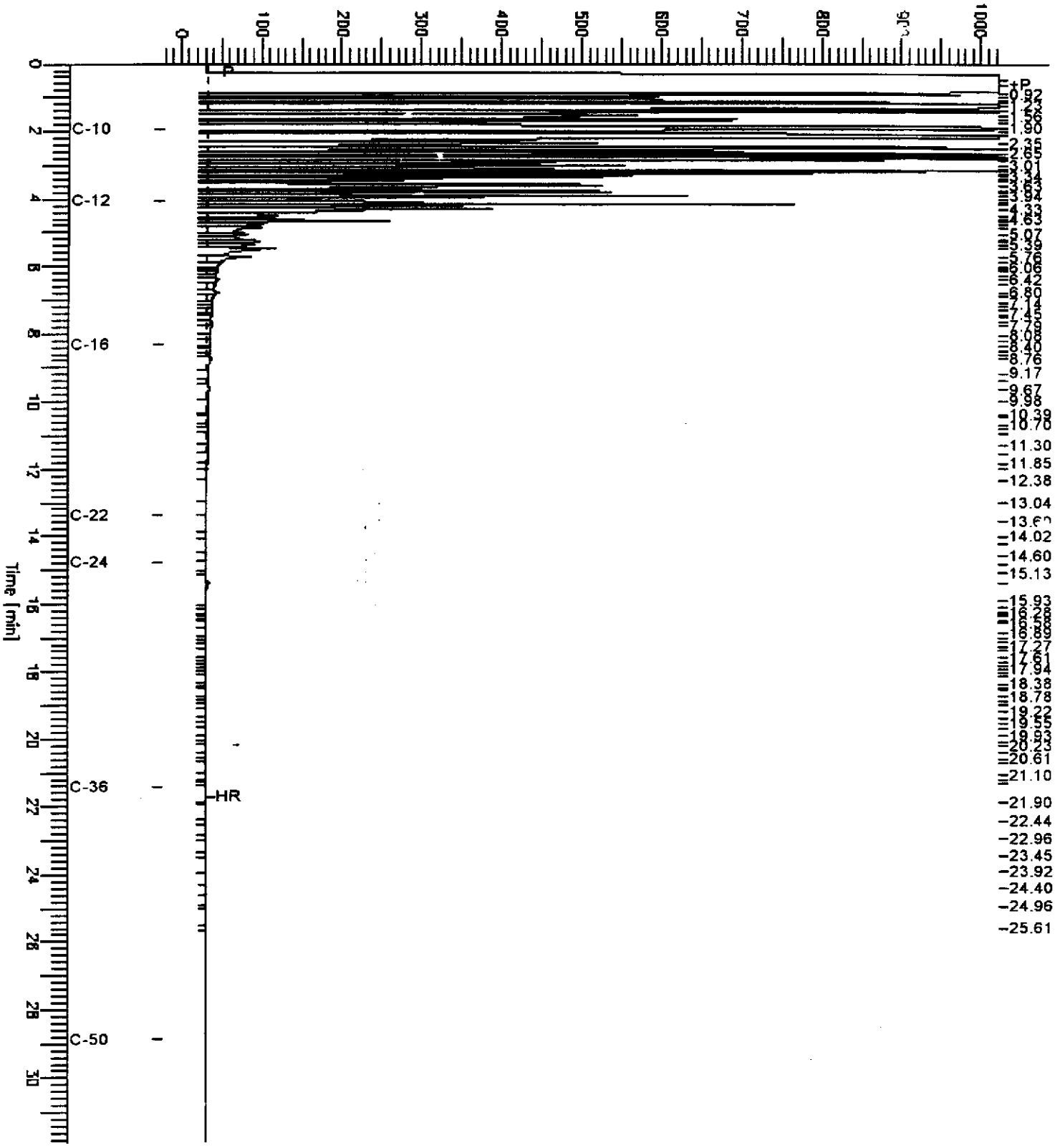
Sample #: 47490 Page 1 of 1
Date : 4/23/99 09:41 AM
Time of Injection: 4/22/99 11:25 PM
Low Point : 2.38 mV High Point : 307.17 mV
Plot Scale: 304.8 mV



Chromatogram

Sample Name : 138934-005,47490
FileName : G:\GC11\CHA\117A017.RAW
Method : ATEH055.MTH
Start Time : 0.00 min End Time : 31.90 min
Scale Factor: 0.0 Plot Offset: -22 mV

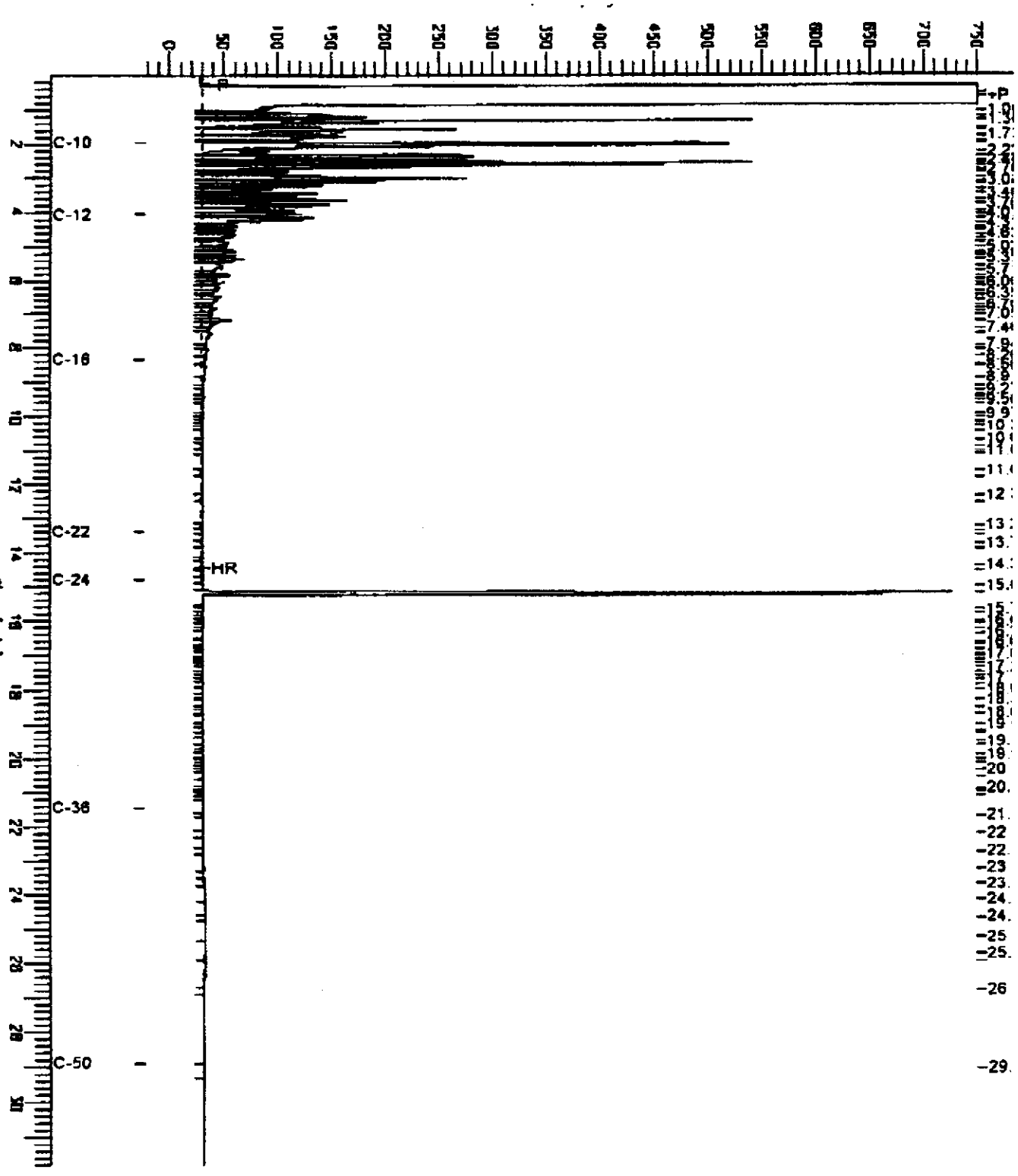
Sample #: 47490 Page 1 of 1
Date : 4/28/99 04:51 PM
Time of Injection: 4/28/99 04:14 PM
Low Point : -21.62 mV High Point : 1024.00 mV
Plot Scale: 1045.6 mV



Chromatogram

Sample Name : 139452-001,48109
FileName : G:\GC11\CHA\136A009.RAW
Method : ATEH055.MTH
Start Time : 0.01 min End Time 31.81 min
Scale Factor: 0.0 Plot Offset -23 mV

Sample # : 48109
Date : 5/18/99 06:54 PM
Time of Injection: 5/18/99 03:53 PM
Low Point : -23.36 mV High Point : 750.20 mV
Plot Scale: 773.6 nV



TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 3520

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-014	HP-06-GW	47490	04/14/99	04/16/99	04/24/99	
138934-016	HP-07-GW	47490	04/14/99	04/16/99	04/24/99	
138934-018	HP-08-GW	47490	04/14/99	04/16/99	04/23/99	
138934-020	HP-09-GW	47490	04/14/99	04/16/99	04/25/99	

Matrix: Water

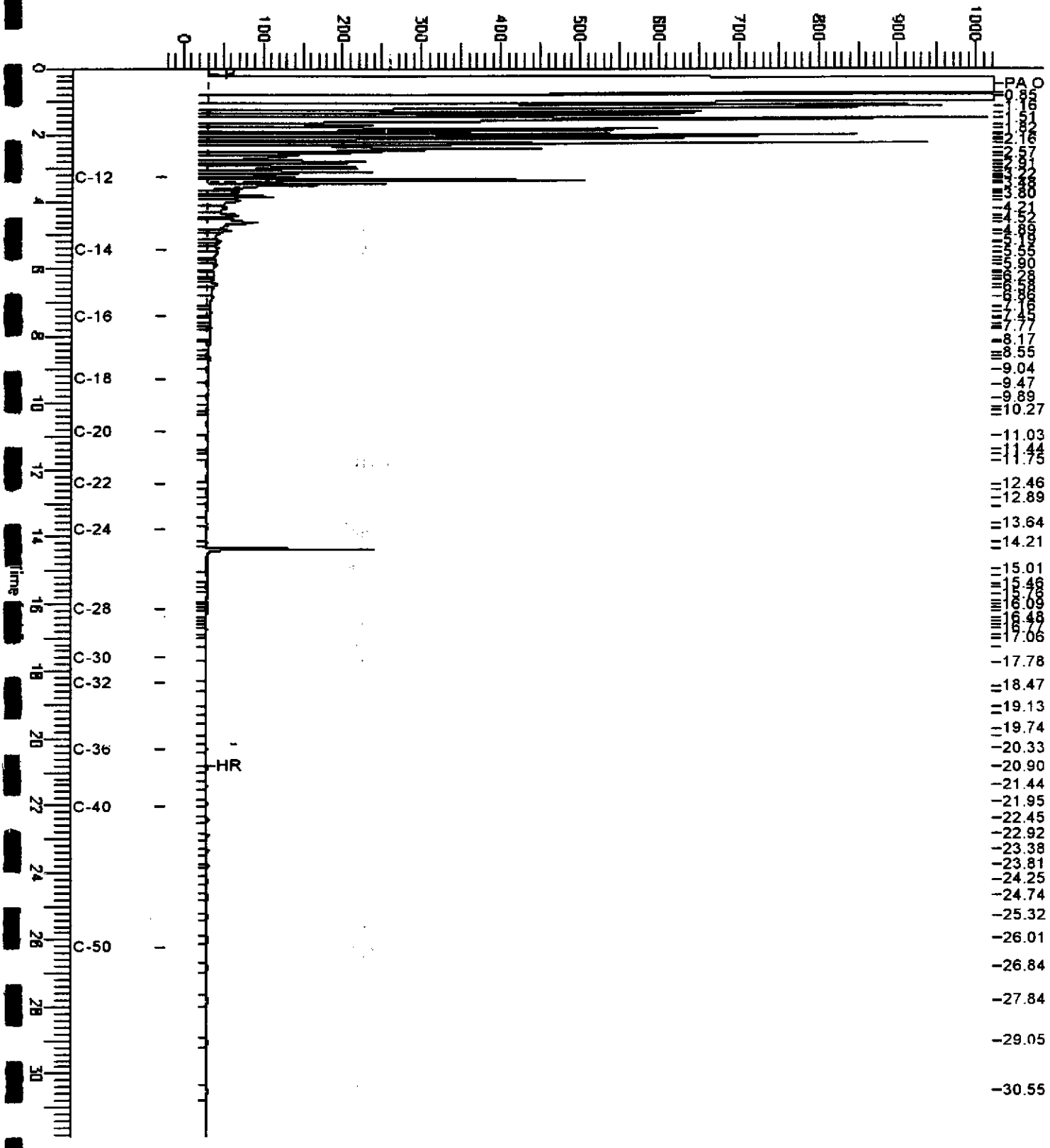
Analyte Diln Fac:	Units	138934-014 5	138934-016 5	138934-018 1	138934-020 5
Diesel C10-C24	ug/L	16000 YL	15000 YL	1900 LY	6700 YL
Surrogate					
Hexacosane	%REC	95	89	80	68

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

Chromatogram

Sample Name : 138934-014,47503
FileName : G:\GC13\CHB\112B052.RAW
Method : BTEH015X.MTH
Start Time : 0.00 min End Time : 31.90 min
Scale Factor: 0.0 Plot Offset: -22 mV

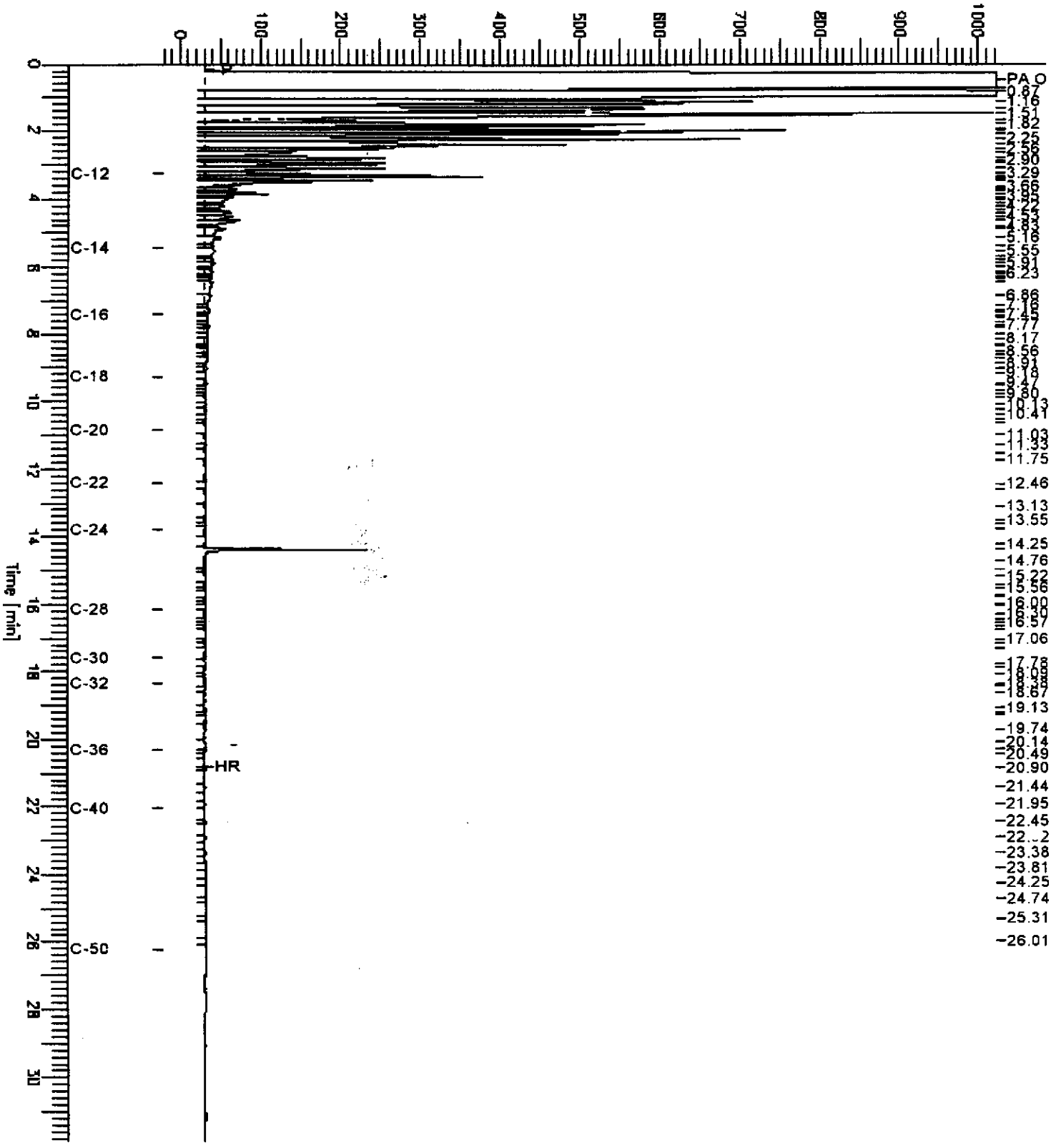
Sample #: 47490 Page 1 of 1
Date : 4/24/99 01:53 PM
Time of Injection: 4/24/99 01:58 AM
Low Point : -21.70 mV High Point : 1024.00 mV
Plot Scale: 1045.7 mV



Chromatogram

Sample Name : 138934-016,47503
FileName : G:\GC13\CHB\112B053.RAW
Method : BTEH015X.MTH
Start Time : 0.00 min End Time : 31.90 min
Scale Factor: 0.0 Plot Offset: -22 mV

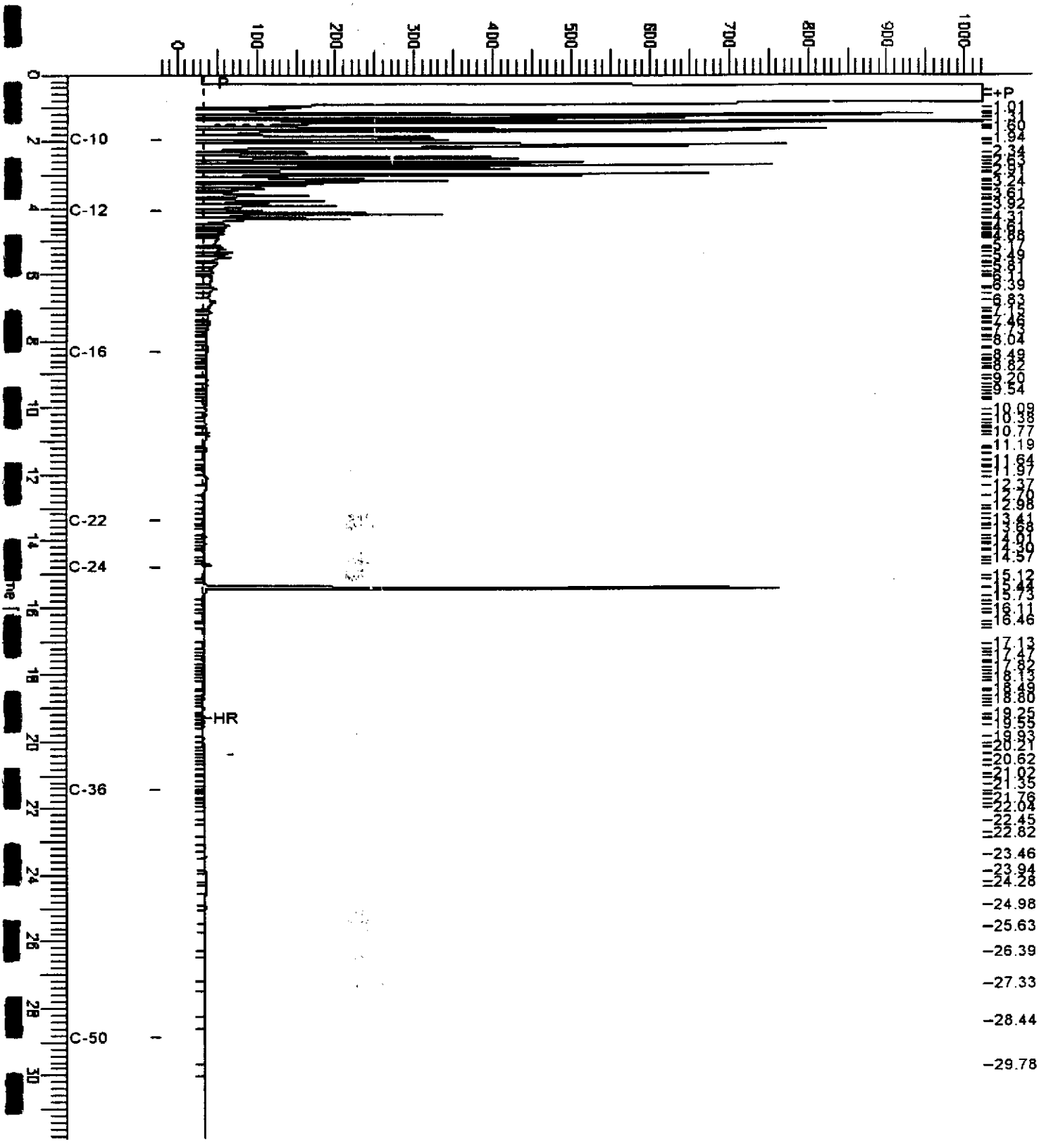
Sample #: 47490 Page 1 of 1
Date : 4/24/99 01:55 PM
Time of Injection: 4/24/99 02:40 AM
Low Point : -21.62 mV High Point : 1024.00 mV
Plot Scale: 1045.6 mV



Chromatogram

mple Name : 138934-018,47490
ileName : G:\GC11\CHA\112A021.RAW
Method : ATEH055.MTH
Start Time : 0.00 min End Time : 31.90 min
ale Factor: 0.0 Plot Offset: -22 mV

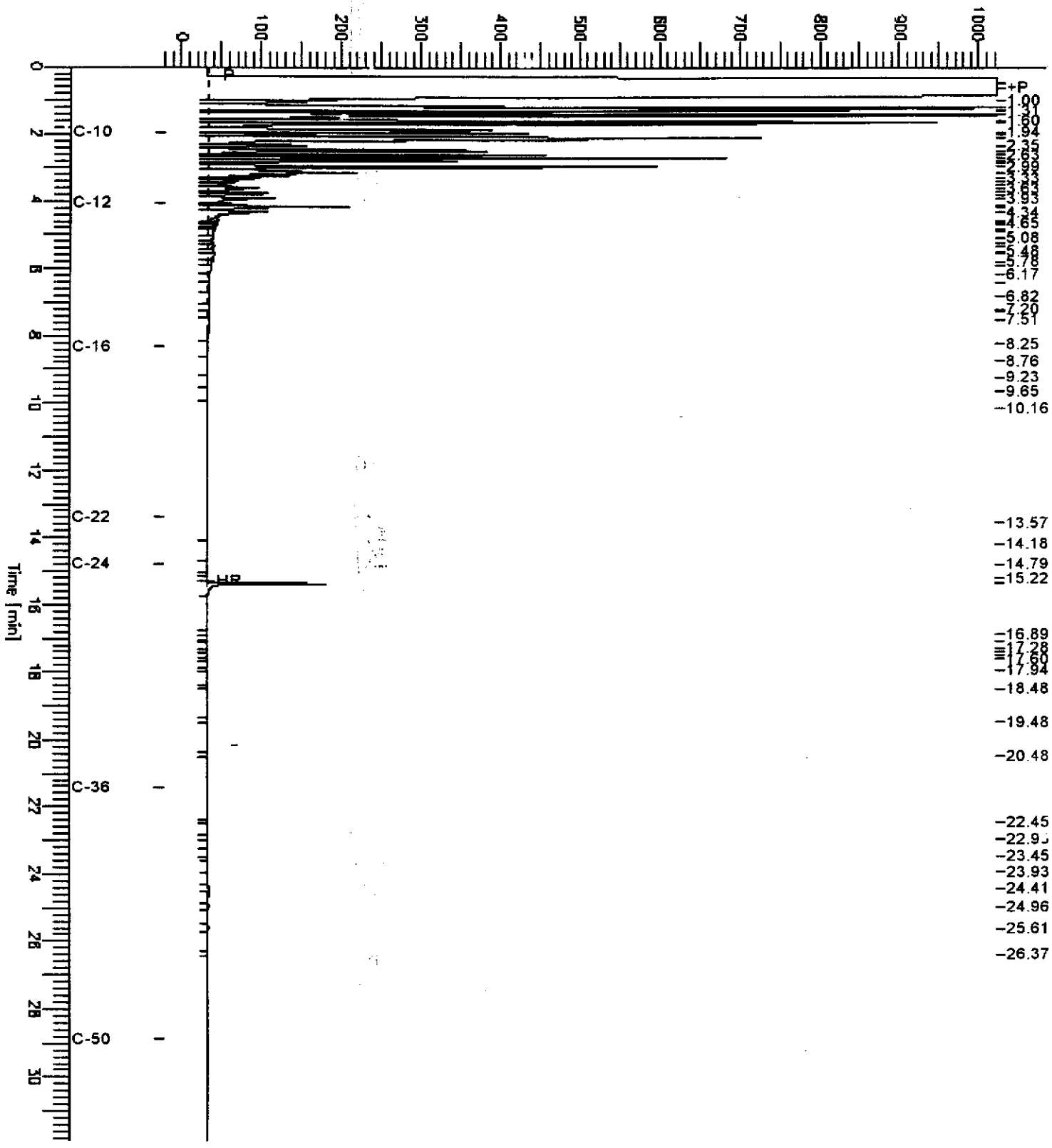
Sample #: 47490 Page 1 of 1
Date : 4/23/99 10:12 AM
Time of Injection: 4/23/99 03:28 AM
Low Point : -21.56 mV High Point : 1024.00 mV
Plot Scale: 1045.6 mV



Chromatogram

Sample Name : 138934-020,47490
FileName : G:\GC11\CHA\114A026.RAW
Method : ATEH055.MTH
Start Time : 0.00 min End Time : 31.90 min
Scale Factor: 0.0 Plot Offset: -21 mV

Sample #: 47490 Page 1 of 1
Date : 4/26/99 03:26 PM
Time of Injection: 4/25/99 12:59 PM
Low Point : -20.89 mV High Point : 1024.00 mV
Plot Scale: 1044.9 mV



TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 3520

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
138934-022	HP-10-GW	47490	04/14/99	04/16/99	04/24/99	

Matrix: Water

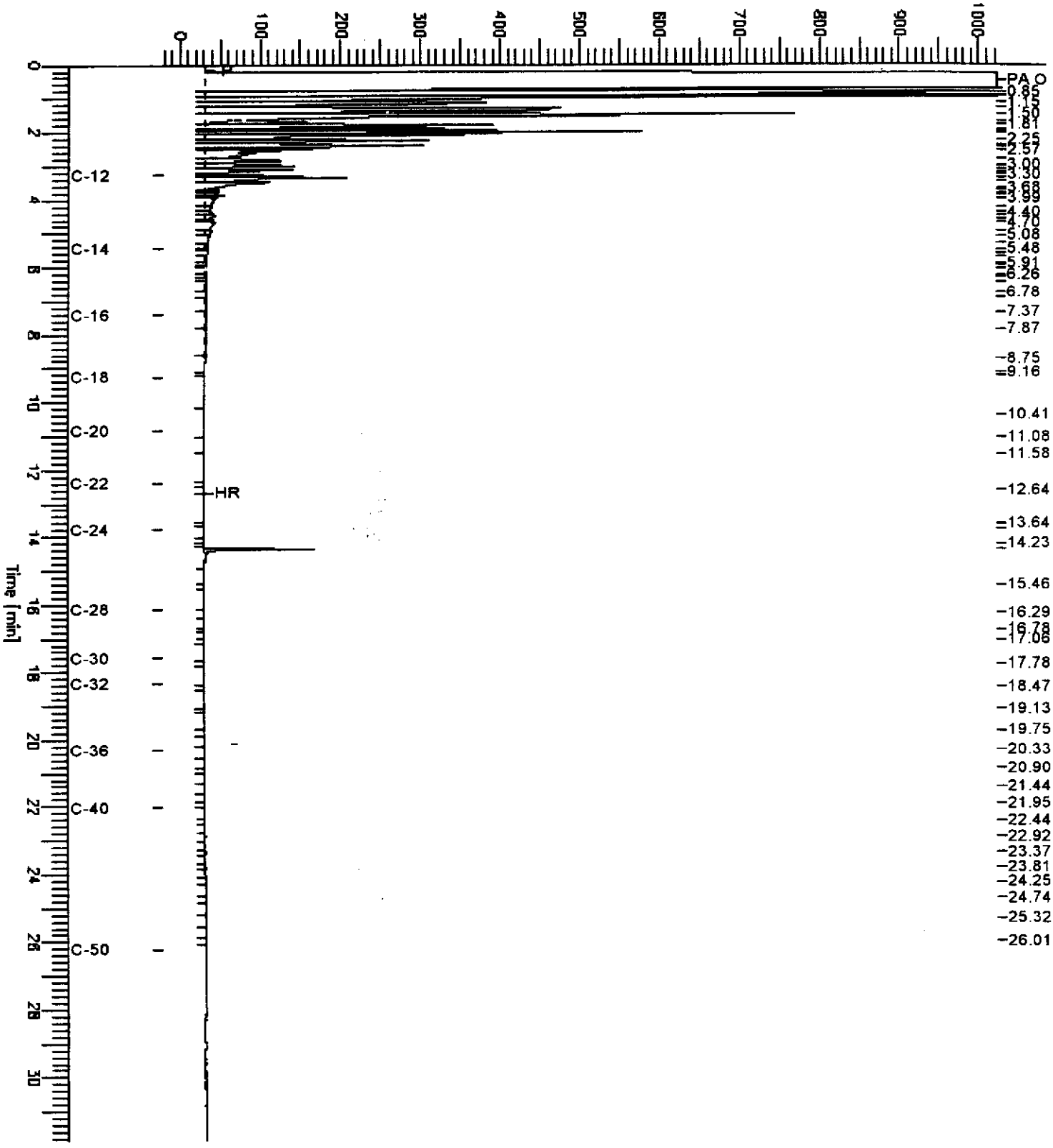
Analyte	Units	138934-022	
Diln Fac:		5	
Diesel C10-C24	ug/L	8400	YL
Surrogate			
Hexacosane	%REC	67	

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

Chromatogram

Sample Name : 138934-022,47503
FileName : G:\GC13\CHB\112B058.RAW
Method : BTEH015X.MTH
Start Time : 0.00 min End Time : 31.9C min
Scale Factor: 0.0 Plot Offset: -21 mV

Sample #: 47490 Page 1 of 1
Date : 4/24/99 02:00 PM
Time of Injection: 4/24/99 06:10 AM
Low Point : -21.48 mV High Point : 1024.00 mV
Plot Scale: 1045.5 mV



Lab #: 138934

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 3520

METHOD BLANK

Matrix: Water
Batch#: 47490
Units: ug/L
Diln Fac: 1

Prep Date: 04/16/99
Analysis Date: 04/24/99

MB Lab ID: QC95476

Analyte	Result	
Diesel C10-C24	<50	
Surrogate	**%Rec**	**Recovery Limits**
Hexacosane	96	58-128

Lab #: 138934 BATCH QC REPORT Curtis & Tompkins, Ltd. Page 1 of 1

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park
Analysis Method: EPA 8015M
Prep Method: EPA 3520

BLANK SPIKE/BLANK SPIKE DUPLICATE

Matrix: Water
Batch#: 47490
Units: ug/L
Diln Fac: 1
Prep Date: 04/16/99
Analysis Date: 04/24/99

BS Lab ID: QC95477

Analyte	Spike Added	BS	%Rec #	Limits
Diesel C10-C24	2475	2066	83	50-114

Surrogate	%Rec	Limits
Hexacosane	102	58-128

BSD Lab ID: QC95478

Analyte	Spike Added	BSD	%Rec #	Limits	RPD #	Limit
Diesel C10-C24	2475	2018	82	50-114	2	25

Surrogate	%Rec	Limits
Hexacosane	98	58-128

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

Lab#: 138934
Page 1 of 1

Curtis & Tompkins, Ltd.

Nitrogen,Nitrate

Client: Stellar Environmental Solutions
Project #: 99012
Location : Redwood Regional Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
138934-002	HP-01-GW	47476	14-APR-99	16-APR-99	-
138934-005	HP-02-GW UNFILTERED	47476	14-APR-99	16-APR-99	-
138934-007	HP-03-GW	47476	14-APR-99	16-APR-99	-
138934-009	HP-04-GW	47476	14-APR-99	16-APR-99	-
138934-011	HP-05-GW	47476	14-APR-99	16-APR-99	-
138934-014	HP-06-GW	47476	14-APR-99	16-APR-99	-
138934-016	HP-07-GW	47476	14-APR-99	16-APR-99	-
138934-018	HP-08-GW	47476	14-APR-99	16-APR-99	-
138934-020	HP-09-GW	47476	14-APR-99	16-APR-99	-
QC95413	Method Blank	47476	-	16-APR-99	-

Analyte: Nitrogen, Nitrate **Matrix:** Water **Units:** mg/L

Sample #	Client ID	Result	Reporting Limit	Dilution Factor
138934-002	HP-01-GW	ND	0.5	10
138934-005	HP-02-GW UNFILTERED	ND	0.5	10
138934-007	HP-03-GW	ND	0.5	10
138934-009	HP-04-GW	ND	0.5	10
138934-011	HP-05-GW	0.9	0.5	10
138934-014	HP-06-GW	ND	0.5	10
138934-016	HP-07-GW	ND	0.5	10
138934-018	HP-08-GW	ND	0.5	10
138934-020	HP-09-GW	ND	0.5	10
QC95413	Method Blank	ND	0.05	1

ND = None Detected at or above Reporting Limit

Lab#: 138934
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Curtis & Tompkins, Ltd.

Nitrogen,Nitrate

Client: Stellar Environmental Solutions
Project #: 99012
Location : Redwood Regional Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
QC95414	Blank Spike	47476	-	16-APR-99	-
QC95415	Blank Spike Duplicate	47476	-	16-APR-99	-

Analyte: Nitrogen, Nitrate **Matrix:** Water **Units:** mg/L

Sample #	Sample Type	Spike Amt.	Result	%Rec	Limits	%RPD	Limit
QC95414	Blank Spike	2.260	2.270	100	80-120		
QC95415	Blank Spike Duplicate	2.260	2.260	100	80-120	1	25

Lab#: 138934
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Curtis & Tompkins, Ltd.

Nitrogen,Nitrate

Client: Stellar Environmental Solutions
Project #: 99012
Location : Redwood Regional Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
QC95416	MS of 138923-006	47476	14-APR-99	16-APR-99	-
QC95417	MSD of 138923-006	47476	14-APR-99	16-APR-99	-

Analyte: Nitrogen, Nitrate **Matrix:** Water **Units:** mg/L

Sample #	Client ID	Spikeamt	Result	%Rec	Limits	%RPD	Limit
QC95416	MS of 138923-006	5.650	5.830	103	75-125		
QC95417	MSD of 138923-006	5.650	5.830	103	75-125	0	35
138923-006	ZZZZZZZZ		<0.5000				

Curtis & Tompkins, Ltd.

Sulfate

Client: Stellar Environmental Solutions
Project #: 99012
Location : Redwood Regional Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
138934-002	HP-01-GW	47476	14-APR-99	16-APR-99	-
138934-005	HP-02-GW UNFILTERED	47476	14-APR-99	16-APR-99	-
138934-007	HP-03-GW	47476	14-APR-99	16-APR-99	-
138934-009	HP-04-GW	47476	14-APR-99	16-APR-99	-
138934-011	HP-05-GW	47476	14-APR-99	16-APR-99	-
138934-014	HP-06-GW	47476	14-APR-99	16-APR-99	-
138934-016	HP-07-GW	47476	14-APR-99	16-APR-99	-
138934-018	HP-08-GW	47476	14-APR-99	16-APR-99	-
138934-020	HP-09-GW	47476	14-APR-99	16-APR-99	-
QC95413	Method Blank	47476	-	16-APR-99	-

Analyte: Sulfate **Matrix:** Water **Units:** mg/L

Sample #	Client ID		Result	Reporting Limit	Dilution Factor
138934-002	HP-01-GW		60	5.0	10
138934-005	HP-02-GW UNFILTERED		ND	5.0	10
138934-007	HP-03-GW		61	5.0	10
138934-009	HP-04-GW		70	5.0	10
138934-011	HP-05-GW		100	5.0	10
138934-014	HP-06-GW		7.7	5.0	10
138934-016	HP-07-GW		21	5.0	10
138934-018	HP-08-GW		10	5.0	10
138934-020	HP-09-GW		14	5.0	10
QC95413	Method Blank	ND		0.50	1

ND = None Detected at or above Reporting Limit

Lab#: 138934
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Curtis & Tompkins, Ltd.

Sulfate

Client: Stellar Environmental Solutions
Project #: 99012
Location : Redwood Regional Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
QC95414	Blank Spike	47476	-	16-APR-99	-
QC95415	Blank Spike Duplicate	47476	-	16-APR-99	-

Analyte: Sulfate **Matrix:** Water **Units:** mg/L

Sample #	Sample Type	Spike Amt.	Result	%Rec	Limits	%RPD	Limit
QC95414	Blank Spike	15.00	14.90	99	80-120		
QC95415	Blank Spike Duplicate	15.00	14.64	98	80-120	2	25

Lab#: 138934
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Curtis & Tompkins, Ltd.

Sulfate

Client: Stellar Environmental Solutions
Project #: 99012
Location : Redwood Regional Park

Analysis Method: EPA 300.0
Prep Method: EPA 300.0

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
QC95416	MS of 138923-006	47476	14-APR-99	16-APR-99	-
QC95417	MSD of 138923-006	47476	14-APR-99	16-APR-99	-

Analyte: Sulfate **Matrix:** Water **Units:** mg/L

Sample #	Client ID	Spikeamt	Result	%Rec	Limits	%RPD	Limit
QC95416	MS of 138923-006	37.50	51.46	99	75-125		
QC95417	MSD of 138923-006	37.50	50.82	97	75-125	1	35
138923-006	ZZZZZZZZ		14.25				

Lab#: 138934
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Curtis & Tompkins, Ltd.

Total Organic Carbon (TOC)

Client: Stellar Environmental Solutions
Project #: 99012
Location : Redwood Regional Park

Analysis Method: WALKLEY-BLACK
Prep Method: WALKLEY-BLACK

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
138934-004	HP-02-17.5'	47536	14-APR-99	20-APR-99	-
138934-013	HP-06-11.5'	47536	14-APR-99	20-APR-99	-
QC95648	Method Blank	47536	-	20-APR-99	-

Analyte: Total Organic Carbon **Matrix:** Soil **Units:** %

Sample #	Client ID		Result	Reporting Limit	Dilution Factor
138934-004	HP-02-17.5'		0.12	0.01	1
138934-013	HP-06-11.5'		0.19	0.01	1
QC95648	Method Blank	ND		0.01	1

ND = None Detected at or above Reporting Limit

Lab#: 138934
Page 1 of 1

Curtis & Tompkins, Ltd.

Total Organic Carbon (TOC)

Client: Stellar Environmental Solutions
Project #: 99012
Location : Redwood Regional Park

Analysis Method: WALKLEY-BLACK
Prep Method: WALKLEY-BLACK

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
QC95649	Lab Control Sample	47536	-	20-APR-99	-

Analyte: Total Organic Carbon **Matrix:** Soil **Units:** %

Sample #	Sample Type	Spike Amt.	Result	%Recovery	Limits
QC95649	Lab Control Sample	0.1300	0.1170	90	80-120

Lab#: 138934
Page 1 of 1

Curtis & Tompkins, Ltd.

Total Organic Carbon (TOC)

Client: Stellar Environmental Solutions
Project #: 99012
Location : Redwood Regional Park

Analysis Method: WALKLEY-BLACK
Prep Method: WALKLEY-BLACK

Sample #	Client ID	Batch#	Sampled	Analyzed	Moisture
QC95650	MS of 138934-013	47536	14-APR-99	20-APR-99	-
QC95651	MSD of 138934-013	47536	14-APR-99	20-APR-99	-

Analyte: Total Organic Carbon **Matrix:** Soil **Units:** %

Sample #	Client ID	Spikeamt	Result	%Rec	Limits	%RPD	Limit
QC95650	MS of 138934-013	0.1300	0.2820	71*	75-125		
QC95651	MSD of 138934-013	0.1300	0.2770	68*	75-125	2	35
138934-013	HP-06-11.5'		0.1890				

*** = Values outside QC limits**

Curtis & Tompkins, Ltd., Analytical Laboratories, Since 1878
2323 Fifth Street, Berkeley, CA 94710, Phone (510) 486-0900, Fax (510) 486-0532

ANALYTICAL REPORT

Prepared for:

Stellar Environmental Solutions
2198 6th Street
Suite 201
Berkeley, CA 94710

Date: 02-JUN-99
Lab Job Number: 139559
Project ID: 99012
Location: Redwood Regional Park

Reviewed by: _____

Reviewed by: _____

CHAIN OF CUSTODY FORM

Curtis & Tompkins, Ltd.
Analytical Laboratory Since 1878
2323 Fifth Street
Berkeley, CA 94710
(510)486-0900 Phone
(510)486-0532 Fax

C&T LOGIN # 13459

Sampler: Bruce Ruder

Project No: 9901J

Report To: Same

Project Name: Redwood Regional Park

Company: Stellar Environmental Solutions

Project P.O.:

Telephone: 510/644-3123

Turnaround Time: 5 DAY

Fax: 510/644-3859

Laboratory Number	Sample ID.	Sampling Date Time	Matrix: Soil	Water	Waste	# of Containers	Preservative: HCL	H_2SO	HNO_3	ICE	Field Notes	Analyses: TEH-Diesel	TVH-gas + BTEX + MTBE
For Laboratory Use	HP-11-GW	5/23/99-1400		✓		4	X			X		X	X

Notes:

RELINQUISHED BY:	RECEIVED BY:
Bruce Ruder 5/24/99 1005 DATE/TIME	5/24/99 1005 DATE/TIME
DATE/TIME	DATE/TIME
DATE/TIME	DATE/TIME

Signature

TVH-Total Volatile Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
139559-001	HP-11-GW	48245	05/22/99	05/25/99	05/25/99	

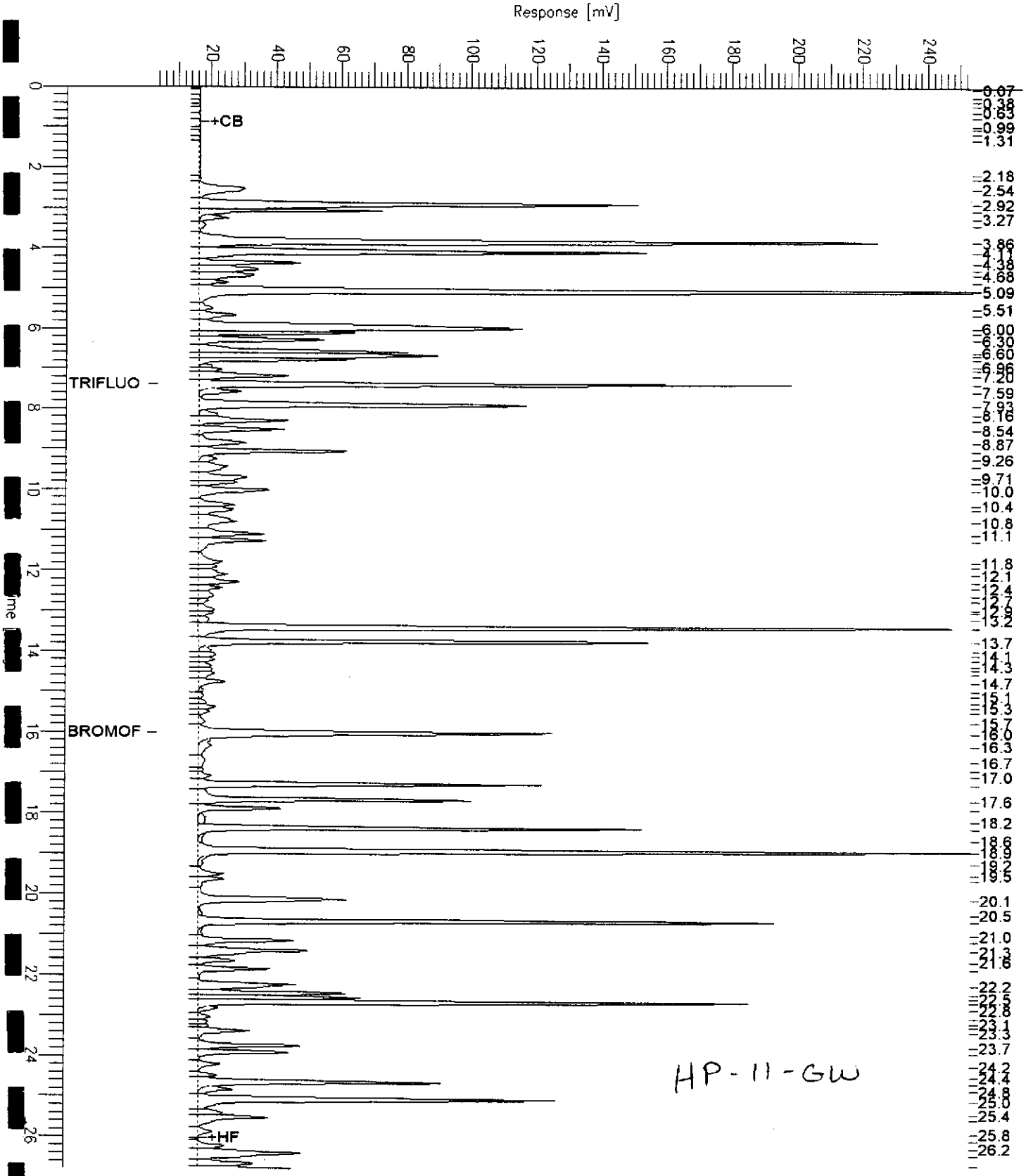
Matrix: Water

Analyte	Units	139559-001
Diln Fac:		1
Gasoline C7-C12	ug/L	2000
Surrogate		
Trifluorotoluene	%REC	115
Bromofluorobenzene	%REC	145

GC19 TVH 'X' Data File (FID)

mple Name : MSS,139559-001,48245
FileName : G:\GC19\DATA\145X013.raw
Method : TVHBTXE
art Time : 0.00 min End Time : 26.80 min
cale Factor: -1.0 Plot Offset: 4 mV

Sample #: Page 1 of 1
Date : 5/26/99 12:07 PM
Time of Injection: 5/25/99 08:24 PM
Low Point : 3.75 mV High Point : 253.75 mV
Plot Scale: 250.0 mV

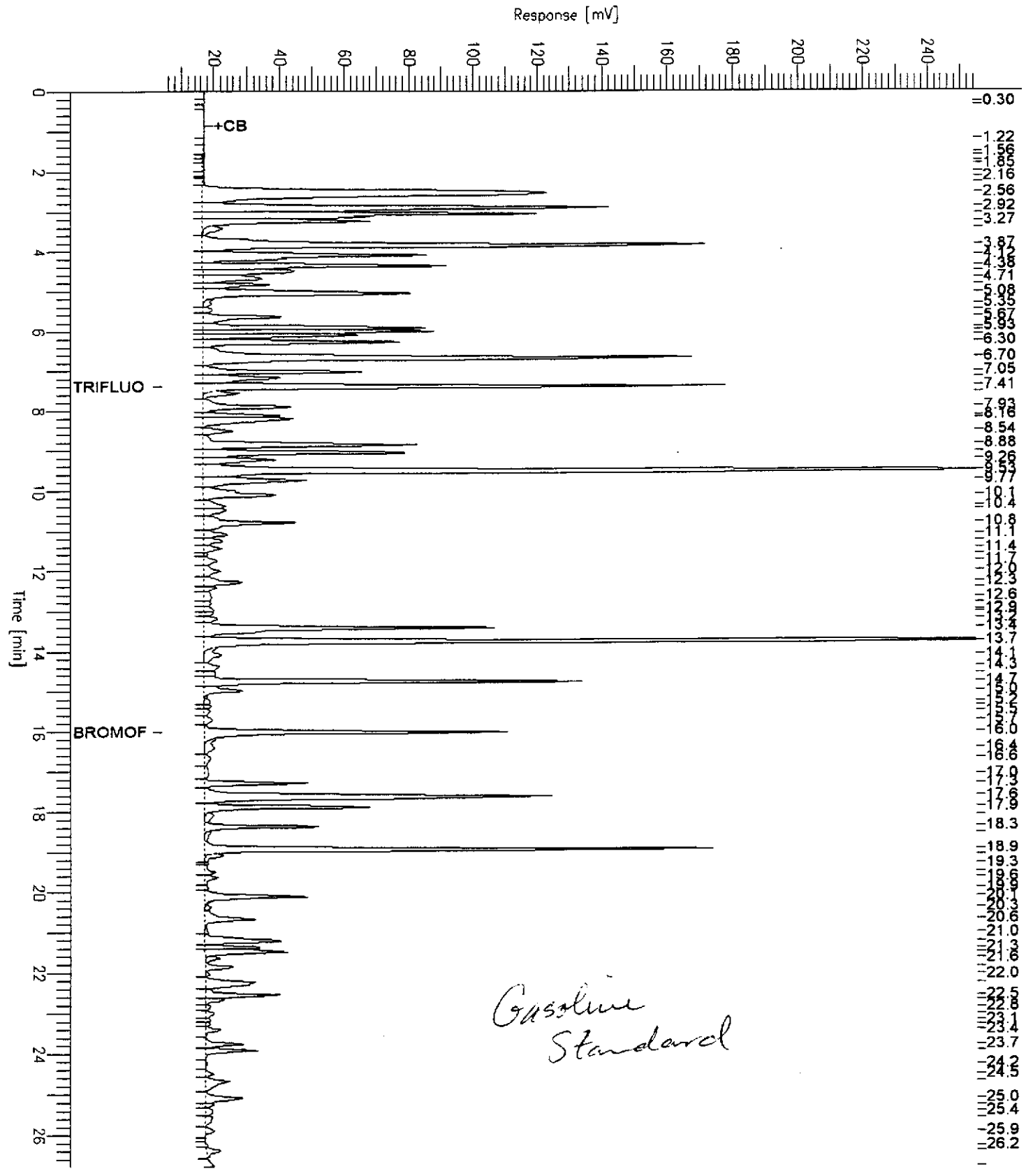


HP-11-GW

GC19 TVH 'X' Data File (FID)

Sample Name : CCV/LCS,QC98318,99WS7547,48245
FileName : G:\GC19\DATA\145X001.raw
Method : TVHBTXE
Start Time : 0.00 min End Time : 26.80 min
Scale Factor: -1.0 Plot Offset: 4 mV

Sample #: GAS Page 1 of 1
Date : 5/25/99 12:54 PM
Time of Injection: 5/25/99 12:26 PM
Low Point : 4.01 mV High Point : 254.01 mV
Plot Scale: 250.0 mV



TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

METHOD BLANK

Matrix:	Water	Prep Date:	05/25/99
Batch#:	48245	Analysis Date:	05/25/99
Units:	ug/L		
Diln Fac:	1		

MB Lab ID: QC98319

Analyte	Result
Gasoline C7-C12	<50

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	98	53-150
Bromofluorobenzene	93	53-149

Lab #: 139559 BATCH QC REPORT Curtis & Tompkins Ltd. Page 1 of 1

TVH-Total Volatile Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 5030
Location:	Redwood Regional Park		

LABORATORY CONTROL SAMPLE

Matrix:	Water	Prep Date:	05/25/99
Batch#:	48245	Analysis Date:	05/25/99
Units:	ug/L		
Diln Fac:	1		

LCS Lab ID: QC98318

Analyte	Result	Spike Added	%Rec #	Limits
Gasoline C7-C12	1742	2000	87	77-117

Surrogate	%Rec	Limits
Trifluorotoluene	104	53-150
Bromofluorobenzene	108	53-149

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 #: 139559 BATCH QC REPORT Curtis & Tompkins Ltd.

TVH-Total Volatile Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 5030

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Field ID: HP-11-GW
Lab ID: 139559-001
Matrix: Water
Batch#: 48245
Units: ug/L
Diln Fac: 1

Sample Date: 05/22/99
Received Date: 05/24/99
Prep Date: 05/25/99
Analysis Date: 05/25/99

MS Lab ID: QC98322

Analyte	Spike Added	Sample	MS	%Rec #	Limits
Gasoline C7-C12	2000	2048	3729	84	69-131

Surrogate	%Rec	Limits
Trifluorotoluene	81	53-150
Bromofluorobenzene	126	53-149

MSD Lab ID: QC98323

Analyte	Spike Added	MSD	%Rec #	Limits	RPD #	Limit
Gasoline C7-C12	2000	3729	84	69-131	0	13

Surrogate	%Rec	Limits
Trifluorotoluene	109	53-150
Bromofluorobenzene	146	53-149

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

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
139559-001	HP-11-GW	48245	05/22/99	05/25/99	05/25/99	

Matrix: Water

Analyte	Units	139559-001
Diln Fac:		1
MTBE	ug/L	31
Benzene	ug/L	30
Toluene	ug/L	0.85C
Ethylbenzene	ug/L	92
m,p-Xylenes	ug/L	51
o-Xylene	ug/L	2.3
Surrogate		
Trifluorotoluene	%REC	133
Bromofluorobenzene	%REC	145

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

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

METHOD BLANK

Matrix: Water
Batch#: 48245
Units: ug/L
Diln Fac: 1

Prep Date: 05/25/99
Analysis Date: 05/25/99

MB Lab ID: QC98319

Analyte	Result
MTBE	<2.0
Benzene	<0.5
Toluene	<0.5
Ethylbenzene	<0.5
m,p-Xylenes	<0.5
o-Xylene	<0.5

Surrogate	%Rec	Recovery Limits
Trifluorotoluene	116	51-143
Bromofluorobenzene	114	37-146

Lab #: 139559

BATCH QC REPORT

Curtis & Tompkins, Ltd.

BTXE

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8021B
Prep Method: EPA 5030

BLANK SPIKE/BLANK SPIKE DUPLICATE

Matrix: Water
Batch#: 48245
Units: ug/L
Diln Fac: 1

Prep Date: 05/26/99
Analysis Date: 05/26/99

BS Lab ID: QC98320

Analyte	Spike Added	BS	%Rec #	Limits
MTBE	20	18.2	91	66-126
Benzene	20	17.94	90	65-111
Toluene	20	18.59	93	76-117
Ethylbenzene	20	18.32	92	71-121
m,p-Xylenes	40	37.98	95	80-123
o-Xylene	20	18.4	92	75-127

Surrogate	%Rec	Limits
Trifluorotoluene	95	51-143
Bromofluorobenzene	93	37-146

BSD Lab ID: QC98321

Analyte	Spike Added	BSD	%Rec #	Limits	RPD #	Limit
MTBE	20	18.66	93	66-126	2	12
Benzene	20	18.06	90	65-111	1	10
Toluene	20	18.55	93	76-117	0	10
Ethylbenzene	20	18.4	92	71-121	0	11
m,p-Xylenes	40	38.27	96	80-123	1	10
o-Xylene	20	18.49	92	75-127	0	11

Surrogate	%Rec	Limits
Trifluorotoluene	92	51-143
Bromofluorobenzene	92	37-146

Column to be used to flag recovery and RPD values with an asterisk
* Values outside of QC limits
RPD: 0 out of 6 outside limits
Spike Recovery: 0 out of 12 outside limits

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 3520

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
139559-001	HP-11-GW	48240	05/22/99	05/24/99	05/27/99	

Matrix: Water

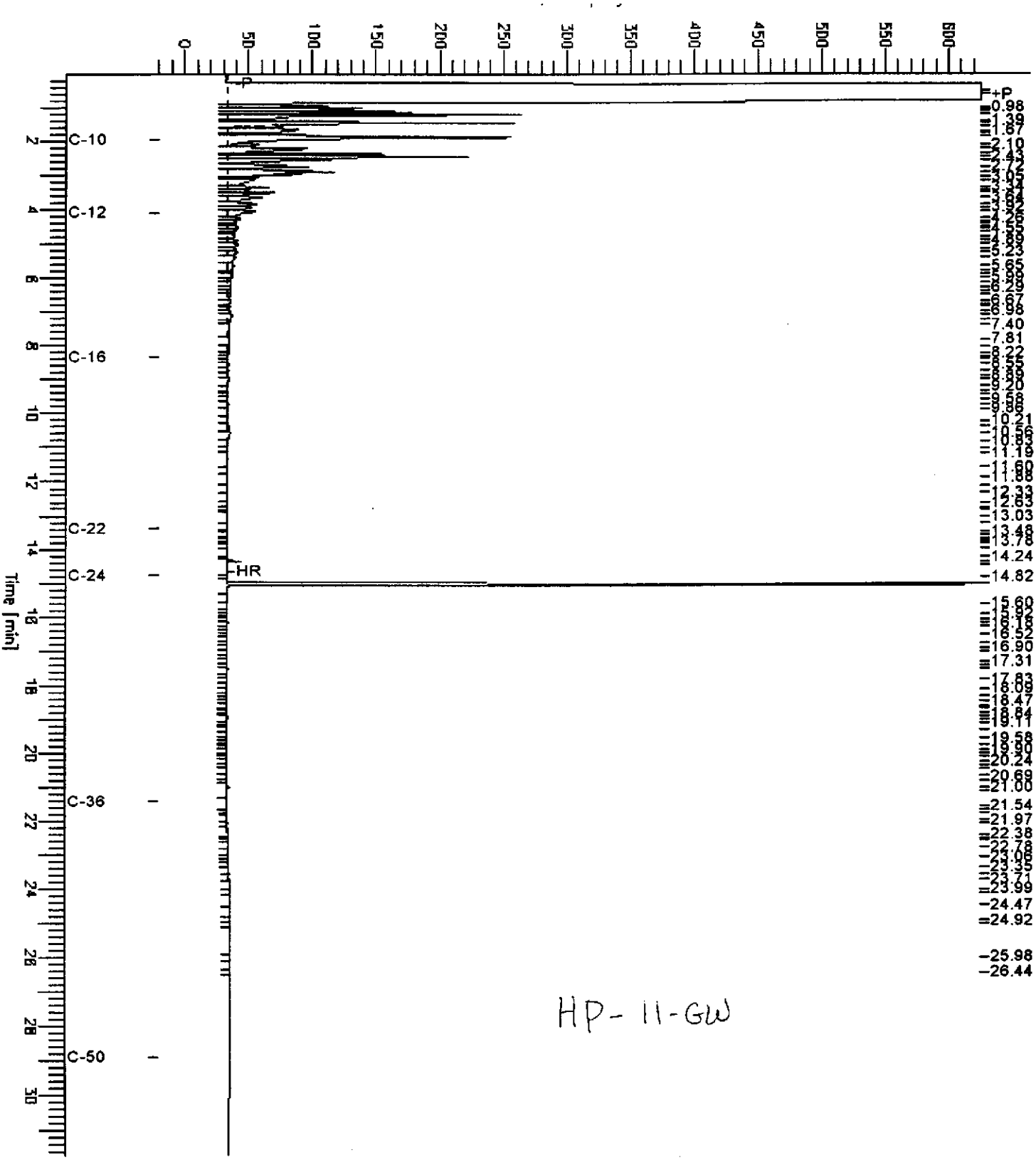
Analyte	Units	139559-001
Diln Fac:		1
Diesel C10-C24	ug/L	440 YL
Surrogate		
Hexacosane	%REC	69

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

Chromatogram

Sample Name : 139559-001,48240
FileName : G:\GC11\CHA\146A021.RAW
Method : ATEH055.MTH
Start Time : 0.01 min End Time : 31.75 min
Scale Factor: 0.0 Plot Offset: -21 mV

Sample #: 48240 Page 1 of 1
Date : 5/27/99 04:25 PM
Time of Injection: 5/27/99 11:04 AM
Low Point : -20.86 mV High Point : 625.98 mV
Plot Scale: 646.8 mV



HP-11-GW

Lab #: 139559 BATCH QC REPORT Curtis & Tompkins, Ltd. Page 1 of 1

TEH-Tot Ext Hydrocarbons			
Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 3520
Location:	Redwood Regional Park		

METHOD BLANK			
Matrix:	Water	Prep Date:	05/24/99
Batch#:	48240	Analysis Date:	05/27/99
Units:	ug/L		
Diln Fac:	1		

MB Lab ID: QC98298

Analyte	Result	
Diesel C10-C24	<50	
Surrogate	**%Rec**	**Recovery Limits**
Hexacosane	82	58-128

Lab #: 139559

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 3520

BLANK SPIKE/BLANK SPIKE DUPLICATE

Matrix: Water
Batch#: 48240
Units: ug/L
Diln Fac: 1

Prep Date: 05/24/99
Analysis Date: 05/27/99

BS Lab ID: QC98299

Analyte	Spike Added	BS	%Rec	#	Limits
Diesel C10-C24	2475	1360	55		50-114

Surrogate	%Rec	Limits
Hexacosane	72	58-128

BSD Lab ID: QC98300

Analyte	Spike Added	BSD	%Rec	#	Limits	RPD	#	Limit
Diesel C10-C24	2475	1456	59		50-114	7		25

Surrogate	%Rec	Limits
Hexacosane	76	58-128

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, Fax (510) 486-0532

ANALYTICAL REPORT

Prepared for:

Stellar Environmental Solutions
2198 6th Street
Suite 201
Berkeley, CA 94710

Date: 04-JUN-99
Lab Job Number: 139452
Project ID: 99012
Location: Redwood Regional Park

Reviewed by: Tracy Bobja

Reviewed by:

4 7414

CURTIS & TOMPKINS, LTD. BERKELEY LOGIN CHANGE FORM

Reason for change: X Client Request: By: Bruce Rucker Date/Time: 5/17/99 Initials: TB

________ Login Review

Current Lab ID	Previous Lab ID	Client ID	Matrix	Add/Cancel	Analysis	Duedate
139452-001	138934-007	HP-03-GW	H_2O	Add	TEH	ASAP

Analyze outside of Acid.

Curtis & Tompkins, Ltd.

TEH-Tot Ext Hydrocarbons

Client: Stellar Environmental Solutions
Project#: 99012
Location: Redwood Regional Park

Analysis Method: EPA 8015M
Prep Method: EPA 3520

Sample #	Client ID	Batch #	Sampled	Extracted	Analyzed	Moisture
139452-001	HP-03-GW	48109	04/14/99	05/17/99	05/18/99	

Matrix: Water

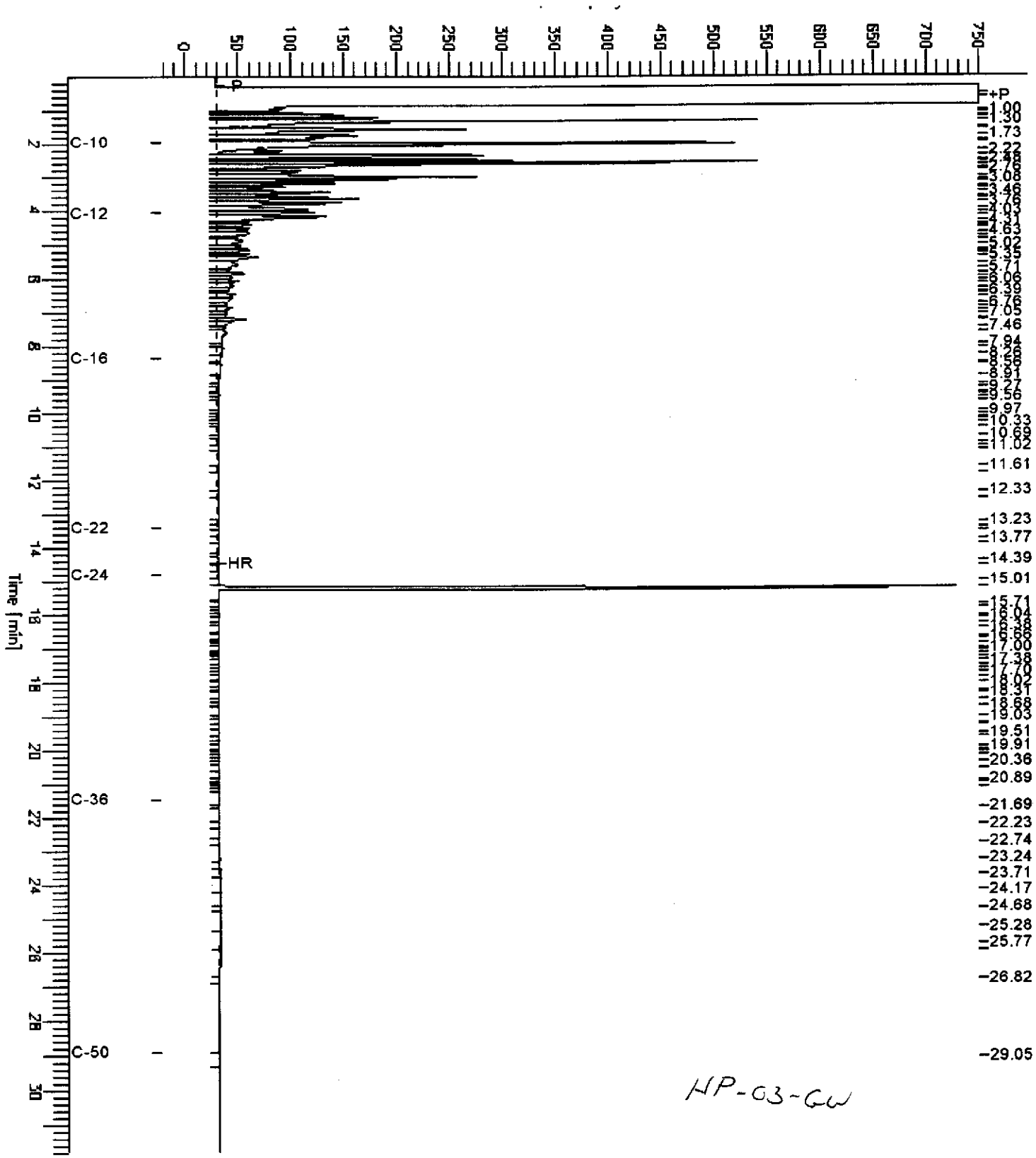
Analyte	Units	139452-001
Diln Fac:		1
Diesel C10-C24	ug/L	1400 YL
Surrogate		
Hexacosane	%REC	73

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

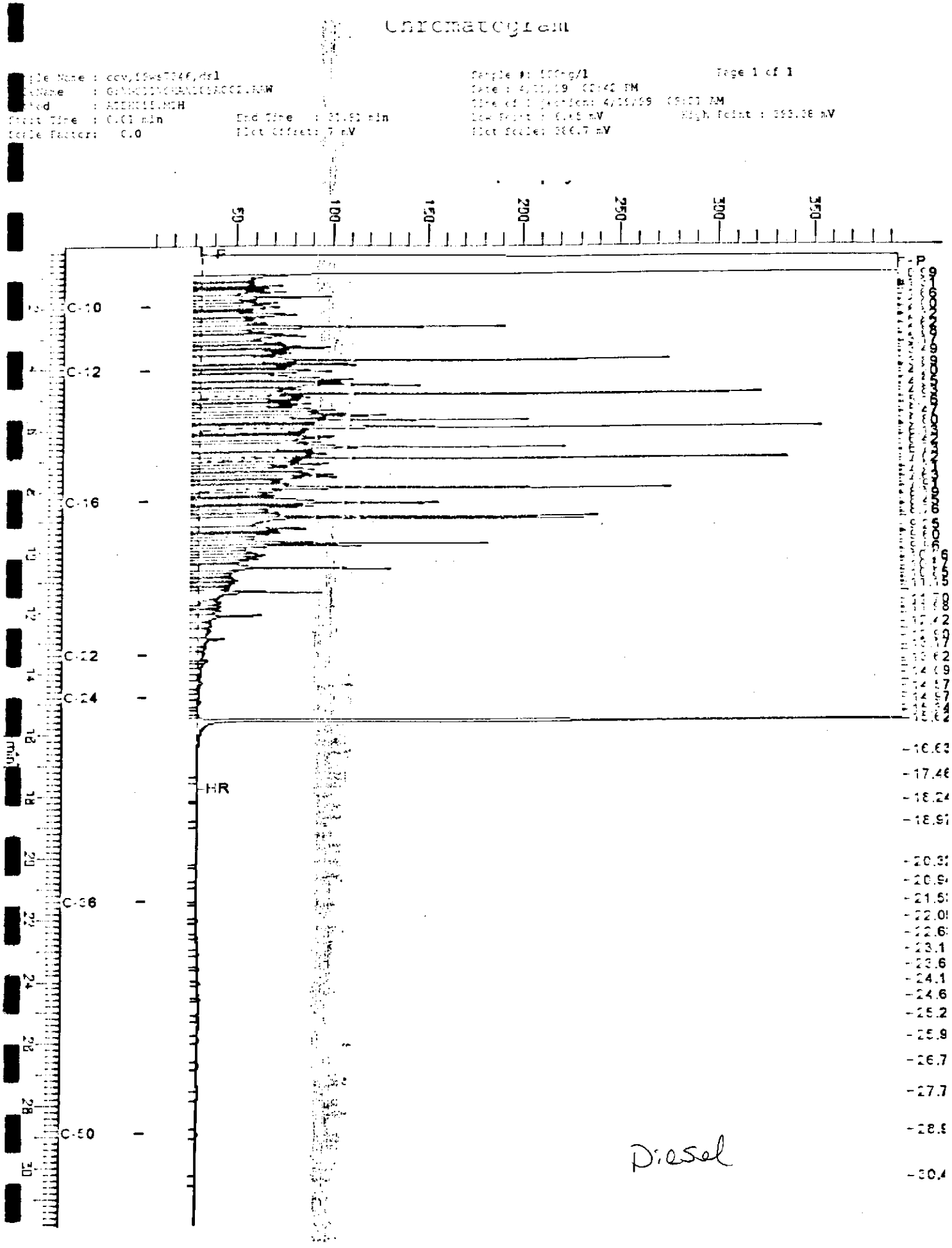
Chromatogram

Sample Name : 139452-001,48109
FileName : G:\GC11\CHA\138A009.RAW
Method : ATEH055.MTH
Start Time : 0.01 min End Time : 31.81 min
Scale Factor: 0.0 Plot Offset: -23 mV

Sample #: 48109 Page 1 of 1
Date : 5/18/99 06:54 PM
Time of Injection: 5/18/99 03:53 PM
Low Point : -23.36 mV High Point : 750.20 mV
Plot Scale: 773.6 mV



HP-03-GW


Chromatogram
File Name : ccv,15ug7046,dsl
Method : ADD0115.MTH
Start Time : 0.01 min
End Time : 31.91 min
Scale Factor: 0.0
Plot Offset: 7 nV
Sample #: 500ng/l
Page 1 of 1
Low Point : 6.45 nV
High Point : 999.38 nV
Plot Scale: 986.7 nV
C-10
C-12
C-16
C-22
C-24
C-36
C-50
HR
Diesel

Lab #: 139452

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TEH-Tot Ext Hydrocarbons			
Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 3520
Location:	Redwood Regional Park		
METHOD BLANK			
Matrix:	Water	Prep Date:	05/17/99
Batch#:	48109	Analysis Date:	05/20/99
Units:	ug/L		
Diln Fac:	1		

MB Lab ID: QC97781

Analyte	Result	
Diesel C10-C24	<50	
Surrogate	**%Rec**	**Recovery Limits**
Hexacosane	75	58-128

Lab #: 139452

BATCH QC REPORT

Curtis & Tompkins, Ltd.

TEH-Tot Ext Hydrocarbons

Client:	Stellar Environmental Solutions	Analysis Method:	EPA 8015M
Project#:	99012	Prep Method:	EPA 3520
Location:	Redwood Regional Park		

BLANK SPIKE/BLANK SPIKE DUPLICATE

Matrix:	Water	Prep Date:	05/17/99
Batch#:	48109	Analysis Date:	05/20/99
Units:	ug/L		
Diln Fac:	1		

BS Lab ID: QC97782

Analyte	Spike Added	BS	%Rec	#	Limits
Diesel C10-C24	2475	1599	65		50-114
Surrogate	**%Rec**	**Limits**			
Hexacosane	72	58-128			

BSD Lab ID: QC97783

Analyte	Spike Added	BSD	%Rec	#	Limits	RPD	#	Limit
Diesel C10-C24	2475	1627	66		50-114	2		25
Surrogate	**%Rec**	**Limits**						
Hexacosane	72	58-128						

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