Weiss Associates *Environmental and Geologic Services*

5500 Shellmound Street, Emeryville, CA 94608-2411 Fax: 510-547-5043 Phone: **510-450-6000**

97 JUN 24 PM 2:21

June 23, 1997

Mr. Scott O. Seery, CHMM
Alameda County Department of Environmental Health
1131 Harbor Bay Pkwy, #250
Alameda, CA 94502-6577

RE: Former Shell Service Station
15275 Washington Avenue
San Leandro, California
WIC # 204-6852-1008
WA Job #81-1227

Dear Mr. Seery:

Please find attached a copy of the *Vadose Zone Characterization Report and Tier 2 Risk-Based Corrective Action Evaluation*, prepared by Weiss Associates on behalf of Shell Oil Company. The report concludes that corrective action may be necessary to remediate contaminated soils at the site. A corrective action workplan, to be submitted by Enviros, Inc., will follow this report. Please feel free to call me if you have any questions.

Sincerely,
Weiss Associates

Steve Long, P.E.
Project Engineer

Enclosures: Vadose Zone Characterization Report and Tier 2 Risk-Based Corrective Action Evaluation

cc: Alex Perez, Brad Boschetto, Shell Oil Products Company
Erik Hansen, Shell Development Company
John Verber, Larson and Burnham
Jonathan Redding, Fitzgerald Abbott & Beardsley LLP

SPL/hs

Weiss Associates *Environmental and Geologic Services*

5500 Shellmound Street, Emeryville, CA 94608-2411 *Fax: 510-547-5043 Phone: **510-450-6000***

PM 2:21

VADOSE ZONE CHARACTERIZATION REPORT

and

TIER 2 RISK-BASED CORRECTIVE ACTION EVALUATION

for 6-23-97

Former Shell Service Station
WIC #204-6852-1008
15275 Washington Avenue
San Leandro, California

prepared for

Shell Oil Products Company
P.O. Box 4023
Concord, California 94524

June 23, 1997

Weiss Associates *Environmental and Geologic Services*

5500 Shellmound Street, Emeryville, CA 94608-2411 *Fax: 510-547-5043* *Phone: 510-450-6000*

VADOSE ZONE CHARACTERIZATION REPORT AND RISK-BASED CORRECTIVE ACTION EVALUATION

for

Former Shell Service Station
WIC #204-6852-1008
15275 Washington Avenue
San Leandro, California

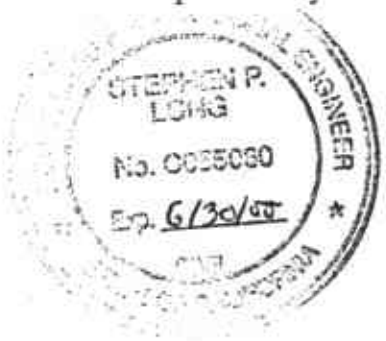
prepared by

Weiss Associates
5500 Shellmound Street
Emeryville, CA 94608

WA Job #81-1227-72

Pleasant J. McNeel, IV, PE
Senior Staff Engineer

Weiss Associates' work for the former Shell Service Station at 15275 Washington Avenue, was conducted under my supervision. To the best of my knowledge, the data contained herein are true and accurate and satisfy the scope of work prescribed by the client for this project. The data, findings, recommendations, specifications or professional opinions were prepared solely for the use of Shell Oil Products Company in accordance with generally accepted professional engineering and geologic practice. We make no other warranty, either expressed or implied, and are not responsible for the interpretation by others of the contents herein.



Stephen Long, P.E. Date
Project Engineer
CA License No. C055060

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APPENDICES

1. INTRODUCTION

Weiss Associates (WA) has prepared this report presenting the results for the soil vapor survey investigation and Tier 2 Risk Based Corrective Action (RBCA) Evaluation for the former Shell Service Station WIC #204-6852-1008, located at 15275 Washington Avenue in San Leandro, California (Figure 1). Vadose zone data was also collected from the adjoining trailer park property located to the west of the former service station. The work was conducted in accordance with the revised *Workplan for Risk-Based Corrective Action* Evaluation, which was submitted by WA on April 21, 1997, and approved by Alameda County Department of Environmental Health (ACDEH) in a letter dated April 30, 1997. In accordance with the workplan, and discussions between Shell, WA, and ACDEH in a meeting conducted on April 10, 1997, the soil vapor data collected was to be the first of two rounds of soil vapor sampling. The second round of data was requested by ACDEH to evaluate temporal variations at the site, and to corroborate the initial round of data.

The purpose of the soil vapor survey was to further evaluate the potential for adverse impacts due to potential inhalation of vapors from known subsurface petroleum hydrocarbons. The collected data was modeled using American Society for Testing and Materials (ASTM) Standard E-1739, *Risk-Based Corrective Action Applied at Petroleum Release Sites* (RBCA) (ASTM, 1995) in order to evaluate excess risk associated with the conditions at the site.

1.1 Scope of Work

The workplan objective was to collect shallow soil and soil vapor data beneath the former Shell station and the adjacent mobile home park. Tasks proposed in the workplan included:

- Install soil vapor probes at five (5) locations and collect soil vapor samples at a depth of 4 ft.
- Install soil vapor probes at four (4) locations and collect soil vapor samples at depths of 2 ft, 4 ft, and 6 ft.
- Analyze all vapor samples for Total Petroleum Hydrocarbons (TPH), benzene, toluene, ethylbenzene, and xylenes (BTEX), methyl tert butyl ether (MTBE), oxygen, carbon dioxide, and methane.
- Collect continuous core samples at four (4) locations to a depth of 8 feet.
- Analyze sixteen (16) soil samples for Total Petroleum Hydrocarbons as Gasoline (TPH-G), BTEX, methyl tert butyl ether (MTBE), wet and dry bulk density, moisture content, and fraction organic carbon.
- Collect an ambient, above ground air sample over 8 hours for comparison to the SVS data.

A brief site background and a detailed description of the tasks performed are presented below.

1.2 Site Setting and Local Geology

The former Shell service station, located at the northwest corner of Washington Avenue and Lewelling Boulevard, is in a mixed commercial and residential neighborhood in San Leandro, California (Figure 2). All underground storage tanks and dispenser islands have been removed, the former service station building is currently unoccupied and the property is fenced. A residential trailer park bounds the site to the west and commercial buildings bound the site to the north. There is an active gasoline service station across Lewelling Boulevard to the South.

The closest surface water, San Lorenzo Creek located 3/16 of a mile south of the site, is not threatened based on the current plume delineation. The surface soils in the region consist of Holocene-aged fine-grained alluvium generally consisting of well-bedded, unconsolidated, carbonaceous silt and clay. Boring log data from site investigations indicate that the site is underlain primarily by clays and silts which contain thin interbeds of sand and clayey sand.

Depth to ground water ranges from 5 to 10 ft below ground surface (bgs). Water in the shallow zone is most likely yielded from discrete sandy interbeds and silty horizons which appear to extend from 6 to 15 ft bgs. Shallow ground water beneath the site is not used for any beneficial purpose and there are no active ground water supply wells in the shallow zone in the vicinity of the site. The use of shallow ground water wells is most likely for irrigation. Historically, the ground water flow direction has been to the south and southwest with an average gradient of 0.004 ft/ft. Nearby residences and commercial properties receive water from the San Leandro and Pardee reservoirs through the East Bay Municipal Utility District (EBMUD). Drinking water is generally not supplied from ground water.

1.3 Environmental History

The former Shell service station property is currently unoccupied and fenced. In 1985, monitoring wells S-1 through S-4 were installed, and dissolved TPH-G was detected in ground water. A thickness of 0.5-ft separate phase product was observed in Well S-3. In 1986, four exploratory borings S-A through S-D were drilled in the UST area and monitoring well S-5 was installed. Separate phase product was observed in boring S-B, which was subsequently completed as a monitoring well.

In June 1987 one waste oil tank was replaced with a double-walled tank. Soils were overexcavated to a depth of 13-ft bgs and 2 to 4 ft beyond the former waste oil tank. Also in June, 1987, two 5,000-gallon, one 8,000-gallon and one 7,500-gallon USTs were removed. Soils to 10.5-ft depth were excavated. A total of 500 cubic yards of soil were stockpiled on-site and subsequently disposed of at an appropriate Class III facility. Overexcavation in the UST area was limited due to a nearby sewer line. In December 1987, trenches in the former tank pit area were excavated to a depth

of 8.5 ft. Approximately 200 cubic yards of soil were stockpiled on-site and subsequently transported and disposed of at a Class III facility.

In 1988, monitoring wells S-6 through S-12 were installed and a soil vapor survey was conducted. In 1989 wells S-13 through S-17 and a recovery well SR-1 were installed. In 1991 monitoring well S-18 was installed. Ground water monitoring has been conducted since 1988. No active soil or ground water remediation other than soil excavation was conducted at the site. The site is next to a residential mobile home park and the future use of the site is not determined.

1.4 Description of Sampling Activities

WA conducted an investigation on the subject site and adjacent trailer park property on May 5th and 6th, 1997. The site was dry and no precipitation fell for a number of weeks prior to the field work. The entire area is paved with the exception of small garden patches between unpaved areas beneath a few of the mobile homes. The soil vapor samples collected in the mobile home park would not likely have been influenced by any limited irrigation activities. The weather during sampling was warm with temperatures ranging from the mid-60's to the upper 80's °F. Winds were generally very slight and variable and were predominantly westerly to southwesterly from the San Francisco Bay.

1.4.1 Soil Vapor Survey

On May 5th and 6th, 1997, InterPhase Environmental Chemistry Specialists (InterPhase) of San Diego, California, under the supervision of WA, conducted a soil vapor survey (SVS) in the vicinity of the former Shell Service Station and the adjoining mobile home park property. InterPhase's standard sampling, analysis, QA/QC, and record-keeping procedures are presented in Appendix A.

SVS samples were collected using GeoProbe direct-push soil vapor sampling equipment, at nine (9) locations in the vicinity of the former Shell Service Station and the adjoining trailer park property. The locations of the SVS sampling points are shown in Figure 3. At five (5) locations (SG-01, SG-02,. SG-05, SG-06, and SG-09) soil vapor samples were collected only at a depth of 4 ft bgs. At four (4) locations (SG-03, SG-04, SG-07, and SG-08) soil vapor profile samples were collected at depths of 2 ft, 4 ft, and 6 ft bgs (Figure 3).

The soil vapor depth profile samples were intended to help characterize the soil vapor gradient from the water table to ground surface, and to determine the effect of the asphalt pavement on the migration of subsurface hydrocarbon vapors. WA collected samples in one-liter SUMMA canisters for EPA Method TO-3 analysis and in glass syringes for onsite analysis by InterPhase for TPH, BTEX, oxygen, carbon dioxide and methane. The one-liter SUMMA canister samples were sent to Air Toxics LTD and analyzed using EPA Method TO-3 for TPH, BTEX and MTBE. Air Toxics LTD provided detection limits as low as 1 $ppb_{v/v}$ for the TO-3 samples. InterPhase's onsite laboratory provided soil vapor screening analyses of BTEX with a detection limit of 1.0 µg/L (about 308 $ppb_{v/v}$ for benzene).

During the soil vapor survey, an ambient air sample was collected at a location between the former service station area and the trailer park . The sample was collected using a 6-L SUMMA canister at breathing level with a flow controller set to collect an 8-hour integrated sample. The ambient air sample provides a measure of the background air concentration of the chemicals of concern. The 6-L SUMMA canister was analyzed by Air Toxics LTD using the EPA Method TO-14 with a detection limit of 1.0 parts per billion by volume ($ppb_{v/v}$).

1.4.2 Soil Sampling

During SVS sampling activities, soil samples were collected at four (4) locations (SG-03, SG-04,. SG-07, and SG-08) following collection of each soil vapor profile. The soil samples were labeled SG-03-xxx, SG-04-xxx,. SG-07-xxx, and SG-08-xxx, respectively (where xxx indicates the depth at which the sample was collected). At each location, the GeoProbe direct-push soil sampling equipment was used to collect continuous core samples to a depth of 8 ft bgs in two 4 ft clear polyethylene-terephthalate tubes. Each tube was cut into two sections and sent to Sequoia Analytical, Inc., a state-certified laboratory, and analyzed for TPH-G, BTEX, fractional organic carbon, dry bulk density, wet bulk density, and percent moisture.

2. SAMPLING RESULTS

2.1 Soil Vapor Survey

The results of the soil vapor survey measurements are presented in Tables 1, 2 and 3. Table 1 presents a summary of all the soil vapor survey data collected, including: (1) the analytic TO-3 results for the 1 liter SUMMA canister samples; (2) the InterPhase onsite laboratory analyses for TPH, BTEX, oxygen, carbon dioxide and methane; and (3) field comments. Table 2 presents the same data sorted by depth. Table 3 presents the SVS data sorted by location. The InterPhase soil vapor onsite laboratory analyses utilized a gas chromatagraph (GC) with a detection limit for BTEX of 1 µg/L (about 308 $ppb_{v/v}$ for benzene). **The Air Toxics LTD TO-3 laboratory analyses utilized a GC/Photoionization Detector with a detection limit for BTEX of 1 $ppb_{v/v}$ (0.003 µg/L for benzene). Therefore, the Air Toxics LTD TO-3 laboratory analyses is assumed to be more representative of the soil vapor survey concentrations,** and the InterPhase BTEX data is not included in Tables 2 and 3. The InterPhase Environmental Chemistry Specialists and Air Toxics LTD reports for the soil vapor survey are presented as Appendices B and C, respectively.

The SVS locations are shown in Figure 3. SVS samples were collected using GeoProbe direct-push soil vapor sampling equipment, at nine (9) locations in the vicinity of the former Shell Service Station and the adjoining trailer park property. Five (5) sampling locations (SG-01, SG-02, SG-03, SG-08, and SG-09) were located within the former service station property and four (4) sampling locations (SG-04, SG-05, SG-06, and SG-07) were located within the trailer park property. At five (5) locations (SG-01, SG-02, SG-05, SG-06, and SG-09) soil vapor samples were collected at a depth of 4 ft, and at four (4) locations (SG-03, SG-04, SG-07, and SG-08) soil vapor profile samples were collected at depths of 2 ft, 4 ft, and 6 ft. **The SVS sample collected at location SG-02 encountered soil at 4 ft which was too impermeable to yield sufficient air flow to allow collecting a soil vapor sample. At this location, the sampler was raised by two feet so that a sample could be successfully collected at a depth of 2 ft.** Sampling field notes for each SVS location are included in Table 1.

Elevated concentrations of TPH-G, BTEX, and MTBE were observed in almost all of the collected samples. The resulting vapor depth profiles for BTEX and MTBE are plotted on Figure 4. Oxygen, carbon dioxide, nitrogen, and methane vapor depth profiles are plotted on Figure 5. Petroleum hydrocarbons are typically highest at the 2-4 ft sampling depth, and lowest at the 6 ft sampling depth. This indicates that soil vapor concentrations measured during this survey are more likely due to residual soil contamination **or preferential soil vapor transport**, than to diffusive transport upwards from contaminated ground water sources.

The average carbon dioxide (CO_2), oxygen (O_2), nitrogen (N_2) and methane (CH_4) concentrations in soil gas are also plotted in Figure 6. Because aerobic bacteria require oxygen (O_2)

and produce carbon dioxide (CO_2) during the metabolism of petroleum hydrocarbons, a simple indicator of aerobic biological activity is the observance of decreased concentrations of O_2 and elevated concentrations of CO_2 in soil gas. The normal ambient concentration of O_2 and CO_2 in the atmosphere is about 21.6% O_2 and 355 $ppm_{v/v}$, or 0.035% CO_2. The average CO_2 concentration in soil gas (also plotted in Figure 4) is greatly elevated with respect to typical atmospheric concentrations, particularly at 2 ft and 4 ft bgs. The converse is true of O_2 concentration, as would also be expected in the case of aerobic biodegradation. Elevated levels of methane in the soil vapor samples may indicate areas undergoing anaerobic degradation.[1]

The average site-wide concentrations for contaminants and bioactivity indicators are plotted by depth on Figure 6. Figures 4 through 6 illustrate the large variability of soil vapor profile results occurring at this site. These are likely the result of differing transport phenomena and potential hydrocarbon sources.

The highest benzene concentrations in site soil vapor samples were measured in SG-1, at a depth of 4 ft. This location is immediately south of a former fuel island and is within 10 feet of the service station building. The closest soil vapor sample to SG-1 is SG-3, where a soil vapor profile was collected under the service station building by installing a GeoProbe soil vapor sampling probe through the floor of one of the service station bays. The service station bay floor was only approximately 1 inch thick, and was underlain with very loose gravel. Soil vapor concentrations beneath the service bay decreased with depth, indicating that the source of the vapors was more likely due to shallow soils or preferential transport of hydrocarbon vapors through the shallow, high permeability gravel layer, rather than transport from groundwater sources. The elevated methane, carbon dioxide and reduced oxygen concentrations observed in SG-1-4ft and SG-3-2ft, indicate anaerobic biodegradation conditions. These samples indicate that there is little to no transport of soil vapor across the asphalt pavement and concrete service station bay floor.

Relatively low soil vapor hydrocarbon concentrations were measured in the soil vapor sample collected from SG-2 at 2 ft bgs. This sample was collected near a planter, however, and the elevated carbon dioxide and reduced oxygen concentrations indicate the likelihood that biodegradation is occurring in this area.

SG-4, SG-5 and SG-6 are located on the trailer park property. At SG-4 a soil vapor profile was collected at 2ft, 4ft, and 6ft. The concentration gradient is indicative of diffusive transport from a contaminated water table which has been highly attenuated by a low permeability barrier.

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[1] Assuming the petroleum hydrocarbons can be approximated as heptane, a simplified aerobic biodegradation stoichiometry is given by:

$$C_7H_{16} + 11O_2 \rightarrow 8H_2O + 7CO_2$$

and a simplified anaerobic biodegradation stoichiometry is given by:

$$2C_7H_{16} + 6H_2O \rightarrow 3CO_2 + 11CH_4$$

Relatively high concentrations of hydrocarbon soil vapors were observed in SG-5, and only low concentrations were observed in SG-6. Measured concentrations of CO_2, O_2, N_2, and CH_4, indicate that little biodegradation is occurring in these areas.

The soil vapor profile collected at SG-7 identified a high permeability layer at the 4 ft sampling depth. This high permeability layer coincided with elevated concentrations of hydrocarbon vapors, CO_2 and CH_4, and reduced concentrations of O_2. The concentration gradient indicates that the source of hydrocarbon soil vapor concentrations at this sampling location is likely the result of preferential transport through the higher permeability zone observed at 4 ft. The elevated CO_2 and CH_4, and reduced concentrations of O_2 indicate anaerobic biodegradation conditions and that there is minimal transport of soil vapor across the asphalt pavement.

A similar high permeability zone was observed in the soil vapor profile collected at SG-8. Again, this higher permeability layer coincided with elevated concentration of CO_2 and reduced concentrations of O_2. At this sampling location, however, the hydrocarbon soil vapor profile is consistent with diffusive vapor transport from a ground water source to the surface, attenuated by aerobic biodegradation.

Elevated soil vapor hydrocarbon concentrations were measured in the soil gas sample collected from SG-9 at 4 ft bgs. Measured concentrations of CO_2, O_2, N_2, and CH_4, indicate that little biodegradation is occurring near this sampling location.

Based on the measured soil vapor samples at this site, it is clear that the asphalt pavement is acting as a low permeability barrier and is significantly affecting sub-surface soil vapor transport. In areas where high hydrocarbon soil vapor concentrations are observed, it is not clear whether the source of measured concentrations are residual soil contamination, preferential transport of soil vapor through higher permeability soils, or preferential transport through conduits such as utility lines. It is clear that in areas of high hydrocarbon concentrations, anaerobic conditions are present, and little transport is occurring across the asphalt pavement and the service station concrete slab. Assuming the asphalt pavement provides a continuous, low-permeability layer, conditions are favorable for preferential diffusive transport though high permeability zones, such as the gravel bedding of the sewer and utility lines and the gravel layer beneath the service station building.

2.2 Soil Sampling

The results of soil sampling activities at the site are presented in Table 4. During SVS sampling activities, soil samples were collected at four (4) SVS sampling locations SG-3, SG-4, SG-7, and SG-8, following collection of each soil vapor profile. The soil samples were labeled SG-03-xxx, SG-04-xxx, SG-07-xxx, and SG-08-xxx, respectively (where xxx indicates the sampling depth). At each location, the GeoProbe direct-push soil sampling equipment was used to collect two 4 ft macro-core samples in a clear polyethylene-terephthalate tube between 0 ft and 8 ft. Each tube was cut into two sections and sent to Sequoia Analytical, Inc., a state-certified laboratory. The analytic results for the soil samples are presented as Appendix D.

located under station building

Weiss Associates

The highest benzene concentration measured in site soils (10 mg/kg) during this investigation was obtained from the sample collected at a depth of 4-6 ft in SG-3. TPH-G concentrations in this sample were 4,200 mg/kg. This sample was collected immediately south of a former fuel island on the center of the station property. Elevated benzene concentrations were also measured in the sample collected from 6-8 feet at this location.

3. RISK-BASED CORRECTIVE ACTION (RBCA) EVALUATION

The RBCA evaluation was performed in accordance with the American Society for Testing and Materials Standard E 1739-95, *Risk-Based Corrective Action Applied at Petroleum Release Sites* (ASTM, 1995. The ASTM framework utilizes a tiered or phased approach to evaluate health risks. The objective of this evaluation is to determine the most appropriate future action to address subsurface petroleum hydrocarbons based on site-specific characteristics and the extent and nature of the contaminants of concern (COCs).

The RBCA evaluation assesses potential impacts of the COCs on current and potential future site occupants and on ground water quality. The COCs include benzene, ethylbenzene, toluene, and xylenes (BTEX) and methyl tert butyl ether (MTBE).

3.1 Review of Tier 1 RBCA Evaluation

A Tier I RBCA Evaluation, dated December 9, 1996 was prepared by WA to provide an initial estimate of potential health effects due to residual contamination at the site. WA established Tier 1 risk-based screening levels (RBSLs) for each COC and for each potentially complete exposure pathway. These conservative Tier 1 RBSLs were established using the models and recommended parameter values in the ASTM Standard. Tier 1 RBSLs represent extremely conservative concentrations, below which no significant adverse effects on human health are expected to occur.

Based on the Tier I RBCA evaluation, RBSLs were exceeded for the following potentially complete pathways:

- Volatilization of benzene and toluene from subsurface soils (>3 ft. depth) to indoor air;
- Volatilization of benzene from subsurface soils to outdoor air;
- Leaching of benzene and toluene from subsurface soils to ground water;
- Volatilization of benzene from ground water to indoor air;
- Ingestion of benzene contaminated ground water.

3.2 Update to Tier 1 RBCA Evaluation

The representative concentrations which were compared to the RBSLs for each COC have been updated based on the recently collected site data. Additionally, pathways involving exposure to surface soils (<3 ft. depth) were not evaluated in Tier I due to the presence of a cap over most of the site surface and a lack of shallow soil data. However, these pathways were evaluated as part of the

Tier II assessment. A revised table showing representative concentrations and RBSLs for each COC and potentially complete exposure pathway is included in Appendix E - Worksheet 1.6. The updated table indicates that representative concentrations of toluene in the site soils no longer exceed RBSLs for volatilization to indoor air and leachate to ground water for ingestion. Additionally, COC concentrations in surface soils do not exceed the Tier 1 RBSLs.

3.3 Tier 2 RBCA Evaluation

For those contaminant/pathways for which the conservative Tier 1 RBSLs were exceeded in a particular medium (surface soil, subsurface soil, or ground water), WA completed a Tier 2 analysis (contained herein). Tier 2 site-specific target levels (SSTLs), which represent the same level of health protection as the Tier 1 RBSLs, were developed using generally accepted modeling methods with site-specific characterization data. The Tier 2 SSTL is a site-specific, rather than generic, level below which contaminants are not expected to pose a significant threat to human health.

The objective of the Tier 2 evaluation is to use site-specific data to determine site-specific target levels (SSTLs) for comparison to site-specific levels of COCs, followed by a determination of the need for further action. Tier 2 SSTLs are typically higher than Tier 1 RBSLs, not because they represent a lesser protection to human or ecological receptors, but because the site-specific evaluation eliminates some of the very conservative assumptions used to formulate the RBSLs. In fact, like Tier 1 RBSLs, Tier 2 SSTLs are conservative estimates of the maximum concentrations that do not pose a significant risk to identified receptors. Once the SSTLs are established, they are compared to maximum site concentrations.

The Tier II RBCA evaluation, performed using proprietary software developed by Ground water Services, Inc. (GSI) is included in Appendix E.

3.3.1 Comparison of Site Concentrations to SSTLs

Comparison of representative benzene concentrations in the site soils and ground water to the Tier 2 SSTLs indicates:

- Benzene concentrations in the site soils exceed the SSTL for volatilization to indoor air;
- Benzene concentrations in the ground water exceed the SSTL for volatilization to indoor air;
- Benzene concentrations in ground water at the site exceed the SSTLs and the drinking water standard (MCL);
- Benzene concentrations in ground water do not exceed the SSTLs if the nearest potential off-site receptor is considered.

3.4 MTBE Evaluation

MTBE has been measured in site soils, soil vapor, and ground water. MTBE was not considered in the RBCA evaluation as definitive health risk data for MTBE has not yet been published. The primary focus of current research of toxicological effects of MTBE is through ingestion of MTBE contaminated ground water. To our knowledge, little or no research has been conducted to evaluate the effects of inhalation of MTBE or dermal contact with MTBE. However, due to the physical properties of MTBE, the most important health risk is likely through ingestion of contaminated ground water.

Additionally, the presence of MTBE at the site cannot be historically related to Shell's operation of the facility as a service station. Shell ceased operation at this location prior to their first usage of MTBE as a gasoline additive in northern California.

MTBE concentrations in the ground water are likely of the greatest concern at the site. No detectable benzene concentrations have been measured in the down gradient, off-site wells in the previous four quarters. However, MTBE concentrations in downgradient well S-13 (center of Lewelling Blvd.) have been as high as 210 ug/L. MTBE concentrations in the off-site well are significantly higher than concentrations measured in on-site wells.

The measured MTBE concentrations may be attributable to co-mingling of the plume from the neighboring service station, or another un-identified source. The ground water gradients exhibited at the site have generally ranged from south to southwest. **However, as shown through the soil gas data, preferential migration of contaminants through high permeability conduits may be of concern.**

Once the source of MTBE is better defined and health risk data becomes available, a risk assessment should be conducted to evaluate the effects of residual MTBE in the area.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the soil vapor profiling, soil sampling, and RBCA evaluation, the following conclusions were made:

- Vapor concentrations in shallow soil vapor samples exceeded concentrations in deeper samples in several locations where soil vapor profiles were collected. This pattern is not typical for sites at which upward diffusion and bio-attenuation of vapors from contaminated soils and ground water is the primary transport phenomenon;
- Two shallow zones of relatively high permeability soils have been identified in many borings which may allow for preferential migration of vapors;
- A review of bio-activity indicator parameters such as oxygen, carbon dioxide, and methane indicate that biodegradation in highly contaminated areas is likely taking place through anaerobic processes;
- Vapor transport to indoor air from contaminated soils and ground water appears to be the primary pathway of concern at the site. Representative concentrations of benzene in site soils and groundwater exceed Tier 2 SSTLs for this pathway;
- MTBE present in the site soils, soil vapor, and ground water may be due to off-site sources. MTBE was not evaluated in the RBCA process;

WA makes the following recommendations for continued work to address the potential health risks at this site:

- A thorough evaluation of potential preferential pathways for vapor transport should be performed;
- An evaluation of remedial alternatives for reducing subsurface soil and ground water concentrations below SSTL values should be performed;
- Based on the initial round of soil vapor samples collected at the site and the fact that the soil values exceed Tier 2 SSTLs, an additional round of soil vapor sampling does not appear warranted.

And:

- additional SVS pts should be emplaced north of SG-5, SG-16, and SG-9 near potential receptor locations

5. REFERENCES

ASTM, 1995; *Risk-Based Corrective Action Applied at Petroleum Release Sites*; American Society for Testing and Materials (ASTM) Standard E-1739, 1995.

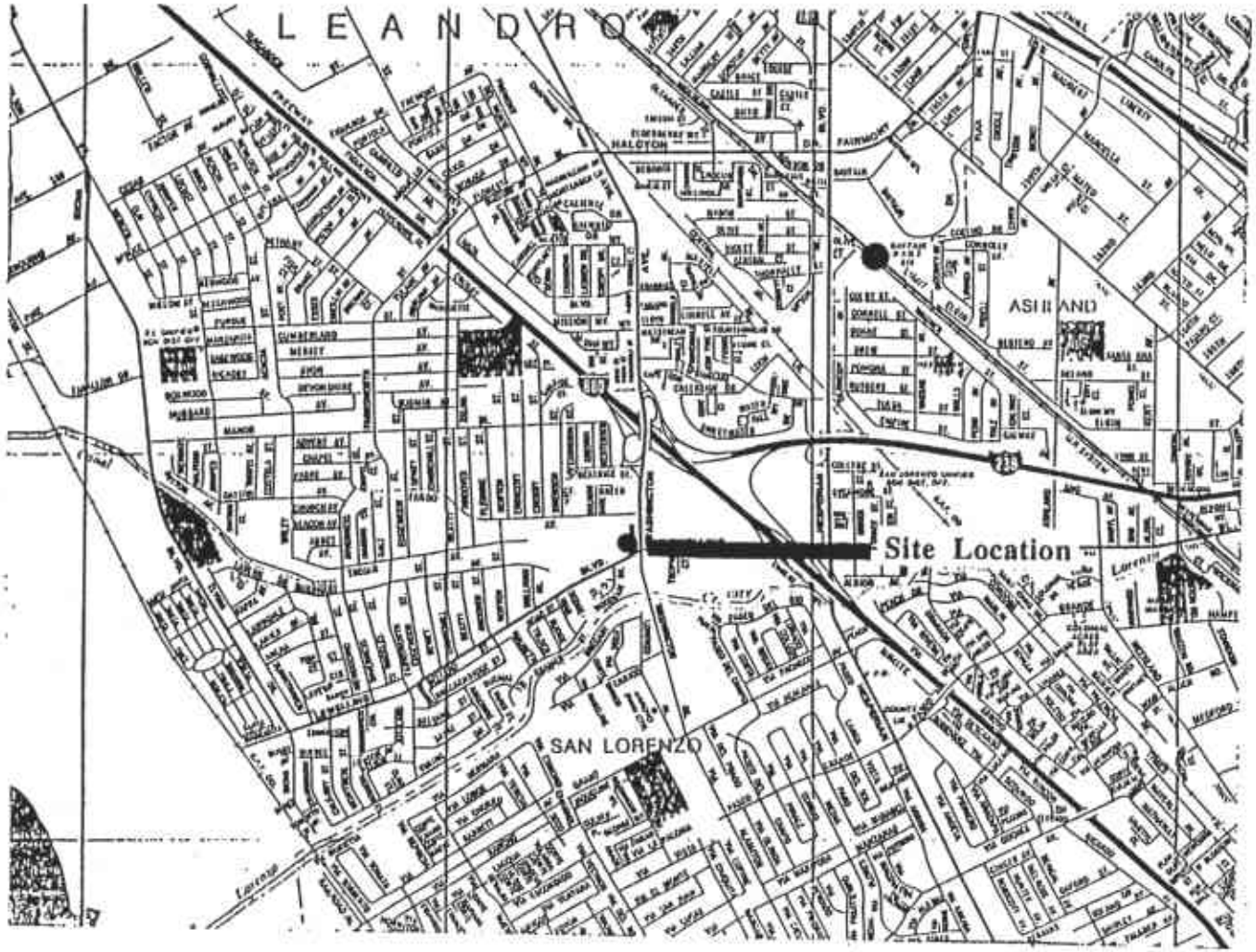
DeVaull, G.E.; Gustafson, J.B.; Schmidt, C.E.; *Surface Emission Flux Measurements: Background Levels*; 5th Annual AWMA/CARB Conference on Current Issues in Air Toxics; November 1994; Sacramento CA.

BAAQMD, 1994; *1994 Status Report: BAAQMD Toxic Air Contaminant Control Program*; Bay Area Air Quality Management District, 1994

Ostendorf, D.W.; Kampbell, D.H.; *Biodegradation of Hydrocarbon Vapors in the Unsaturated Zone*; Water Resources Research; Vol. 27, No. 4, Pages 453-462; April, 1991

USEPA, 1986; *Measurement of Gaseous Emission Rates from Land Surfaces Using Emission Isolation Flux Chamber: User's Guide*; Las Vegas, NV, (EPA/600/8-86/008).

USEPA, 1989, *Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual, Part A, Interim Final*; Office of Emergency and Remedial Response, US EPA, Washington, DC, (EPA/540/1-89/002).



Note: Vicinity Map taken from California State Automobile Association Map.

Figure 1. Site Vicinity Map - Shell Oil Company, 15275 Washington Avenue, San Leandro, California

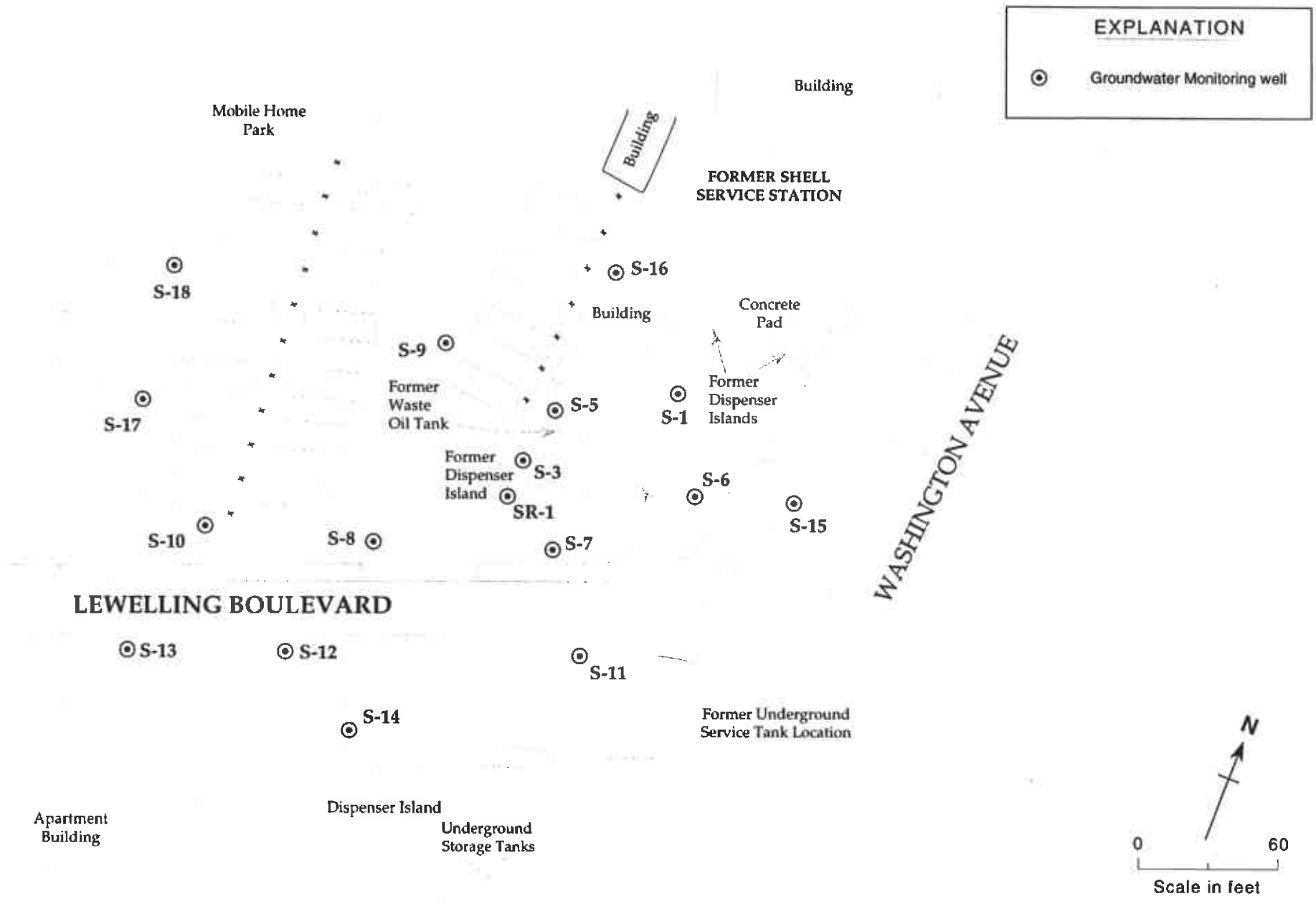


Figure 2. Site Plan - Shell Oil Company, 15275 Washington Avenue, San Leandro, California

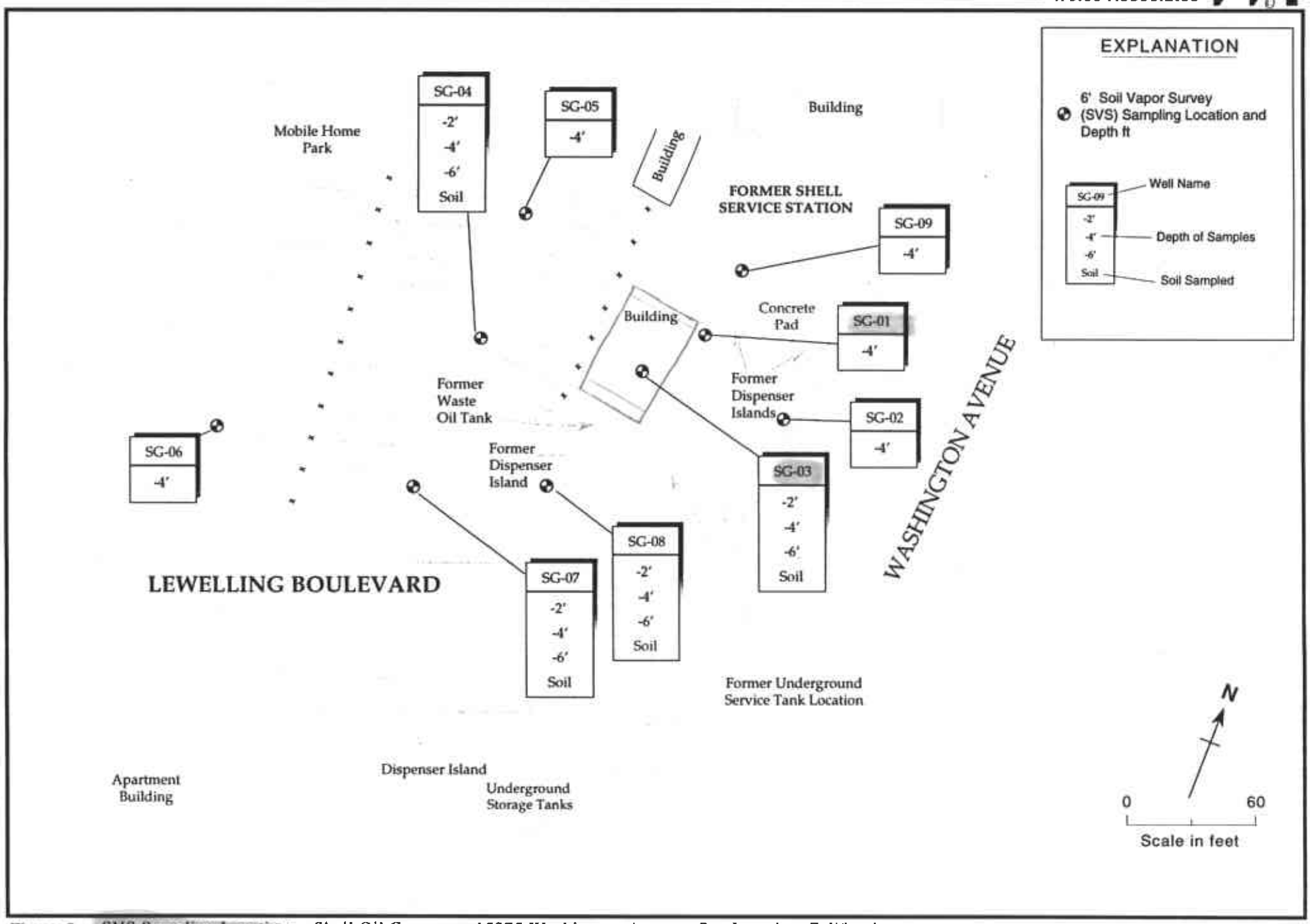


Figure 3. SVS Sampling Locations - Shell Oil Company, 15275 Washington Avenue, San Leandro, California

s-1227-04.a1

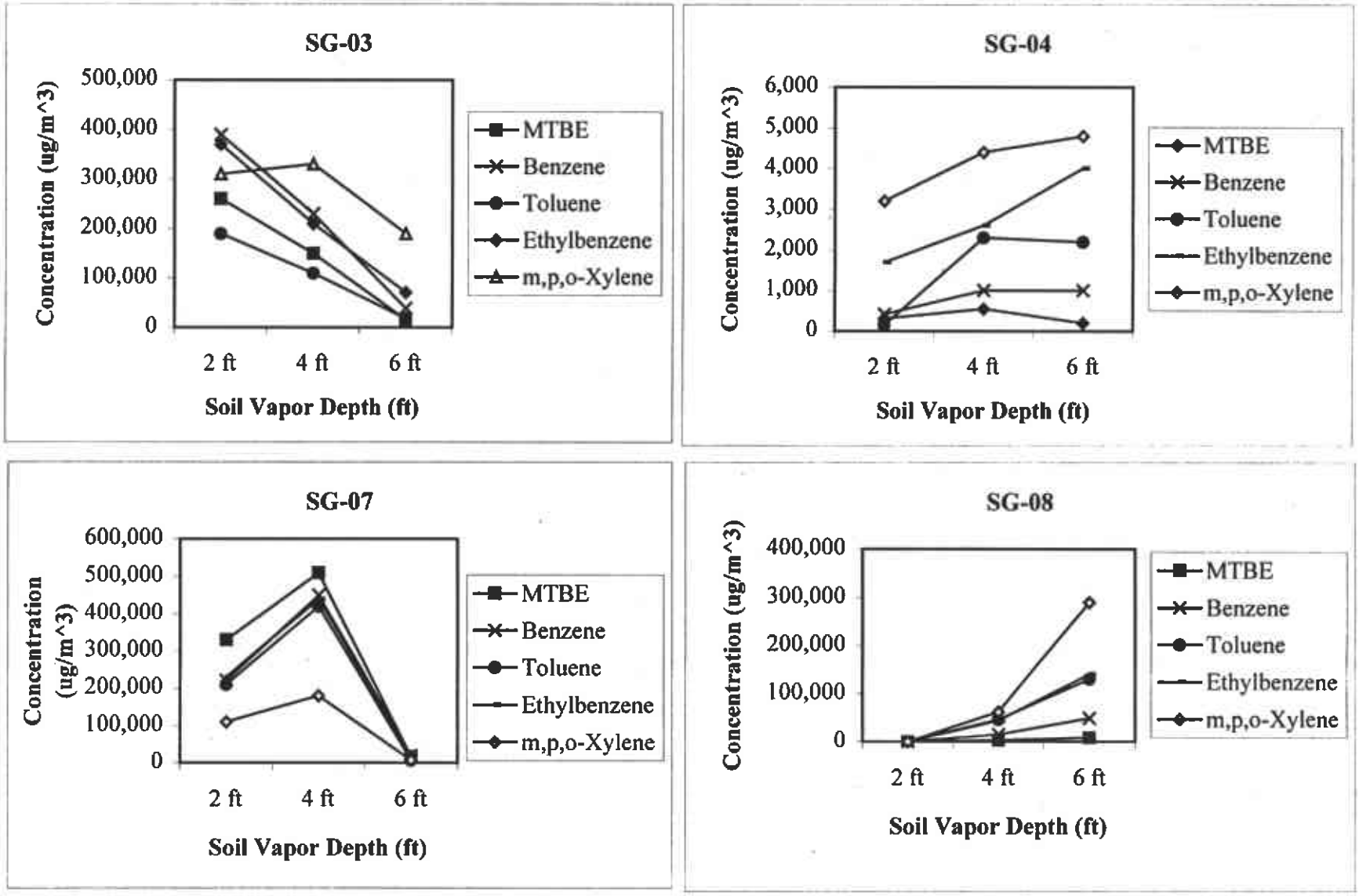


Figure 4. Benzene, Toluene, Ethylbenzene and Xylenes Soil Vapor Concentrations by Depth.

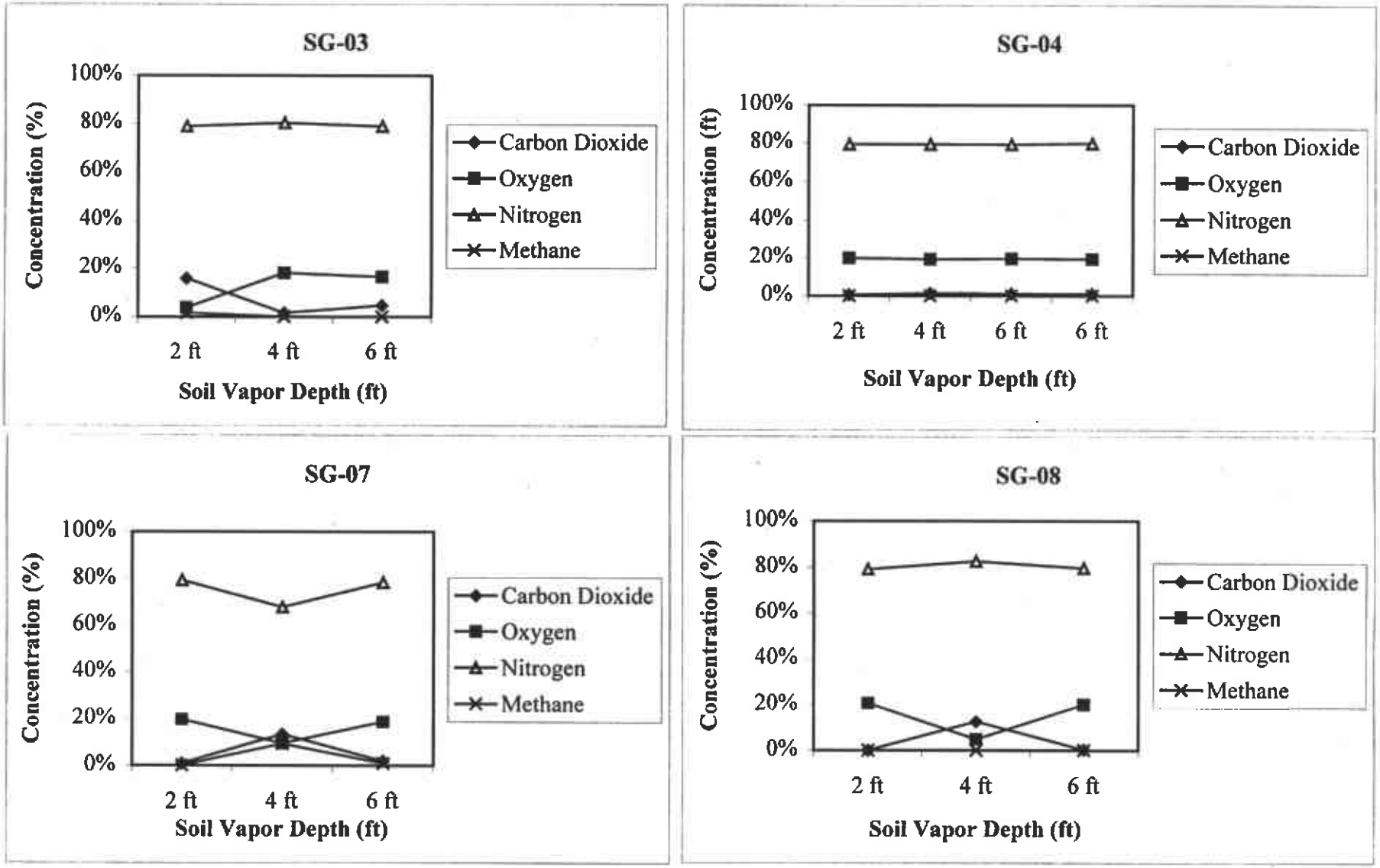


Figure 5. Carbon Dioxide, Oxygen, Nitrogen, and Methane Soil Vapor Concentrations by Depth.

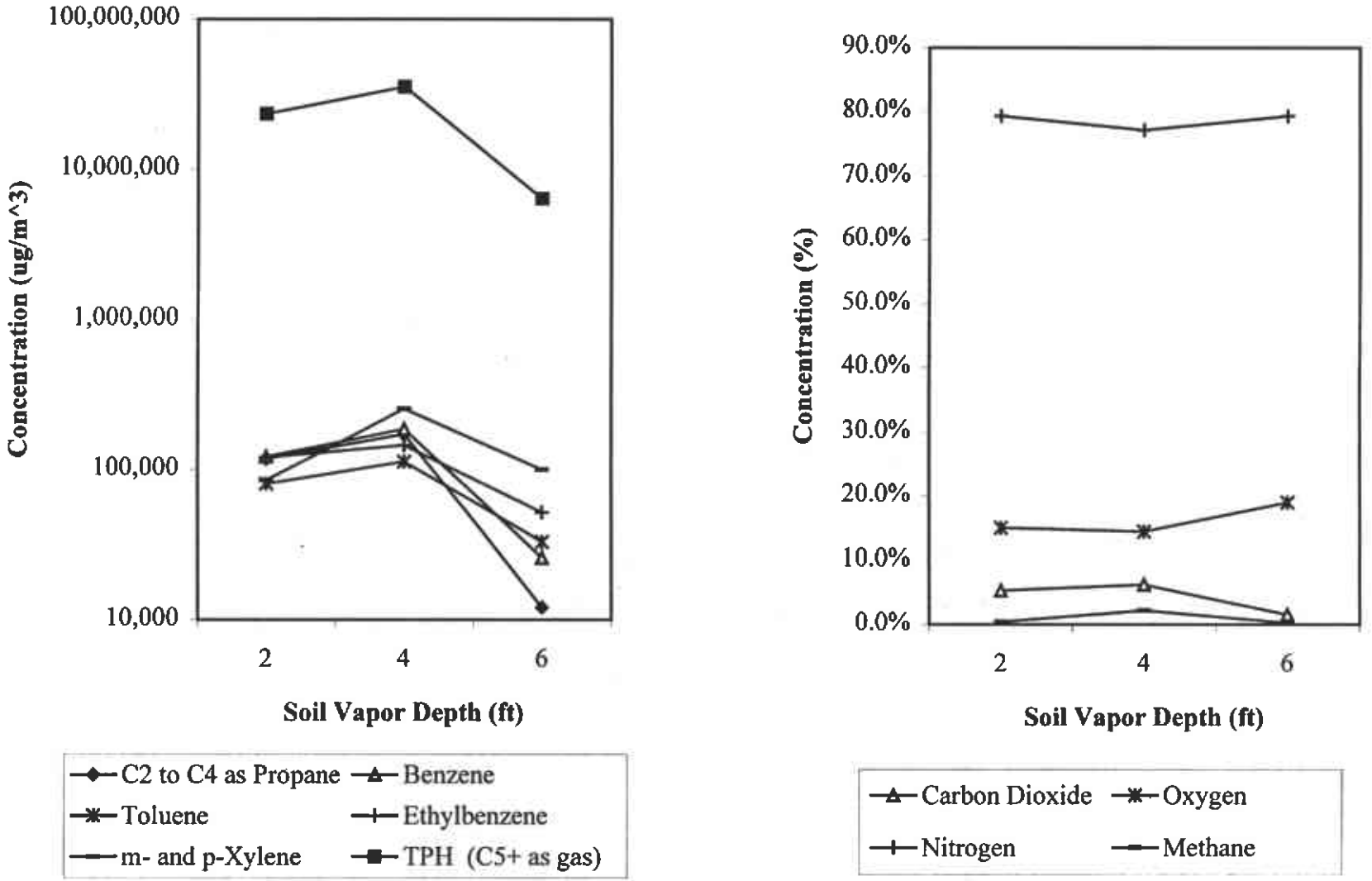


Figure 6. Average Site Concentrations by Depth - Former Shell Service Station, WIC#204-6852-1008, 15275 Washington Avenue, San Leandro, California

- MtBE result inconclusive
  1) TO-3 is GC method w/o second column conf.
  2) TO-14 is GS/MS and was used only for ambient samples

TABLES

Table 1. Soil Vapor Survey Data
Former Shell Service Station, WIC #204-6852-1008, 15275 Washington Avenue, San Leandro, California

WA Sample ID	Depth below ground surface	Date sampled	Air Toxics ID	Date Analyzed	TPH (C_5+ as gas)	MTBE	Benzene	Toluene	Ethylbenzene	m,p,o-Xylene	TVH (C_4-C_{10} as gas)	Benzene	Toluene	Ethylbenzene	m- and p-Xylene	o-Xylene	Carbon Dioxide	Oxygen	Nitrogen	Methane	Comments
					Air Toxics LTD Data (ug/m³)						InterPhase Data (ug/m³)						InterPhase Data (%)				
SG-01-4ft	4 ft	5/4/93	9705071B-02A	5/29/93	100,000,000	700,000	750,000	280,000	370,000	1,300,000	78,000,000	910,000	110,000	70,000	160,000	40,000	19.7%	3.9%	68.6%	7.8%	Good flow, tight soil
SG-02-2ft	2 ft	5/4/93	9705071B-03A	5/29/93	46,000	73	250	96	250	880	< 5,000	< 1,000	< 1,000	< 1,000	< 1,000	< 1,000	9.2%	11.3%	79.5%	< 0.1%	No flow, sample collected at 2 ft
SG-03-2ft	2 ft	5/4/93	9705071B-04A	5/29/93	54,000,000	260,000	390,000	190,000	370,000	310,000	20,000,000	280,000	57,000	44,000	34,000	15,000	15.8%	3.8%	78.9%	1.6%	Good flow, gravel
SG-03-4ft	4 ft	5/4/93	9705071B-05A	5/29/93	33,000,000	150,000	230,000	110,000	210,000	330,000	3,700,000	49,000	12,000	7,400	4,300	< 1,000	1.6%	18.1%	80.3%	< 0.1%	Somewhat restricted flow
SG-03-6ft	6 ft	5/4/93	9705071B-06A	5/29/93	5,000,000	16,000	39,000	18,000	71,000	190,000	44,000,000	79,000	88,000	400,000	190,000	57,000	4.7%	16.4%	78.9%	< 0.1%	Somewhat restricted flow
SG-04-2ft	2 ft	5/4/93	9705071B-08A	5/29/93	220,000	310	420	150	1,700	3,200	110,000	1,600	< 1,000	< 1,000	< 1,000	< 1,000	0.7%	19.8%	79.4%	< 0.1%	Pretty good/medium flow
SG-04-4ft	4 ft	5/4/93	9705071B-07A	5/29/93	350,000	550	1,000	2,300	2,600	4,400	370,000	2,900	< 1,000	2,500	2,000	< 1,000	1.4%	19.2%	79.4%	< 0.1%	
SG-04-6ft	6 ft	5/4/93	9705071B-09A	5/29/93	310,000	200	1,000	2,200	4,000	4,800	490,000	2,800	3,400	7,100	1,500	7,900	1.2%	19.5%	79.3%	< 0.1%	Medium flow
SG-04-6ft (dup)	6 ft	5/4/93	NA	5/29/93	NA	NA	NA	NA	NA	NA	500,000	3,000	4,000	7,200	1,700	5,800	1.0%	19.2%	79.8%	< 0.1%	Medium flow
SG-05-4ft	4 ft	5/4/93	9705071B-17A	5/29/93	8,700,000	6,200	20,000	42,000	75,000	130,000	26,000	< 1,000	< 1,000	< 1,000	< 1,000	< 1,000	0.3%	20.3%	79.4%	< 0.1%	Very tight
SG-06-4ft	4 ft	5/4/93	9705071B-16A	5/29/93	66,000	22	8	150	380	790	< 5,000	< 1,000	< 1,000	< 1,000	< 1,000	< 1,000	0.5%	19.9%	79.6%	< 0.1%	Good flow
SG-07-2ft	2 ft	5/4/93	9705071B-10A	5/29/93	62,000,000	330,000	220,000	210,000	230,000	110,000	700,000	38,000	1,400	14,000	< 1,000	< 1,000	0.9%	19.7%	79.4%	< 0.1%	Good flow
SG-07-4ft	4 ft	5/4/93	9705071B-11A	6/2/93	130,000,000	510,000	450,000	420,000	440,000	180,000	38,000,000	18,000	40,000	43,000	12,000	5,000	13.4%	9.5%	67.9%	9.3%	Good flow, high permeability
SG-07-6ft	6 ft	5/4/93	9705071B-12A	5/29/93	3,000,000	17,000	19,000	6,500	20,000	6,600	2,000,000	13,000	7,400	< 10,000	< 10,000	< 10,000	1.9%	18.7%	78.5%	1.0%	Low flow/very low permeability
SG-07-6ft (dup)	6 ft	5/4/93	9705071B-12AA	5/29/93	3,400,000	19,000	21,000	7,300	22,000	7,500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Low flow/very low permeability
SG-08-2ft	2 ft	5/5/93	9705071B-13A	5/29/93	15,000	22	10	38	190	220	< 5,000	< 1,000	< 1,000	< 1,000	< 1,000	< 1,000	0.1%	20.6%	79.3%	< 0.1%	Good flow
SG-08-4ft	4 ft	5/5/93	9705071B-14A	5/29/93	7,100,000	3,200	15,000	46,000	44,000	62,000	2,400,000	< 1,000	64,000	7,400	10,000	4,300	12.6%	4.8%	82.7%	< 0.1%	Good flow
SG-08-6ft	6 ft	5/5/93	9705071B-15A	5/29/93	20,000,000	8,400	49,000	130,000	140,000	290,000	1,000,000	< 1,000	35,000	3,500	5,000	5,800	0.3%	20.0%	79.7%	< 0.1%	Low flow, a little tighter than 2 ft and 4 ft depth
SG-08-6ft (dup)	6 ft	5/4/93	NA	5/29/93	NA	NA	NA	NA	NA	NA	1,100,000	< 1,000	36,000	4,000	5,700	5,800	0.2%	20.0%	79.8%	< 0.1%	Low flow, a little tighter than 2 ft and 4 ft depth
SG-09-4ft	4 ft	5/4/93	9705071B-18A	5/29/93	540,000	1,600	18,000	610	17,000	15,000	1,800,000	87,000	10,000	28,000	20,000	1,300	0.9%	20.0%	79.1%	< 0.1%	Pretty good flow
AVERAGES:					23,763,722	112,365	123,538	81,408	112,118	163,633	10,221,632	78,489	24,958	34,374	24,326	8,732	4.5%	16.0%	78.4%	1.1%	

QA/QC Samples

AMB-01		5/4/93	9705071A-01A	5/15/93	< 10,000	< 4,000	< 1,000	< 1,000	< 1,000	< 1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Air Toxics Ambient Air Sample
Ambient Air		5/4/93	NA	NA	NA	NA	NA	NA	NA	NA	< 5,000	< 1,000	< 1,000	< 1,000	< 1,000	< 1,000	< 0.1%	21.0%	79.0%	< 0.1%	InterPhase Ambient Air Sample
Ambient Air		5/5/93	NA	NA	NA	NA	NA	NA	NA	NA	< 5,000	< 1,000	< 1,000	< 1,000	< 1,000	< 1,000	< 0.1%	20.8%	79.2%	< 0.1%	InterPhase Ambient Air Sample
Lab Blank		NA	9705071A-02A	5/15/93	< 5,000	< 2,000	< 500	< 500	< 500	< 500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Air Toxics Laboratory Blank
Lab Blank		NA	9705071B-20A	5/29/93	NA	< 4	< 3	< 4	< 4	< 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Air Toxics Laboratory Blank
Lab Blank		NA	9705071B-20B	6/2/93	NA	< 4	< 3	< 4	< 4	< 4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Air Toxics Laboratory Blank

Notes: < - Below the method detection limit.
M - reported value may be biased due to apparent matrix interferences.

Table 2. Soil Vapor Survey Data: Sorted by Depth
Former Shell Service Station WIC #204-6852-1008, 15275 Washington Avenue, San Leandro, California

WA Sample ID	Depth below ground surface	TPH (C_4+ as gas)	MTBE	Benzene	Toluene	Ethylbenzene	m,p,o-Xylene	Carbon Dioxide	Oxygen	Nitrogen	Methane	Comments
		Air Toxics LTD Data (ug/m³)						InterPhase Data (%)				
SG-02-2ft	2 ft	46,000	73	250	96	250	880	9.2%	11.3%	79.5%	< 0.1%	No flow, sample collected at 2 ft
SG-03-2ft	2 ft	54,000,000	260,000	390,000	190,000	370,000	310,000	15.8%	3.8%	78.9%	1.6%	Good flow, gravel
SG-04-2ft	2 ft	220,000	310	420	150	1,700	3,200	0.7%	19.8%	79.4%	< 0.1%	Pretty good/medium flow
SG-07-2ft	2 ft	62,000,000	330,000	220,000	210,000	230,000	110,000	0.9%	19.7%	79.4%	< 0.1%	Good flow
SG-08-2ft	2 ft	15,000	22	10	38	190	220	0.1%	20.6%	79.3%	< 0.1%	Good flow
Mean	2 ft	23,256,200	118,081	122,136	80,057	120,428	84,860	5.3%	15.0%	79.3%	0.4%	
SG-01-4ft	4 ft	100,000,000	700,000	750,000	280,000	370,000	1,300,000	19.7%	3.9%	68.6%	7.8%	Good flow, tight soil
SG-03-4ft	4 ft	33,000,000	150,000	230,000	110,000	210,000	330,000	1.6%	18.1%	80.3%	< 0.1%	Somewhat restricted flow
SG-04-4ft	4 ft	350,000	550	1,000	2,300	2,600	4,400	1.4%	19.2%	79.4%	< 0.1%	
SG-05-4ft	4 ft	8,700,000	6,200	20,000	42,000	75,000	130,000	0.3%	20.3%	79.4%	< 0.1%	Very tight
SG-06 4ft	4 ft	66,000	22	8	150	380	790	0.5%	19.9%	79.6%	< 0.1%	Good flow
SG-07-4ft	4 ft	130,000,000	510,000	450,000	420,000	440,000	180,000	13.4%	9.5%	67.9%	9.3%	Good flow, high permeability
SG-08-4ft	4 ft	7,100,000	3,200	15,000	46,000	44,000	62,000	12.6%	4.8%	82.7%	< 0.1%	Good flow
SG-09-4ft	4 ft	540,000	1,600	18,000	610	17,000	15,000	0.9%	20.0%	79.1%	< 0.1%	Pretty good flow
Mean	4 ft	34,969,500	171,447	185,501	112,633	144,873	252,774	6.3%	14.5%	77.1%	2.2%	
SG-03-6ft	6 ft	5,000,000	16,000	39,000	18,000	71,000	190,000	4.7%	16.4%	78.9%	< 0.1%	Somewhat restricted flow
SG-04-6ft	6 ft	310,000	200	1,000	2,200	4,000	4,800	1.2%	19.5%	79.3%	< 0.1%	Medium flow
SG-04-6ft (dup)	6 ft	NA	NA	NA	NA	NA	NA	1.0%	19.2%	79.8%	< 0.1%	Medium flow
SG-07-6ft	6 ft	3,000,000	17,000	19,000	6,500	20,000	6,600	1.9%	18.7%	78.5%	1.0%	Low flow/very low permeability
SG-07-6ft (dup)	6 ft	3,400,000	19,000	21,000	7,300	22,000	7,500	NA	NA	NA	NA	Low flow/very low permeability
SG-08-6ft	6 ft	20,000,000	8,400	49,000	130,000	140,000	290,000	0.3%	20.0%	79.7%	< 0.1%	Low flow, a little tighter than 2 ft and 4 ft depths
SG-08-6ft (dup)	6 ft	NA	NA	NA	NA	NA	NA	0.2%	20.0%	79.8%	< 0.1%	Low flow, a little tighter than 2 ft and 4 ft depths
Mean	6 ft	6,342,000	12,120	25,800	32,800	51,400	99,780	1.6%	19.0%	79.3%	0.3%	

Notes: < - Below the method detection limit.
M - reported value may be biased due to apparent matrix interferences.

Table 3. Soil Vapor Survey Data: Sorted by Location

Former Shell Service Station WIC #204-6852-1008, 15275 Washington Avenue, San Leandro, California

WA Sample ID	Depth below ground surface	Air Toxics LTD Data (ug/m³) TPH (C_4+ as gas)	MTBE	Benzene	Toluene	Ethylbenzene	m,p,o-Xylene	InterPhase Data (%) Carbon Dioxide	Oxygen	Nitrogen	Methane	Comments
SG-01-4ft	4 ft	100,000,000	700,000	750,000	280,000	370,000	1,300,000	19.7%	3.9%	68.6%	7.8%	Good flow, tight soil
SG-02-2ft	2 ft	46,000	73	250	96	250	880	9.2%	11.3%	79.5%	< 0.1%	No flow, sample collected at 2 ft
SG-03-2ft	2 ft	54,000,000	260,000	390,000	190,000	370,000	310,000	15.8%	3.8%	78.9%	1.6%	Good flow, gravel
SG-03-4ft	4 ft	33,000,000	150,000	230,000	110,000	210,000	330,000	1.6%	18.1%	80.3%	< 0.1%	Somewhat restricted flow
SG-03-6ft	6 ft	5,000,000	16,000	39,000	18,000	71,000	190,000	4.7%	16.4%	78.9%	< 0.1%	Somewhat restricted flow
SG-04-2ft	2 ft	220,000	310	420	150	1,700	3,200	0.7%	19.8%	79.4%	< 0.1%	Pretty good/medium flow
SG-04-4ft	4 ft	350,000	550	1,000	2,300	2,600	4,400	1.4%	19.2%	79.4%	< 0.1%	
SG-04-6ft	6 ft	310,000	200	1,000	2,200	4,000	4,800	1.2%	19.5%	79.3%	< 0.1%	Medium flow
SG-04-6ft (dup)	6 ft	NA	NA	NA	NA	NA	NA	1.0%	19.2%	79.8%	< 0.1%	Medium flow
SG-05-4ft	4 ft	8,700,000	6,200	20,000	42,000	75,000	130,000	0.3%	20.3%	79.4%	< 0.1%	Very tight
SG-06 4ft	4 ft	66,000	22	8	150	380	790	0.5%	19.9%	79.6%	< 0.1%	Good flow
SG-07-2ft	2 ft	62,000,000	330,000	220,000	210,000	230,000	110,000	0.9%	19.7%	79.4%	< 0.1%	Good flow
SG-07-4ft	4 ft	130,000,000	510,000	450,000	420,000	440,000	180,000	13.4%	9.5%	67.9%	9.3%	Good flow, high permeability
SG-07-6ft	6 ft	3,000,000	17,000	19,000	6,500	20,000	6,600	1.9%	18.7%	78.5%	1.0%	Low flow/very low permeability
SG-07-6ft (dup)	6 ft	3,400,000	19,000	21,000	7,300	22,000	7,500	NA	NA	NA	NA	Low flow/very low permeability
SG-08-2ft	2 ft	15,000	22	10	38	190	220	0.1%	20.6%	79.3%	< 0.1%	Good flow
SG-08-4ft	4 ft	7,100,000	3,200	15,000	46,000	44,000	62,000	12.6%	4.8%	82.7%	< 0.1%	Good flow
SG-08-6ft	6 ft	20,000,000	8,400	49,000	130,000	140,000	290,000	0.3%	20.0%	79.7%	< 0.1%	Low flow, a little tighter than 2 ft and 4 ft dept
SG-08-6ft (dup)	6 ft	NA	NA	NA	NA	NA	NA	0.2%	20.0%	79.8%	< 0.1%	Low flow, a little tighter than 2 ft and 4 ft dep
SG-09-4ft	4 ft	540,000	1,600	18,000	610	17,000	15,000	0.9%	20.0%	79.1%	< 0.1%	Pretty good flow

Notes: < - Below the method detection limit.

M - **reported value may be biased due to apparent matrix interferences.**

Table 4. Sequoia Analytical Soil Data
Former Shell Service Station, WIC #204-6852-1008, 15275 Washington Avenue, San Leandro, California

WA Sample ID	Depth below ground surface	Date sampled	Date Analyzed	TPH (C_5+ as gas)	Benzene	Toluene	Ethylbenzene	Total-Xylene	Chromatogram Pattern	Fraction Organic Carbon (%)	Moisture (%)	Dry Bulk Density (g/cc)	Wet Bulk Density (g/cc) Calculated from Dry Bulk	Grain Density - assumed	Total Porosity	Water filled Porosity	Air filled Porosity	Comments
Soil Data				**TPPH w/ BETX (8015 Mod/8020, µg/kg)**						**Other laboratory Analyses**					**Calculated values**			
SG-03-0-4 ft	0-4 ft	5/5/97	5/14/97	23,000	260	110	210	410	Gas/UH	1.3%	7%	1.8	1.9	2.65	0.32	0.05	0.27	0-4" Gravel (GP), 4"-4' Sand & Gravel (SW) fill, slight odor
SG-03-4-6 ft	4-6 ft	5/5/97	5/14/97	4,200,000	10,000	3,700	52,000	220,000	Gas	0.37%	15%	2.0	2.3	2.65	0.25	0.04	0.21	4'-6' Moist Clayey Silt w/ Gravel, Slight odor
SG-03-6-8 ft	6-8 ft	5/5/97	5/14/97	3,600,000	6,300	5,900	47,000	190,000	Gas	0.30%	17%	2.1	2.5	2.65	0.21	0.03	0.17	6'-8' Silty Sand, less moist, slight odor
SG-04-0-2 ft	0-2 ft	5/5/97	5/14/97	2,000	13	< 5	21	67	Gas	3.4%	1%	1.9	1.9	2.65	0.28	0.05	0.24	0-6" Gravel, Asphalt, 6"-2' Clayey Sand, no odor
SG-04-2-4 ft	2-4 ft	5/5/97	5/14/97	9,000	55	23	150	470	Gas	1.2%	20%	2.0	2.4	2.65	0.25	0.04	0.21	2'-4' Clayey Silt, no odor
SG-04-4-6 ft	4-6 ft	5/5/97	5/14/97	410,000	360	750	720	1,200	Gas/UH	0.38%	19%	2.1	2.5	2.65	0.21	0.03	0.17	4'-6' Clayey Silt, slight odor
SG-04-6-8 ft	6-8 ft	5/5/97	5/14/97	140,000	< 5	270	810	1,400	Gas	2.8%	21%	2.1	2.5	2.65	0.21	0.03	0.17	6'-7' Clayey Sand, moist, slight odor, 7'-8' Clayey Silt, no odor
SG-07-0-2 ft	0-2 ft	5/6/97	5/15/97	5,100	220	7.7	670	170	Gas	0.65%	3%	2.1	2.2	2.65	0.21	0.03	0.17	0-4" Asphalt, 4"-2' Clayey Silt, slight odor
SG-07-2-4 ft	2-4 ft	5/6/97	5/14/97	27,000	340	87	1,100	180	Gas	0.68%	21%	1.8	2.2	2.65	0.32	0.05	0.27	2'-4' Clayey Silt, slight odor
SG-07-4-6 ft	4-6 ft	5/6/97	5/15/97	26,000	310	< 5	660	120	Gas	0.33%	25%	2.0	2.5	2.65	0.25	0.04	0.21	4'-6' Clayey Silt, strong odor
SG-07-6-8 ft	6-8 ft	5/6/97	5/14/97	840,000	< 5	3,000	12,000	< 5	Gas	0.28%	20%	2.2	2.6	2.65	0.17	0.03	0.14	6'-8' Clayey Sand, strong odor
SG-08-0-2 ft	0-2 ft	5/6/97	5/14/97	< 1,000	< 5	< 5	< 5	< 5	NA	0.88%	15%	2.1	2.4	2.65	0.21	0.03	0.17	0-4" Asphalt, 4"-2' Mottled Clayey Sand & Gravel, Wood frag. at 2', no o
SG-08-2-4 ft	2-4 ft	5/6/97	5/14/97	< 1,000	< 5	< 5	< 5	6.6	Gas	0.82%	16%	1.7	2.0	2.65	0.36	0.06	0.30	2'-4' Clayey Sand, no odor
SG-08-4-6 ft	4-6 ft	5/6/97	5/15/97	390,000	< 5	< 5	< 5	3,100	Gas/UH	0.52%	25%	1.9	2.4	2.65	0.28	0.05	0.24	4'-6' Silty Sand, strong odor
SG-08-6-8 ft	6-8 ft	5/6/97	5/14/97	1,200,000	< 5	< 5	8,500	14,000	Gas	0.26%	19%	2.1	2.5	2.65	0.21	0.03	0.17	6'-8' Silty Sand, strong odor
			Averages	724,940	1,193	925	8,257	28,742		0.94%	16%	2.0	2.3	2.65	0.25	0.04	0.21	

Notes: < - Below the method detection limit.
Chromatogram Pattern: Gas = Gasoline
Gas/UH = Gasoline & Unidentified Hydrocarbons >C8

APPENDIX A

INTERPHASE ENVIRONMENTAL CHEMISTRY SPECIALISTS
STANDARD OPERATING PROCEDURES
FOR SOIL VAPOR SURVEYS

STANDARD OPERATING PROCEDURES FOR THE COLLECTION AND ANALYSIS OF SOIL GAS SAMPLES

Equipment/Instrumentation

InterPhase operates a mobile sampling and analytical van which is capable of collecting soil gas and ambient air samples. Real-time chemical analyses of soil gas and air samples are performed for indicator compounds (analytes) selected for each project site. Field equipment and sampling systems used by InterPhase are as follows:

* Modified one-ton Ford E350 van;
* Two gasoline-powered AC generators;
* Van-mounted hydraulic driving/hammering system designed to install or remove sampling probes;
* 100 feet of percussion drill steel in 3-foot probe sections;
* Oilless air pump and evacuation chamber for collecting exact volumes of soil gas at atmospheric pressure;

Analytical instrumentation and chemical supplies include the following:

* Varian 3400, Hewlett-Packard 5890 and SRI 8610 gas chromatographs;
* 486 PC-based data management and GC integration systems;
* A combination of ECD (electron capture), FID (flame ionization), PID (photoionization), and TCD (thermal conductivity) detectors;
* UHP grade compressed analytical gases (nitrogen, helium, hydrogen);
* Analytical vapor and methanolic standards for priority pollutants, gaseous hydrocarbons and fixed/biogenic gases;
* High resolution megabore, capillary, and packed gas chromatographic columns;
* Fittings, tools, plumbing and syringes required for normal GC operation.

Sampling Procedures

Soil gas samples are collected at designated depths by filling a sampling syringe from a length of polyethylene tubing installed within the bore of 1" OD percussion drill steel sampling probes. An unbroken length of 1/4 " polyethylene tubing is connected via a threaded adapter the deepest probe. Probes are driven into the ground by a vehicle-mounted hydraulic hammer which loads the probe with the weight of the vehicle. Pre-designated sampling depths are reached by coupling the

three foot sections of probe. Discrete volumes of gas are removed by 60 ml syringe to purge the tubing of atmospheric air and to allow subsurface air to enter. The volume of gas removed is determined by the volume of tubing employed and results of purge volume tests. Unlike groundwater sampling, purging of a soil gas probe is designed to remove only the ambient air in the system.

A minimum sampling depth of 3 to 5 feet below ground surface (bgs) is recommended in areas where bare soil is the surface cover in an effort to minimize sample dilution with atmospheric air. Soil gas samples may be collected at depths less than 3 feet bgs to assess the accumulation of vapors under a surface cover such as asphalt or concrete. Comparing contaminant concentrations and fixed/biogenic gas composition as a function of purge volume may be performed at the beginning of a survey. Purge volume experiments may be conducted in an area where subsurface contamination is expected to be greatest and are designed to assess optimal purge times and potential sample dilution with atmospheric air.

As the pressure within the sampling system reaches atmospheric, a 10 cc vapor sample is collected in a glass syringe by inserting the needle through the wall of the tubing. In order to minimize the possibility of cross-contamination among sampling locations; dedicated lengths of polyethylene tubing and drive points are used for each sampling location, and non-dispensable tools are baked in an oven at 80 degrees C for 10 minutes.

Two ambient air samples are collected over the course of each day and analyzed for background concentrations of the target compounds. All components of the sampling system are checked for contamination prior to sampling at the beginning of the day by drawing atmospheric air or nitrogen gas through the system, subjecting it to GC analysis, and comparing the resulting chromatogram with that of ambient air or UHP nitrogen. Steel sampling components are cleaned using steam or pressurized water and detergent (Alconox) at the conclusion of each day.

As part of the sampling procedure, probe locations are recorded on the field sampling sheets. In addition, field data forms (and chain-of-custody forms, if necessary) are used to record observations regarding vapor sampling and probe installation. These field data forms may include, but are not limited to, sample identification, sampling depth, time of sample collection and analysis, volume of soil gas extracted, and observations of soil characteristics.

Confirmatory soil vapor samples are collected by connecting dedicated sections of polyethylene tubing to an evacuated canister. Gas canisters are normally transferred under chain-of-custody procedures to a commercial laboratory where they are analyzed according to the specified methods. The percentage of duplicates submitted for laboratory analysis is dependent on project objectives and

regulatory specifications. InterPhase recommends that duplicates be collected at 5% of the sampling points.

InterPhase scientists have conducted field experiments to estimate the capture zone around the end of the soil gas sampling probe in order to demonstrate that vapor samples are not diluted with atmospheric air. Capture zone estimates were calculated for sandy soils and for silty or clayey soils as follows:

Sampling Depth: 6 feet
Volume of sampling probe: 15 cm^3/3-foot length
Purge Volume: 60 cm^3 (Approximately 2 probe volumes)
Air porosity of sandy soils: 30% = 0.3
Air porosity of silt or clay soils: 20% = 0.2
Volume of soil gas collected from sandy materials:
60 cm^3/0.3 = 200 cm^3
Volume of soil gas collected from silty or clayey materials:
60 cm^3/0.2 = 300 cm^3

Assuming isotropic vapor flow, the volume of soil gas collected may be described as a sphere with the origin at the tip of the soil gas probe. Therefore,

$$(4/3)(pi)(r^3) = 200\ cm^3 \text{ (sand)}$$
$$r = 3.6\ cm$$

$$(4/3)(pi)(r^3) = 300\ cm^3 \text{ (silt/clay)}$$
$$r = 4.1\ cm.$$

The purge volume of 60 cm^3 ensures that two volumes of the sampling apparatus are evacuated (2 probe lengths x 15 cm^3 = 30 cm^3). The calculated radius of influence is substantially less than the distance to ground surface (182.9 cm), thus minimizing the potential for sample dilution with atmospheric air.

Analytical Procedures

The 10 cc soil gas samples are subsampled and analyzed within 30 minutes of collection in order to preserve the integrity of the vapor sample. Duplicates may be analyzed approximately every twenty samples by gas chromatography for documentation of reproducibility. Analytes are identified by their respective elution times through the selected columns and detectors. Retention or elution times are compared with external standards injected in a gaseous, organic, or

aqueous phase. Analyte separation for compounds detected by the FID (e.g. petroleum hydrocarbons and ketones) is performed using a 30 m x 0.53 mm DB-624 or DB-1 megabore capillary column (J&W Scientific). Analyte separation for compounds detected by the ECD (e.g. halogenated aliphatics) is performed by using a 30 m x 0.53 mm DB-624 or DB-1 megabore capillary column (J&W Scientific). Identification of vinyl chloride and alkyl benzenes may be performed using the aforementioned capillary columns and a PID. Analyte separation for compounds detected by the TCD is performed by using either a molecular sieve or CTR-1 2 m stainless steel packed columns (Alltech Associates), ranging in diameter from 0.64 to 0.32 cm. Difficulties associated with peak separation are minimized by the use of low viscosity carrier gases, compound-specific detectors, megabore capillary columns, and method-specific temperature programs.

Analyte concentrations are estimated by comparing the detector response for a known concentration or mass of the external standard with the detector response for the sample. Multi-point calibration curves are computer-generated by plotting the detector response for external standards against a range of analyte concentrations. The detector response is checked at the beginning and end of each day during a survey to ensure that the calibration curves are accurate. Analyte detection limits are determined by the response factor for each day.

Although preliminary results are often available in the field, all chromatograms generated during a soil gas survey are subsequently reviewed by another chemist to ensure that computer identification and quantification of analytes are correct. The InterPhase van operates directly under the supervision of a degreed project chemist.

The following procedures are employed during all soil gas surveys:

* High-volume sampling and subsampling syringes are decontaminated by washing with a mild detergent and drying at a minimum temperature of 90 degrees Celsius;

* Microliter syringes (used for sample injection onto the GC column) are solvent rinsed, purged with an inert gas, and checked for contamination by immediate injection into the appropriate gas chromatograph;

* External standards are either commercially-prepared EPA chemical standards or mixtures of commercially-prepared gases;

* Detector response to analytes is documented over a 10 to 50-fold range in mass or concentration and compared to the theoretical responses in order to check the linearity of the detector response to analytes;

* Septa on the GC column injectors are replaced daily to minimize the possibility of carrier gas leaks (only UHP gases are used for chromatography); and

* All analytical data (e.g., chromatograms, calibration curves, integration reports) are stored on a computer floppy disk or hard copy, transmitted to the InterPhase office, and reviewed by a second chemist.

In the unlikely event that chromatograph sensitivity is affected by electrical surges or vibration, resulting changes are immediately observed by continuously monitoring the baseline voltage for all detectors. It should be noted that the analytical instruments are powered by a generator system which is completely separate from that running either the hydraulic/pneumatic equipment or the motor vehicle.

Determination of Detection Limits

Limits of detection for quantitative analysis are determined by the following factors:
1) Analytical Method
2) Specific Analyte
3) Instrumentation (detector)
4) Injection Size

Practical quantitation limits (PQLs) are tabulated in the results describing analyte concentrations. PQLs are defined by the precision of a detector's response to an analyte over the range of mass the detector is calibrated for the selected method.

Data Interpretation

Vapor-phase diffusion is the prevailing mechanism by which soil gas analytes are transported in the subsurface. The presence of an analyte in soil gas is a function of the phase, location and concentration of the source, physical properties of the analyte, and the media through which transport occurs. The site-specific variability among soil properties profoundly affect vapor-phase diffusion and must be considered in the interpretation of analyte distribution in the soil gas. Among these soil properties are: soil moisture, soil particle size and distribution, and air-filled porosity. Anomalies in the spatial distribution (vertically or laterally) of analyte concentrations in soil gas samples will be noted. InterPhase provides an interpretive report upon request of the client.

Although isoconcentration contours of soil gas data can be plotted on site maps, it should be emphasized that these isotherms are only representative of the

contaminant distribution in soil vapor. Isoconcentration contours for compounds in soil or groundwater may differ in extent and orientation from those delineated in soil gas. Inherent assumptions that are infrequently discussed in preparing soil gas isotherms are:

* Soil gas concentration data are adequate to describe the spatial distribution of contaminants underlying the site;

* Vertical anisotropy is either insignificant or can be described by existing site data;

* Vapor barriers that may impede the gaseous diffusion of analytes are either nonexistent or do not vary over the investigation site; and

* Soil texture, water content, and air-filled porosity are spatially uniform over the site.

SCOPE OF THE METHOD

This document describes a procedure for the analysis of volatile organic compounds (VOCs) in soil gas. The method is based on EPA Method TO-14 (The Determination of VOCs in Ambient Air Using Summa Passivated Canister Sampling & Gas Chromatographic Analysis) with modifications for the collection of subsurface rather than above-ground air. This method describes the procedures for analyzing samples collected with glass syringes at ambient atmospheric pressures. Soil gas surveys are performed by collecting vapor samples from probes installed within a specified area and analyzing these samples on-site using laboratory grade, multi-detector gas chromatographs (GC). The primary objective of soil gas surveys is the real-time collection of semi-quantitative and qualitative data regarding the presence and spatial distribution of subsurface contamination.

SYSTEM DESCRIPTION

The analytical system is comprised of traditional stationary laboratory grade gas chromatographs configured with capillary and packed columns and a combination of compound-selective detectors. The three gas chromatographs employed in the analysis of soil gas and ambient air include Varian 3400, Hewlett-Packard 5890a, and SRI 8610 instruments. A total of five detectors are used for vapor and air analyses. These detectors include electron capture (ECD), electrolytic conductivity (ELCD or Hall), photoionization (PID), flame ionization (FID), and thermal conductivity (TCD).

Analyte separation for compounds detected by the FID (e.g. petroleum hydrocarbons and ketones) is performed using a 30 m x 0.53 mm DB-1 or DB-624 megabore capillary column (J&W Scientific). Analyte separation for compounds detected by the ECD and ELCD (e.g., halogenated hydrocarbons) is performed by using a 30 m x 0.53 mm DB-624 or DB-1 megabore capillary column (J&W Scientific). Analyte separation of vinyl chloride and alkylbenzenes is performed using a 30 m x 0.53 mm DB-1 megabore capillary column (J&W Scientific), quantification is by PID. Analyte separation for compounds detected by the TCD is performed by using a molecular sieve/porous polymer CTR-1, 2 m stainless steel packed column (Alltech Associates) with diameters of 0.64 and 0.32 cm.

Samples are introduced into the instruments by direct injection in volumes ranging from 25 µL to 1000 µL; aliquots are injected within 30 minutes of collection in order to preserve the integrity of the sample. Once introduced into the injector, samples are transported by carrier gas (i.e., the mobile phase) at a rate of 4 to 30 cm^3/min; makeup gas flow rates designed to maximize detector responses are adjusted according to manufacturer's instructions. Detector response is integrated by a data processing software system loaded on an IBM-compatible 486DX personal computer.

Only UHP helium, hydrogen, and nitrogen are used as carrier and make-up gases. Air required by the FID is filtered through a drierite/silica gel and 5Å molecular sieve in order to remove moisture and organic impurities.

GC System Performance Criteria

Initial Certification of the Instrument

Prior to system calibration and sample analysis, the chromatographic instruments are checked according to (i) manufacturer's instructions, (ii) method requirements, and (iii) temporal conditions [e.g., warm-up period, baseline stabilization]. Upon satisfying these check procedures, an injection of UHP nitrogen is made to document that unacceptable levels of residual contamination are not present. The target compounds must not be present above their respective limits of detection (LOD) to be considered acceptable.

Retention Time Determination

Windows for analyte retention time are determined prior to GC analyses. After assuring that the operating conditions for the daily analyses have been satisfied, three injections are made using a mixed standard containing all of the required analytes. For each single component of the standard mixture, standard deviations are calculated from a total of three absolute measurements. The retention window is describe as the mean ± 3 ð standard deviations. A recalculated window is calculated for each compound on each GC column whenever (i) a new column is installed, (ii) changes are made in operational parameters, or (iii) reprogramming of oven temperature profiles or carrier gas flow rates occurs. Windows are re-established at no greater than 72 hour intervals during system operation. These data are noted in a log book, which is kept in the analytical van as part of the standard operating procedure (SOP). Hence, a quality check on the new operating parameters of the system is conducted.

Analyte Confirmation

Confirmation of the designated analytes may be performed by submitting samples to a certified laboratory for GC/MS analysis. Vapor samples are collected in 1 liter Tedlar bags or Summa Canisters and submitted under chain-of-custody procedures. Due to differences in the degradability, volatility and sorption among VOC's holding times should not exceed 48 hours and 2 weeks respectively. The independent analysis of samples by an outside laboratory allows a positive identification of the analyte by atomic mass in a separate and independent environment.

Initial GC Calibration

An initial multi-point dynamic calibration is performed before samples are analyzed. The calibration procedure employs traceable, commercially-prepared standards in methanolic solution. Aliquots are flash evaporated into 125 mL glass bombs to provide standard concentrations over 2 orders-of-magnitude. This method of sample preparation is specifically described by EPA in the SW-846 protocols for the headspace analysis of solid waste. After permitting the system to equilibrate, the standard vapor mixture is injected into the GC system. Injection sizes may vary from 50 to 200 µL, with greater ranges in mass addressed by dilutionary admixtures. Response factors are calculated by the following equation:

$$RF_{analyte} = concentration_{analyte} \times volume\ (\mu L) \div area\ units_{analyte}$$

Once the GC is initially calibrated, a 1-point calibration is performed daily on the analytical system to verify the initial 3-point calibration. Criteria for the acceptance of the initial calibration procedure include: (i) a variation among the determined response factors from the multi-point calibration of less than 15% relative standard deviation (RSD) , (ii) agreement between static and initial calibration checks within 15% relative percent difference (RPD), and (iii) agreement within 15% RPD between average calibration RF and a laboratory control standard. In the event that variance exceeds the stated confidence intervals, recalibration is performed until acceptable confidence intervals are achieved.

The concentration of each analyte in the vapor sample can then be determined by using the previously calculated response factor, the area under the peak, and the volume of sample injected as shown in the following equation:

$$\text{concentration}_{\text{analyte}} = \text{RF}_{\text{analyte}} \times \text{area units}_{\text{analyte}} \div \text{volume } (\mu\text{L})$$

Linearity of Response

Linearity in detector response for an analyte is established by the constancy of the calculated response factors over the range of concentrations used for the calibration standards. Variations in response factors not exceeding 15% RSD permit the use of average calibration factors, while greater variations in response factors over the linear range of the detector require the use of calibration curves to quantitate peak area counts as analyte concentrations.

Response Out-of-Range

Response factors exceeding the linear range of the detector are unacceptable because the calibration curves may not be representative. Responses within the working range of the instrument are provided by sample dilution into a 125 mL glass sampling bulb, which is blanked with nitrogen gas prior to each use. Target compounds must not be present above the limits of detection (LOD) to be considered acceptable.

Control Charts

The historical performance of the system is tracked through the used of control charts. Out-of-control events are identified by wide or consistent fluctuations in detector response and logged as to the time and cause. Control charts are maintained in a log book as part of the standard operating procedure (SOP).

Calibration Checks

The detector response is checked (i) after the initial multi-point calibration, (ii) after every daily 1-point calibration, and (iii) at the completion of GC analyses each day. This procedure evaluates the accuracy of the initial calibration and the reproducibility of that detector response over the duration of each day's analyses. Laboratory Control Samples which are employed to perform a calibration check are prepared by the same procedure as initial calibration standards (see section titled Initial GC Calibration). Acceptable concentrations for check standards must differ from concentrations of standards employed in other calibrations. Commercially prepared gas standards (e.g., Scotty Specialty Gases) may be utilized as a check

standard. Accuracy of these standards are reported to be ± 2%. Detector stability is assessed by comparing these periodic response factors to those generated in the initial calibration. A difference in response of less than 15% is considered to be acceptable.

Instrument Detection Limits

Background noise is for each of the detectors is monitored and recorded throughout the survey to identify any temporal changes in chromatographic conditions. Detection limits are defined as detector signals that are two-fold greater than background levels.

Chromatographic Performance

The performance of the chromatographic system is assessed on the basis of compound identification and the resolution of target analytes. A quantitative indication of chromatographic separation among analytes is provided by calculating the resolution, "R", of two peaks as follows:

Peak Resolution:

$$R = 2 \cdot [RT\ (A) - RT\ (B)] \div [width\ (A) - width\ (B)]$$

where,

A & B = contiguous chromatographic peaks;
width = peak width at the baseline of each peak;
RT = analyte retention time.

An "*R*" value equal to or greater than 1.0 indicates complete baseline resolution of peaks A and B, indicating that the detector response signal drops to the baseline between the peaks. Excessive dead volume, fluctuations in operating conditions or column variations are signaled by variations in resolution between peaks over the course of a survey.

As an indication of chromatographic efficiency, the number of theoretical plates (N) is calculated.

Theoretical Plates:

$$N = 16\ (RT/width)^2$$

APPENDIX B

INTERPHASE ENVIRONMENTAL CHEMISTRY SPECIALISTS
SOIL VAPOR SURVEY REPORT

INTERPHASE
ENVIRONMENTAL CHEMISTRY SPECIALISTS

Soil Gas Survey
and
Soil Core Sample Collection

Former Shell Station
15275 Washington Avenue

San Leandro, California

Submitted to:

Mr. Pleas McNeel
Weiss & Associates
5500 Shellmound Avenue
Emeryville, California 94608

Submitted by:

InterPhase Environmental, Inc.
11558 Sorrento Valley Road
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May 14, 1997

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INTERPHASE ENVIRONMENTAL, INC.
SOIL GAS DOCUMENT REVIEW SHEET

Project Number: 97043

Project Name: Former Shell Station
15275 Washington Avenue
San Leandro, California

Title: Soil Gas Survey and Soil Core Sample Collection

Data Reviewed By: _____ Date: 5/9/97
Scott A. Norris, Senior Chemist
InterPhase Environmental, Inc.

Report Prepared By: _____ Date: 5/14/97
Scott A. Norris, Senior Chemist
InterPhase Environmental, Inc.

Table of Contents

INTRODUCTION

This report presents the equipment, procedures and results of a soil gas investigation for volatile organic compounds conducted May 5th and 6th, 1997 by InterPhase Environmental, Inc. for Weiss & Associates. The site is a former Shell Station located at 15275 Washington Avenue in San Leandro, California. InterPhase also collected eight soil core samples for this project.

SAMPLING

Scope and Application

This section covers the materials, equipment and procedures used by InterPhase for collecting soil gas samples in the field.

Sampling Equipment

Integrated Sampling/Analysis Van

InterPhase mobilized an integrated sampling / analysis van for this project. This unit is comprised of a 1-ton Ford E350 van with an integrated laboratory and Geoprobe® 4220 hydraulic system for installing and removing percussion sampling probes. The mobile rig is made completely self sufficient by two internal gasoline powered generators that provide the electrical power (110 volts AC) to operate the analytical instrumentation and field equipment.

Soil Gas Sampling Apparatus

InterPhase uses the "Post-Run" method of sampling. This means that sample tubing is not carried in the probe rod during probe driving, but rather inserted down the bore once the appropriate sample depth is reached. Sampling probe rod consists of 1 to 2-inch hardened steel. Gas samples are collected from the point holder adaptor mounted on the distal (deep) end of the sampling train. A stainless steel adapter is connected to 1/4-inch clean, virgin polyethylene tubing, lowered down the bore of the drive probe string, and mated to the point holder adaptor. O-ring connections enable the system to deliver a vacuum-tight seal to assure that the sample is collected at the bottom. Hamilton or Dynatech 10-cc gas-tight, glass syringes are used to collect soil gas samples.

Soil Core Sampling Apparatus

Soil coring is conducted using a Geoprobe® Macro-Core (MC) Soil Sampler. The MC Soil Sampler is used to collect soil samples at depth and recover them for visual inspection and/or chemical analysis.

MC Soil Sampler: A 48-inch long x 2.0-inch diameter soil sampler capable of recovering a sample that measures up to 1302 mL in volume, in the form of a 45-inch x 1.5-inch core.

Liner: A 46-inch long x 1.75-inch diameter removable/replaceable, thin-walled tube inserted inside the sampler tube for the purpose of containing and storing soil samples.

Sample Collection

Pre-Sample Purge

To ensure a representative sample, discrete volumes of gas are purged to rid the tubing of atmospheric air and to allow subsurface air to enter. The volume of gas removed is determined by the volume of tubing employed and the analytical results of purge volume tests (if performed). Unlike groundwater sampling, purging of a soil gas probe is designed to remove only the ambient air in the system.

InterPhase scientists have conducted field experiments to estimate the capture zone around the end of the soil gas sampling probe in order to demonstrate that vapor samples are not diluted with atmospheric air. Capture zone estimates are calculated for sandy soils and for silty or clayey soils as follows:

Sampling Depth: 6 feet (182.9 cm)
Volume of sampling probe (¼ " polyethylene tubing): 15 cm^3 per 3 foot probe length
Purge Volume: 60 cm^3 (Approximately 2 probe volumes)

Air porosity of sandy soils: 30% = 0.3
Air porosity of silt or clay soils: 20% = 0.2

Volume of soil gas collected from sandy materials:
60 cm^3/0.3 = 200 cm^3

Volume of soil gas collected from silty or clayey materials:
60 cm^3/0.2 = 300 cm^3

Assuming isotropic vapor flow, the volume of soil gas collected may be described as a sphere of radius r with the origin at the tip of the soil gas probe. Therefore,

Sand: $(4/3)(\pi)(r^3) = 200\ cm^3$
$r = 3.6$ cm

Silt/Clay: $(4/3)(\pi)(r^3) = 300\ cm^3$
$r = 4.1$ cm

The purge volume of 60 cm^3 ensures that two volumes of the sampling apparatus are evacuated (2 probe lengths x 15 cm^3 = 30 cm^3). The calculated radius of influence, approximately 4 cm, is substantially less than the distance to ground surface (182.9 cm), thus minimizing the potential for sample dilution with atmospheric air.

Soil Gas Sampling

After allowing the system to return to atmospheric pressure, a syringe needle is inserted through the wall of the silicon tubing attached to the aboveground end of the sample tubing. A 10 cc aliquot of soil gas is withdrawn from the probe. Duplicate samples are collected as needed.

Soil Core Sample Collection

The assembled sampler is attached to the leading end of a steel probe rod and driven into the subsurface. Additional probe rods are connected in succession to advance the sampler to depth. The sampler may be used as an open-tube or closed piston sampler.

The simplest and most common use of the sampler is an open-tube sampler. In this method, coring starts at the ground surface with an open-ended sampler. From the ground surface, the sampler is advanced 48 inches and retrieved from the hole with the first soil core. In stable soils, the open-tube sampler is inserted down the same hole to obtain the next core.

In unstable soils, which tend to collapse into the cored hole, the sampler can be equipped with a closed-piston point assembly. This assembly actually locks into the cutting shoe and prevents soil from entering the sampler as it is advanced in the existing hole.

The closed-piston samplers are not designed to be driven through undisturbed soil. Soil is first removed to sampling depth with an open-tube sampler, or a pilot hole may be made with a pre-probe tool. A closed-piston tip is then installed and the sample is inserted or driven down the same hole. When the leading end of the sampler reaches the top of the next sampling interval, the piston tip is unlocked using extension rods inserted down the inside of the probe rods.

Once the piston tip is unlocked, the sampler is simply driven another 48 inches. Soil entering the sampler pushes the piston assembly to the top of the sample liner where it is retrieved upon removal of the soil core and liner.

Decontamination of Equipment

Sampling equipment is decontaminated by methods consistent with the equipment's use. Reusable steel parts including adaptors, permanent points and point holders are cleaned by baking in an oven at 100°C. Syringes are cleaned with Alconox and water and then heated to 50°C in a laboratory oven. Methanol or hexane rinses that can carry contamination, contribute to hydrocarbon background, and potentially trap VOCs, are not employed.

Separate storage areas are provided for used and cleaned equipment. The probe rod and drive points are stored in clean storage racks on the sampling rigs. Care is taken with the rods and points to eliminate both soil-surface and cross-hole contamination. Vinyl or latex surgical gloves are worn during handling and assembly of the sampling apparatus. No equipment that is in contact with soil gas is used or reused without being decontaminated.

Soil sampling equipment is decontaminated by first brushing all loose soil away with a wire brush. Next, all parts of the sampling apparatus are washed with Alconox, or a similar detergent, and double rinsed with clean potable, distilled, or deionized water. Hexane is only used in cases where the sampling apparatus comes in contact with free product, such as fuels or solvents. In this case, the hexane rinse precedes the detergent wash. Hexane is never used as the final rinse because it may carry contamination and could contribute to the sample.

ANALYSIS

Summary of Analytical Method

Soil gas samples are subsampled and analyzed within 30 minutes of collection in order to preserve the integrity of the vapor sample. Analytes are identified by their respective elution times through the selected columns and detectors. Retention or elution times are compared with external standards injected in a gaseous phase. The analysis is best described by EPA Methods 8015/8020, analyses for aromatic species and total volatile hydrocarbons (TVH) in the C4-C10 range, typically defined as gasoline range fuels. Additionally, for this project, samples were analyzed for fixed/biogenic gases on a thermal conductivity detector (TCD).

Scope and Application

This section covers the equipment, materials, and procedures used to determine the concentrations of various VOCs in the soil gas samples.

Detection Limits

Background noise for each of the detectors is monitored and recorded throughout the survey to identify any temporal changes in chromatographic conditions. Detection limits are defined as detector signals that are two-fold greater than background noise. For a selected method, Practical Quantitation Limits (PQLs) are defined by the precision of a detector's response to an analyte over the range of mass for which the detector is calibrated.

The method employed by InterPhase offers a PQL of at least 1.0 micrograms per liter (µg/L). Depending on the compound and detector used, PQLs can be as low as 0.01 µg/L.

Apparatus and Equipment

Gas Chromatographs

The analytical system is comprised of two traditional stationary laboratory grade gas chromatographs configured with capillary and packed columns and a combination of compound-selective detectors. The two gas chromatographs employed in the analysis of soil gas and ambient air include a Varian 3400 and a Hewlett-Packard 5890a. A total of three detectors were used for vapor and air analyses for this project. These detectors include photoionization (PID), flame ionization (FID), and thermal conductivity (TCD).

GC Columns

For VOC analyses, InterPhase's mobile laboratories employ 30 meter x 0.53 millimeter DB-624 Megabore and DB-1 Megabore columns (both columns supplied by J&W Scientific). The helium flow rate is adjusted to approximately 5.5 mL/min in each column. The temperature program is typically as follows: initial column temperature at 60°C, 1.2 minute hold, programmed to 160°C at 10 degrees/minute (deg/min), no hold.

Only UHP helium, hydrogen, and nitrogen are used as carrier and make-up gases. Air required by the FID is filtered through a drierite/silica gel and 5Å molecular sieve in order to remove moisture and organic impurities.

Detectors

An OI Analytical PID, equipped with a 10.2 ev lamp, is used for analysis of aromatic species and some dichloro compounds. A Hewlett-Packard thermal conductivity detector (TCD) is used for the analysis of the fixed and biogenic gases. A Hewlett-Packard FID was provided for analysis of total volatile hydrocarbons in the C_4-C_{10} range.

Integration

Each mobile laboratory is equipped with EZ Chrom, a laboratory quality computer integrating system.

Standards and Reagents

Standards are obtained as pure gases, certified gas mixtures, or neat reagent grade compounds. Standards are prepared by weight (weights traceable to NIST standards) and/or by volume from pure gases or certified gas mixtures of pure gases by precision volume syringes. The manufacturer, lot number, date and initial of the person receiving the compound or standard, expiration date of the compound or standard, and unique lab identifier for the compound or standard are kept in a logbook that documents all aspects of standard preparation.

Calibration

Initial Certification of the Analytical Instruments

Prior to system calibration and sample analysis, the chromatographic instruments are checked according to (i) manufacturer's instructions, (ii) method requirements, and (iii) temporal conditions [e.g., warm-up period, baseline stabilization]. Upon satisfying these check procedures, an injection of UHP nitrogen or helium is made to document that unacceptable levels of residual contamination are not present. The target compounds must not be present above their respective limits of detection to be considered acceptable.

Multi-Point Calibration

An initial multi-point dynamic calibration is performed before samples are analyzed. The linearity of the calibration was evaluated by performing a linear least-squares analysis and generating a correlation coefficient. The calibration is not considered acceptable if the correlation coefficient is less than 0.995 or if the percent relative standard deviation (%RSD) exceeds 20%.

Linearity in detector response for an analyte is established by the constancy of the calculated response factors over the range of concentrations used for the calibration standards. Variations in response factors not exceeding 15% RSD permit the use of average calibration factors.

Response factors exceeding the linear range of the detector are unacceptable because the calibration curves may not be representative. Responses within the working range of the instrument are provided by sample dilution into a gas-tight syringe.

Daily Mid-Range Calibration Check

A mid-range standard calibration check is performed to verify the instrument response at the beginning of the day. Criteria for the acceptance of the initial calibration procedure include: (i) a variation among the determined response factors from the multi-point calibration of less than 15% relative standard deviation (RSD) , (ii) agreement between static and initial calibration checks within 15% relative percent difference (RPD), and (iii) agreement within 15% RPD between average calibration RF and a laboratory control sample.

Response Factors

When the external standard method is used, the computer-integration system calculates response factors as follows:

$$RF = C/A$$

where C = concentration of analyte, µg/L
A = area of analyte to be measured

Quality Control

System Blank (Method Blank)

A randomly selected sampling syringe is analyzed to determine whether interferences from syringes are present. If interference is found at unacceptable levels, another syringe is analyzed to determine whether the interference is due to the syringe or to the analytical system. Appropriate measures are taken to eliminate such interferences.

Duplicate Samples

Duplicate soil gas samples are collected per project requirements. Duplicate analyses are performed at least once every twenty field samples. Duplicate analyses must have RPDs of less than ±20%.

Internal Quality Control

Although preliminary results are available in the field, all chromatograms generated during a soil gas survey are subsequently reviewed internally by another chemist to ensure that computer identification and quantification of analytes are correct.

Concentration Calculations

Each analyte in the sample chromatogram is identified by comparing the retention time of the suspect peak to retention times generated by the calibration standards on the appropriate detector. When applicable, the relative response of the alternate detector to the analyte is determined. The relative response should agree to within 20% of the relative response determined from the standards.

Quantification is usually performed on the detector that exhibits the greater response if all detectors respond to an analyte. In cases where greater specificity or precision would result, the analyst uses his/her professional judgment in determining the alternate detector. In the case of coelution, quantification is performed using either the detector that "sees" only one of the compounds or by using the column and detector combination that does not exhibit coelution.

The concentration of the unknowns is determined by comparing the peak area of the unknowns to the peak area of the external standards as follows:

$$C = (A/RF)(I/SA)$$

Where C = concentration of the analyte in sample in µg/L
SA = sample amount in L or kg
RF = relative average response factor
A = area of analyte being measured

Concentrations are reported in µg/L. The results are reported to the nearest µg/L in two significant figures.

DATA INTERPRETATION

Vapor-phase diffusion is the prevailing mechanism by which soil gas analytes are transported in the subsurface. The presence of an analyte in soil gas is a function of the phase, location and concentration of the source, physical properties of the analyte, and the media through which

transport occurs. The site-specific variability among soil properties profoundly affect vapor-phase diffusion and must be considered in the interpretation of analyte distribution in the soil gas. Among these soil properties are: soil moisture, soil particle size and distribution, and air-filled porosity. Anomalies in the spatial distribution (vertically or laterally) of analyte concentrations in soil gas samples should be noted.

Although isoconcentration contours of soil gas data can be plotted on site maps, it should be emphasized that these isotherms are only representative of the contaminant distribution in soil vapor. Isoconcentration contours for compounds in soil or groundwater may differ in extent and orientation from those delineated in soil gas. Inherent assumptions that are infrequently discussed in preparing soil gas isotherms are:

- Soil gas concentration data are adequate to describe the spatial distribution of contaminants underlying the site
- Vertical anisotropy is either insignificant or can be described by existing site data
- Vapor barriers that may impede the gaseous diffusion of analytes are either nonexistent or do not vary over the investigation site
- Soil texture, water content, and air-filled porosity are spatially uniform over the site

RESULTS

A total of seventeen soil gas samples and two duplicate soil gas samples were collected and analyzed from nine borings for this project. These sampling depths ranged from 2 to 6 feet below ground surface (bgs). Sample SG-01-4' contained the highest concentrations of benzene, toluene, TVH, and CO_2. In order to be quantified, this sample had to be injected into the PID/FID three times (500 µL, 20 µL, and 0.5 µL). Sample SG-03-6' contained the highest levels of ethylbenzene and the three xylene isomers. The highest methane detection was at location SG-07-4'.

For the fixed/biogenic gas analyses, 200 µL of each sample was injected into the TCD. These results are reported in relative percentages.

InterPhase also collected two 4' soil core samples at four locations. These locations were SG-03, SG-04, SG-07, and SG-08. In each case, the samples were collected from 0'-4' and from 4'-8'. These soil samples were turned over to Weiss & Associates for handling.

Summary of Analytical Results

Project # : 97043
Client : Weiss & Associates

Site : 15275 Washington Avenue
San Leandro, California

Sample ID :			System Blank	Ambient Air	SG-01-4'	SG-02-2'	SG-03-2'	SG-03-4'	SG-03-6'	SG-04-2'
Date :			5/5/97	5/5/97	5/5/97	5/5/97	5/5/97	5/5/97	5/5/97	5/5/97
Time Collected :			NA	NA	9:15	15:00	16:22	16:34	16:49	17:30
Time Analyzed :			7:07	8:21	9:17	15:02	16:16	16:49	17:01	17:32
Volume Analyzed (PID/FID, µL) :			500	500	500 / 20 / 0.5	200	10	100	100	200
Dilution Ratio (if needed):					1/100					
Compound Name	*Detector*	*RT (min)*								
benzene	PID	4.1	<1	<1	910	<1	280	49	79	1.6
toluene	PID	5.75	<1	<1	110	<1	57	12	88	<1
ethylbenzene	PID	7.267	<1	<1	70	<1	44	7.4	400	<1
m/p-xylenes	PID	7.4	<1	<1	160	<1	34	4.3	190	<1
o-xylene	PID	7.783	<1	<1	40	<1	15	<1	57	<1
TVH (C_4-C_{10})	FID	1.1-12	<5	<5	78000	<5	20000	3700	44000	110
Volume Analyzed (TCD, µL) :			NA	200	200	200	200	200	200	200
Compound Name	*Detector*									
% carbon dioxide (CO_2)	TCD		NA	<0.1	19.7	9.2	15.8	1.6	4.7	0.7
% oxygen (O_2)	TCD		NA	21.0	3.9	11.3	3.8	18.1	16.4	19.8
% nitrogen (N_2)	TCD		NA	79.0	68.6	79.5	78.9	80.3	78.9	79.4
% methane (CH_4)	TCD		NA	<0.1	7.8	<0.1	1.6	<0.1	<0.1	<0.1

Summary of Analytical Results

Project # : 97043
Client : Weiss & Associates

Site : 15275 Washington Avenue
San Leandro, California

Sample ID :			SG-04-4'	SG-04-6'	duplicate SG-04-6'	SG-05-4'	SG-06-4'	SG-07-2'	SG-07-4'	SG-07-6'
Date :			5/5/97	5/5/97	5/5/97	5/5/97	5/5/97	5/5/97	5/5/97	5/5/97
Time Collected :			17:46	18:00	18:00	18:50	19:09	19:32	19:41	20:02
Time Analyzed :			14:44	18:04	18:18	18:52	17:06	19:35	07:31	08:15
Volume Analyzed (PID/FID, µL) :			200	200	200	300	500	500	300	10
Dilution Ratio (if needed):										
Compound Name	*Detector*	*RT (min)*								
benzene	PID	4.1	2.9	2.8	3.0	<1	<1	38	18	13
toluene	PID	5.75	<1	3.4	4.0	<1	<1	1.4	40	7.4
ethylbenzene	PID	7.267	2.5	7.1	7.2	<1	<1	14	43	<10
m/p-xylenes	PID	7.4	2.0	1.5	1.7	<1	<1	<1	12	<10
o-xylene	PID	7.783	<1	7.9	5.8	<1	<1	<1	5.0	<10
TVH (C_4-C_{10})	FID	1.1-12	370	490	500	26	<5	700	38000	2000
Volume Analyzed (TCD, µL) :			200	200	200	200	200	200	200	200
Compound Name	*Detector*									
% carbon dioxide (CO_2)	TCD		1.4	1.2	1.0	0.3	0.5	0.9	13.4	1.9
% oxygen (O_2)	TCD		19.2	19.5	19.2	20.3	19.9	19.7	9.5	18.7
% nitrogen (N_2)	TCD		79.4	79.3	79.8	79.4	79.6	79.4	67.9	78.5
% methane (CH_4)	TCD		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	9.3	1.0

Summary of Analytical Results

Project # : 97043
Client : Weiss & Associates

Site : 15275 Washington Avenue
San Leandro, California

Sample ID :			System Blank	Ambient Air	SG-08-2'	SG-08-4'	SG-08-6'	duplicate SG-08-6'	SG-09-4'
Date :			5/6/97	5/6/97	5/6/97	5/6/97	5/6/97	5/6/97	5/6/97
Time Collected :			NA	NA	8:10	8:28	8:48	8:48	9:49
Time Analyzed :			7:04	7:39	8:18	8:31	8:50	9:04	16:16
Volume Analyzed (PID/FID, µL) :			500	500	200	200	200	200	200
Dilution Ratio (if needed):									
Compound Name	*Detector*	*RT (min)*							
benzene	PID	4.1	<1	<1	<1	<1	<1	<1	87
toluene	PID	5.75	<1	<1	<1	64	35	36	10
ethylbenzene	PID	7.267	<1	<1	<1	7.4	3.5	4.0	28
m/p-xylenes	PID	7.4	<1	<1	<1	10	5.0	5.7	20
o-xylene	PID	7.783	<1	<1	<1	4.3	5.8	5.8	1.3
TVH (C_4-C_{10})	FID	1.1-12	<5	<5	<5	2400	1000	1100	1800
Volume Analyzed (TCD, µL) :			200	200	200	200	200	200	200
Compound Name	*Detector*								
% carbon dioxide (CO_2)	TCD		NA	<0.1	0.1	12.6	0.3	0.2	0.9
% oxygen (O_2)	TCD		NA	20.8	20.6	4.8	20.0	20.0	20.0
% nitrogen (N_2)	TCD		NA	79.2	79.3	82.7	79.7	79.8	79.1
% methane (CH_4)	TCD		NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

QUALITY CONTROL SUMMARY

Date : May 5, 1997
Project # : 97043
Chemist : JCT
Machine ID: Phase 3

				MID-POINT CALIBRATION CHECK					
				Calibration Information and Detector Response					
ANALYTE	DETECTOR	COLUMN TYPE/SERIAL #	STDconc (µg/L)	µL	area	rf	mean rf	% Dif	ACC RGE
benzene	PID	DB-1/1251035	18.94	100	5397305	3.51E-04	4.05E-04	13%	15%
toluene	PID	DB-1/1251035	18.41	100	5493810	3.35E-04	3.91E-04	14%	15%
ethylbenzene	PID	DB-1/1251035	23.38	100	4490289	5.21E-04	5.23E-04	0%	15%
m,p-xylenes	PID	DB-1/1251035	20.71	100	5406415	3.83E-04	4.26E-04	10%	15%
o-xylene	PID	DB-1/1251035	22.3	100	4878868	4.57E-04	5.33E-04	14%	15%
hexane	FID	DB-1/1251035	355	100	318568	1.11E-01	1.37E-01	19%	25%

Date : May 6, 1997
Project # : 97043
Chemist : JCT
Machine ID: Phase 3

				MID-POINT CALIBRATION CHECK					
				Calibration Information and Detector Response					
ANALYTE	DETECTOR	COLUMN TYPE/SERIAL #	STDconc (µg/L)	µL	area	rf	mean rf	% Dif	ACC RGE
benzene	PID	DB-1/1251035	18.94	100	4918009	3.85E-04	4.05E-04	5%	15%
toluene	PID	DB-1/1251035	18.41	100	4674873	3.94E-04	3.91E-04	1%	15%
ethylbenzene	PID	DB-1/1251035	23.38	100	4636326	5.04E-04	5.23E-04	4%	15%
m,p-xylenes	PID	DB-1/1251035	20.71	100	5068106	4.09E-04	4.26E-04	4%	15%
o-xylene	PID	DB-1/1251035	22.3	100	4246546	5.25E-04	5.33E-04	1%	15%
hexane	FID	DB-1/1251035	355	100	313747	1.13E-01	1.37E-01	17%	25%

rf: response factor
µg/L: micrograms per liter
µL: standard volume in microliters

rf = STDconc * µL / Area
STDconc : standard concentration
ACC RGE: acceptable range of % difference

INTERPHASE

ENVIRONMENTAL CHEMISTRY SPECIALISTS

11558 SORRENTO VALLEY ROAD

SAN DIEGO, CA 92121

619•481•2200 800•457•3300

FAX 619•481•1855

InterPhase Project Logbook

Project No.:	97043
Client:	Weiss + Assoc.
Site Name:	Shell Oil Company
Location:	San Leandro
Dates Worked:	5/5/97 - 5/6/97

Logbook # 1 of 1

Project Summary

Total Number of Soil Gas Samples Collected	17
Total Number of Soil Samples Collected	8
Total Number of Groundwater Samples Collected	Ø

List of Materials Lost or Damaged on Project

Expendable Materials Used on Project:

Expendable Drive Points (#): 19	Poly tubing (ft): 125
Bentonite (# bags): 4 1/2	Cement/Asphalt Patch (# bags): Ø Ø / 1/10
Other Expendables: —	Rental Equipment: —

Notes of Interest

2 permeability tests were performed

Project Background Information

Project No.: 97043	Phase No.: 3
Site Name: Shell Oil Co.	Location: San Leandro
Dates Worked: 5/5/97	
Client Name and Address: Weiss + Assoc. 5500 Shellmound St. Emeryville, Ca. 94608	Client Field Representative(s) Name(s): Pleas McNeel
Client Telephone: (510) 450-6100	Client FAX: (510) 547-5043
Crew Chemist: Tangeman	Technician: Fassoth

Additional information to be included with data report at Client's request:

? results of permeability tests
? chromatograms
copy of log book

Purpose of Investigation:

Target VOCs:

BTEX, TVH, CO_2, O_2, N_2, CH_4

Groundwater Information (if available):

Depth to Groundwater: Direction of Flow:

Possible/Known Source(s) of Contamination (if available):

gas station

Subsurface Conditions (Soil Type, Subsurface Geology, etc.)

If maps are required, draw to scale and include: Project Number, Client, Site Name and Location, Scale (both bar and inch equivalent), North Arrow (approximate), Sampling Locations and Numbers.
If maps are supplied by client, check for accuracy and clarity and enclose.

Daily Summary

Date: 5/5/97 / 5/6/97	Project No.: 97043
Client: Weiss + Assoc.	
Weather:	

Field Hours

Time on Site: 0700 / 700	Lunch Hours: 1130-1430
Time off Site: 2100 / 1130	Downtime Hours:
	Standby Hours:

Calibration

Start Calibration:	700	700	
Stop Calibration:	800	745	
Total Calibration Hours:	1.0	0.75	

Sample Summary

Total Syringe/System Blanks: 1 / 1	Total Ambient Air Blanks: 1 / 1
Total Soil Gas Samples: 13 / 14	Total Soil Samples: 4 / 4
Total Groundwater Samples: 0	Other (specify): 2 permeability tests

Backfill Procedures Used: Bentonite hydrated	Decon Procedures Used: Triple rinse w/ alconox + H2O

Expendables TOTAL

Expendable Drive Tips Used: 19	Poly Tubing (ft.) Used: 125
Bentonite Used (# bags): 4½	Cement Used (# bags): -
Asphalt Used (# bags): ½	Other (specify): —

List Equipment Lost or Damaged
Rental Equipment Used: —

Notes

Date: 5/5/97	Client: Weiss + Assoc	Project No.: 97043

Time:	Event / Notes:

0630 Warmed up generator + set up van

0640 Gassed up van

0652 Arrived on site

0751 Pleas McNeal arrived on site; waiting for ~~xxxx~~ locaters + someone to open the fence to let us on site.

0910 locator not arrived utility's inoperative drilled carefully.

0938 Waited for locaters, in mean time picked up supplies

lunch 1130-1430
locaters arrived at. 1400

soil sample SGD3-0-4 drive head threading

1547 crossed unable to remove.

5/6/97

0650 arrived on site

0700 Pleas arrived on site

Sampling Log

Date: 5/5/97					Project No.: 97043
Client: Weiss + Assoc.					Location: San Leandro, Ca.
Time	Sample ID	Depth (ft)	SG Purge Volume (cc)	Sample Type	Note and Observations
0915	SG01-4	4	80	Soil gas	asphalt top good flow
0920	"	"	—	sump	sump collected
013	"	"	—	Permeability test	[illegible]
1052	"	"	—	"	LOW FLOW 1 L/M 23 inch of H_2O
155				"	MED 2.2 L/M + 57 inches of H_2O
1057				"	High (used mid flow) 3.3 L/M + 77 inches of H_2O
1500	SG02-02	2	80	soil gas	No flow at 4' pulled to 3½', 3, 2½', + 2 good flow at 2'
1503	"	2	—	sump	
1546	SG03-(0-4)0-4	—	—	soil	cored x2 holes in concrete — see Note collected 1st soil sample
1609	SG03(4-8) 4-8	—	—	soil	same hole
1616	SG-03-2'	2	60	SG	
1622	SG-03-2'	2	—	sump	
1634	SG-03-4'	4	80	SG	
1636	SG-03-4'	4	—	sump	
1649	SG-03-6'	6	120	SG	
1652	SG-03-6'	6	—	sump	
1730	SG-04-2	2	60	SG	
1731	"	2	—	sump	
1746	SG-04-4	4	80	S.G	
1748	"	4	—	sump	
1800	SG-04-6	6	120	S.G	duplicate

Sampling Log

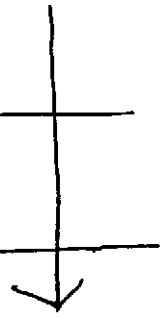
Date: 5/5/97 | Project No.: 97043

Time	Sample ID	Depth (ft)	SG Purge Volume (cc)	Sample Type	Note and Observations
1806	SG04-6	6	~~120~~	Suma	
1820	SS04-(0-4)	(0-4)	—	soil	
1830	SS04-(4-8)	(4-8)	—	soil	
1850	SG05-4	4	80	S.G	
1851	"	4	—	suma	
1909	SG06-4	4	80	S.G	
1910	SG06-4	4	—	suma	
1932	SG07-2	2	60	S.G	
1933	"	"	—	Suma	
1941	SG07-4	4	80	SG	
1942	"	"	—	suma	
2002	SG07-6	6	120	SG	
2003	"	"	—	Suma	
					5/6/97 ↓ ↓ ↓
0739	SS07-(0-4)	(0-4)	—	soil	75% recovered
0754	SS07-(4-8)	4-8	—	soil	80% recovered
0810	SG08-2	2	60	SG	
0812	"	"	—	Suma	
0828	SG08-4	4	80	S.G	
0835	"	"	—	suma	
0848	SG08-6	6	120	SG.	duplicate
0849	"	"	—	suma	
0916	SS08-(0-4)	0-4	—	soil	80% rec.
0933	SS08-(4-8)	4-8	—	soil	
0949	SG09-4	4	80	S.G	
1000	"	4	—	Suma	

over →

Permeability test

	Time	L/min	inches of H_2O
Low	start 1020	.2	34
Low ~~Med~~ (see Notes)		1	62
Low ~~High~~ (see Notes)		1.2	79



Notes
Used low flow gauge, not enough permeability to use medium or high flow gauge

APPENDIX C

AIR TOXICS LTD.,
ANALYTICAL RESULTS FOR
SOIL VAPOR SURVEY DATA

@AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9705071A

Work Order Summary

CLIENT:	Mr. Pleas McNeel Weiss Associates 5500 Shellmound Street Emeryville, CA 94608	**BILL TO:** Same	
PHONE:	510-450-6147	**P.O. #** 81-1227-90 PJM	
FAX:	510-547-5043	**PROJECT #** 81-1227-90 Shell/San Leandro	
DATE RECEIVED:	5/7/97		
DATE COMPLETED:	5/23/97		

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.
01A	AMB-01 (11303)	TO-14	10.5 "Hg
02A	Lab Blank	TO-14	NA

CERTIFIED BY: Linda J. Truman
Laboratory Director

DATE: 6/5/97

Certification numbers: CA ELAP - 1149, NY ELAP - 11291, UT ELAP - E-217

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

AIR TOXICS LTD.

SAMPLE NAME : AMB-01 (11303)
ID#: 9705071A-01A
EPA METHOD TO-14 GC/MS Full Scan

File Name:	**j051615**	**Date of Collection:**	**5/ 5/97**
Dil. Factor:	**2.06**	**Date of Analysis:**	**5/16/97**

Compound	Det. Limit (ppbv)	Amount (ppbv)
Benzene	1.0	Not Detected
Toluene	1.0	1.3
Ethyl Benzene	1.0	Not Detected
m,p-Xylene	1.0	Not Detected
o-Xylene	1.0	Not Detected
Methyl tert-Butyl Ether	4.1	Not Detected
TPH*	10	Not Detected

*Total Petroleum Hydrocarbons (C2 + Hydrocarbons) Referenced to Gasoline (MW = 100).

Container Type: 6 Liter Summa Canister

Surrogates	% Recovery	Method Limits
Octafluorotoluene	100	70-130
Toluene-d8	98	70-130
4-Bromofluorobenzene	102	70-130

AIR TOXICS LTD.

SAMPLE NAME : Lab Blank
ID#: 9705071A-02A
EPA METHOD TO-14 GC/MS Full Scan

File Name:	**j051604**	**Date of Collection: NA**	
Dil. Factor:	**1.00**	**Date of Analysis: 5/16/97**	

Compound	Det. Limit (ppbv)	Amount (ppbv)
Benzene	0.50	Not Detected
Toluene	0.50	Not Detected
Ethyl Benzene	0.50	Not Detected
m,p-Xylene	0.50	Not Detected
o-Xylene	0.50	Not Detected
Methyl tert-Butyl Ether	2.0	Not Detected
TPH*	5.0	Not Detected

*Total Petroleum Hydrocarbons (C2 + Hydrocarbons) Referenced to Gasoline (MW = 100).

Container Type: NA

Surrogates	% Recovery	Method Limits
Octafluorotoluene	104	70-130
Toluene-d8	100	70-130
4-Bromofluorobenzene	102	70-130

AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630 4719
(916) 985-1000 FAX: (916) 985-1020

CHAIN-OF-CUSTODY RECORD

Nº 010821

Contact Person: PLEAS McNeil
Company: Weiss Associates
Address: 5500 Shellmound St City: Emeryville State: CA Zip: 94608
Phone: 510-450-6147 FAX: 510-547-1026
Collected By: Signature:

Project Info:
P.O. # 81-1227-90 POM
Project # 81-1227-90
Project Name: SLAC/Sandia

Turn Around Time:
☑ Normal
☐ Rush _____ Specify

Lab I.D.	Field Sample I.D. (CANISTER)	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt	
01A	AMB-01 (11303)	5-MAY-97 9AM-9PM	TPH + BETX (TO-14)	28" Hg	11.4" Hg	10.5" Hg	✓
	SG-01-4ft (9487)	5-MAY-97 9:20	TPH + BTEX (TO-3)	28.5 Hg	AMB		✓
	SG-02-4ft (11821)	5-MAY-97 15:05	" " "	28.8	AMB		✓
	SG-03-2ft (9533)	5 MAY 97 16:20	TPH + BTEX (TO-3)	28.5	AMB		✓
	SG-03-4ft (11449)	5 MAY 97 16:36		28.7	AMB		✓
	SG-03-6ft (11439)	5 MAY 97 16:52		28.6	AMB		✓
	SG-04-4ft (13898)	5 MAY 97 17:18		28.5	AMB		✓
	SG-04-2ft (9416)	5 MAY 97 17:30		28.8	AMB		✓
	SG-04-6ft (11512)	5 MAY 97 18:00		28.7	AMB		✓

PF 5/8/97

Relinquished By: (Signature) Date/Time 6-MAY-97 11:45 Print Name
Relinquished By (Signature) Date/Time
Received By: (Signature) Date/Time
Relinquished By (Signature) Date/Time
Received By: (Signature) Date/Time Air Cal American AR 5/7/97 1140

Notes: DID NOT USE CAN 12032 - Vac = 25" Hg
" " " " 12030 - Vac = 24.8

Lab Use Only

Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact?	Work Order #
UPS		A-	5/7/97 1140	AMBIENT	Good	Yes No (None) N/A	970507 1A

@AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9705071B

Work Order Summary

CLIENT: Mr. Pleas McNeel
Weiss Associates
5500 Shellmound Street
Emeryville, CA 94608

BILL TO: Same

PHONE: 510-450-6147
FAX: 510-547-5043
DATE RECEIVED: 5/7/97
DATE COMPLETED: 6/4/97

P.O. # 81-1227-90 PJM
PROJECT # 81-1227-90 Shell/San Leandro

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.
02A	SG-01-4ft (9487)	TO-3	0 "Hg
03A	SG-02-2ft (11821)	TO-3	0 "Hg
04A	SG-03-2ft (9533)	TO-3	0 "Hg
05A	SG-03-4ft (11444)	TO-3	0 "Hg
06A	SG-03-6ft (11439)	TO-3	0 "Hg
07A	SG-04-4ft (13898)	TO-3	0.5 "Hg
08A	SG-04-2ft (94916)	TO-3	0.5 "Hg
09A	SG-04-6ft (14512)	TO-3	0.5 "Hg
10A	SG-07-2ft (12378)	TO-3	0.2 psi
11A	SG-07-4ft (9435)	TO-3	0.2 psi
12A	SG-07-6ft (9440)	TO-3	0.2 psi
12AA	SG-07-6ft (9440) Duplicate	TO-3	0.2 psi
13A	SG-08-2ft (9315)	TO-3	0.2 psi
14A	SG-08-4ft (94940)	TO-3	0 "Hg
15A	SG-08-6ft (11435)	TO-3	0.2 psi
16A	SG-06-4ft (12808)	TO-3	0 "Hg
17A	SG-05-4ft (11434)	TO-3	0 "Hg
18A	SG-09-4ft (11896)	TO-3	0 "Hg
19A	Method Spike	TO-3	NA
20A	Lab Blank	TO-3	NA
20B	Lab Blank	TO-3	NA

LAB NARRATIVE:
***Samples were analyzed on a 30 day hold time.**

CERTIFIED BY: Jennifer C. Freeman
Laboratory Director

DATE: 6/5/97

Certification numbers: CA ELAP - 1149, NY ELAP - 11291, UT ELAP - E-217

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

AIR TOXICS LTD.

SAMPLE NAME: SG-01-4ft (9487)
ID#: 9705071B-02A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053005 **Date of Collection: 5/5/97**
Dil. Factor: 2020 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	2.0	6.6	230	750
Toluene	2.0	7.7	72 M	280 M
Ethyl Benzene	2.0	8.9	83	370
Total Xylenes	2.0	8.9	290	1300
Methyl tert-Butyl Ether (MTBE)	2.0	7.4	190	700

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053005 **Date of Collection: 5/5/97**
Dil. Factor: 2020 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	20	84	24000	100000
C2 - C4** Hydrocarbons	20	37	330	600

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

M = Reported value may be biased due to apparent matrix interferences.

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-02-2ft (11821)
ID#: 9705071B-03A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053006 **Date of Collection: 5/5/97**
Dil. Factor: 3.37 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.003	0.011	0.077 M	0.25 M
Toluene	0.003	0.013	0.025	0.096
Ethyl Benzene	0.003	0.015	0.057	0.25
Total Xylenes	0.003	0.015	0.20	0.88
Methyl tert-Butyl Ether (MTBE)	0.003	0.012	0.020	0.073

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053006 **Date of Collection: 5/5/97**
Dil. Factor: 3.37 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.034	0.14	11	46
C2 - C4** Hydrocarbons	0.034	0.062	2.9	5.3

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

M = Reported value may be biased due to apparent matrix interferences.

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-03-2ft (9533)
ID#: 9705071B-04A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053007 **Date of Collection: 5/5/97**
Dil. Factor: 2020 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	2.0	6.6	120	390
Toluene	2.0	7.7	50	190
Ethyl Benzene	2.0	8.9	84	370
Total Xylenes	2.0	8.9	70	310
Methyl tert-Butyl Ether (MTBE)	2.0	7.4	71	260

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053007 **Date of Collection: 5/5/97**
Dil. Factor: 2020 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	20	84	13000	54000
C2 - C4** Hydrocarbons	20	37	66	120

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-03-4ft (11444)
ID#: 9705071B-05A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053008 **Date of Collection: 5/5/97**
Dil. Factor: 1010 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	1.0	3.3	72	230
Toluene	1.0	3.9	29	110
Ethyl Benzene	1.0	4.5	48	210
Total Xylenes	1.0	4.5	75	330
Methyl tert-Butyl Ether (MTBE)	1.0	3.7	42	150

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053008 **Date of Collection: 5/5/97**
Dil. Factor: 1010 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	10	42	7900	33000
C2 - C4** Hydrocarbons	10	18	39	71

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-03-6ft (11439)
ID#: 9705071B-06A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053009 **Date of Collection: 5/5/97**
Dil. Factor: 101 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.10	0.33	12	39
Toluene	0.10	0.39	4.8	18
Ethyl Benzene	0.10	0.45	16	71
Total Xylenes	0.10	0.45	44	190
Methyl tert-Butyl Ether (MTBE)	0.10	0.37	4.3	16

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053009 **Date of Collection: 5/5/97**
Dil. Factor: 101 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	1.0	4.2	1200	5000
C2 - C4** Hydrocarbons	1.0	1.8	4.5	8.2

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-04-4ft (13898)
ID#: 9705071B-07A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053010 **Date of Collection:** 5/5/97
Dil. Factor: 17.1 **Date of Analysis:** 5/30/97

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.017	0.056	0.31	1.0
Toluene	0.017	0.065	0.61	2.3
Ethyl Benzene	0.017	0.075	0.59	2.6
Total Xylenes	0.017	0.075	1.0	4.4
Methyl tert-Butyl Ether (MTBE)	0.017	0.063	0.15	0.55

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053010 **Date of Collection:** 5/5/97
Dil. Factor: 17.1 **Date of Analysis:** 5/30/97

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.17	0.71	84	350
C2 - C4** Hydrocarbons	0.17	0.31	0.38	0.70

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-04-2ft (94916)
ID#: 9705071B-08A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053012 **Date of Collection: 5/5/97**
Dil. Factor: 5.13 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.005	0.017	0.13	0.42
Toluene	0.005	0.020	0.040	0.15
Ethyl Benzene	0.005	0.023	0.39	1.7
Total Xylenes	0.005	0.023	0.72	3.2
Methyl tert-Butyl Ether (MTBE)	0.005	0.019	0.084	0.31

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053012 **Date of Collection: 5/5/97**
Dil. Factor: 5.13 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.051	0.21	52	220
C2 - C4** Hydrocarbons	0.051	0.094	0.54	0.99

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-04-6ft (14512)
ID#: 9705071B-09A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053013 **Date of Collection: 5/5/97**
Dil. Factor: 12.8 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.013	0.042	0.32	1.0
Toluene	0.013	0.049	0.58	2.2
Ethyl Benzene	0.013	0.056	0.91	4.0
Total Xylenes	0.013	0.056	1.1	4.8
Methyl tert-Butyl Ether (MTBE)	0.013	0.047	0.055	0.20

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053013 **Date of Collection: 5/5/97**
Dil. Factor: 12.8 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.13	0.53	75	310
C2 - C4** Hydrocarbons	0.13	0.23	0.38	0.70

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-07-2ft (12378)
ID#: 9705071B-10A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053015 **Date of Collection: 5/5/97**
Dil. Factor: 1990 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	2.0	6.5	69	220
Toluene	2.0	7.6	55	210
Ethyl Benzene	2.0	8.8	53	230
Total Xylenes	2.0	8.8	26	110
Methyl tert-Butyl Ether (MTBE)	2.0	7.3	89	330

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053015 **Date of Collection: 5/5/97**
Dil. Factor: 1990 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	20	83	15000	62000
C2 - C4** Hydrocarbons	20	36	120	220

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-07-4ft (9435)
ID#: 9705071B-11A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6060312 **Date of Collection:** 5/5/97
Dil. Factor: 1990 **Date of Analysis:** 6/3/97

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	2.0	6.5	140	450
Toluene	2.0	7.6	110	420
Ethyl Benzene	2.0	8.8	100	440
Total Xylenes	2.0	8.8	42 M	180 M
Methyl tert-Butyl Ether (MTBE)	2.0	7.3	140	510

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6060312 **Date of Collection:** 5/5/97
Dil. Factor: 1990 **Date of Analysis:** 6/3/97

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	20	83	32000	130000
C2 - C4** Hydrocarbons	20	36	240	440

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

M = Reported value may be biased due to apparent matrix interferences.

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-07-6ft (9440)
ID#: 9705071B-12A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053017 **Date of Collection: 5/5/97**
Dil. Factor: 498 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.50	1.6	5.8	19
Toluene	0.50	1.9	1.7	6.5
Ethyl Benzene	0.50	2.2	4.5	20
Total Xylenes	0.50	2.2	1.5	6.6
Methyl tert-Butyl Ether (MTBE)	0.50	1.8	4.7	17

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053017 **Date of Collection: 5/5/97**
Dil. Factor: 498 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	5.0	21	730	3000
C2 - C4** Hydrocarbons	5.0	9.1	6.3	12

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-07-6ft (9440) Duplicate
ID#: 9705071B-12AA

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053018 **Date of Collection: 5/5/97**
Dil. Factor: 498 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.50	1.6	6.4	21
Toluene	0.50	1.9	1.9	7.3
Ethyl Benzene	0.50	2.2	5.0	22
Total Xylenes	0.50	2.2	1.7	7.5
Methyl tert-Butyl Ether (MTBE)	0.50	1.8	5.2	19

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053018 **Date of Collection: 5/5/97**
Dil. Factor: 498 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	5.0	21	820	3400
C2 - C4** Hydrocarbons	5.0	9.1	6.7	12

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-08-2ft (9315)
ID#: 9705071B-13A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053020 **Date of Collection: 5/6/97**
Dil. Factor: 1.99 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.002	0.006	0.003	0.01
Toluene	0.002	0.008	0.010	0.038
Ethyl Benzene	0.002	0.009	0.044	0.19
Total Xylenes	0.002	0.009	0.051	0.22
Methyl tert-Butyl Ether (MTBE)	0.002	0.007	0.006	0.022

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053020 **Date of Collection: 5/6/97**
Dil. Factor: 1.99 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.020	0.083	3.6	15
C2 - C4** Hydrocarbons	0.020	0.036	0.19	0.35

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-08-4ft (94940)
ID#: 9705071B-14A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053022 **Date of Collection:** 5/6/97
Dil. Factor: 505 **Date of Analysis:** 5/30/97

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.51	1.6	4.6	15
Toluene	0.51	1.9	12	46
Ethyl Benzene	0.51	2.2	10	44
Total Xylenes	0.51	2.2	14	62
Methyl tert-Butyl Ether (MTBE)	0.51	1.9	0.88	3.2

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053022 **Date of Collection:** 5/6/97
Dil. Factor: 505 **Date of Analysis:** 5/30/97

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	5.1	21	1700	7100
C2 - C4** Hydrocarbons	5.1	9.2	Not Detected	Not Detected

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-08-6ft (11435)
ID#: 9705071B-15A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053023 **Date of Collection:** 5/6/97
Dil. Factor: 995 **Date of Analysis:** 5/30/97

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	1.0	3.2	15	49
Toluene	1.0	3.8	34	130
Ethyl Benzene	1.0	4.4	32	140
Total Xylenes	1.0	4.4	66	290
Methyl tert-Butyl Ether (MTBE)	1.0	3.6	2.3	8.4

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053023 **Date of Collection:** 5/6/97
Dil. Factor: 995 **Date of Analysis:** 5/30/97

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	10	41	4900	20000
C2 - C4** Hydrocarbons	10	18	Not Detected	Not Detected

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-06-4ft (12808)
ID#: 9705071B-16A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053021 **Date of Collection: 5/5/97**
Dil. Factor: 2.02 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.002	0.007	0.002	0.008
Toluene	0.002	0.008	0.040	0.15
Ethyl Benzene	0.002	0.009	0.085	0.38
Total Xylenes	0.002	0.009	0.18	0.79
Methyl tert-Butyl Ether (MTBE)	0.002	0.007	0.006	0.022

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053021 **Date of Collection: 5/5/97**
Dil. Factor: 2.02 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.020	0.084	16	66
C2 - C4** Hydrocarbons	0.020	0.037	1.1	2.0

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-05-4ft (11434)
ID#: 9705071B-17A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053025 **Date of Collection: 5/5/97**
Dil. Factor: 505 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.51	1.6	6.3	20
Toluene	0.51	1.9	11	42
Ethyl Benzene	0.51	2.2	17	75
Total Xylenes	0.51	2.2	30	130
Methyl tert-Butyl Ether (MTBE)	0.51	1.9	1.7	6.2

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053025 **Date of Collection: 5/5/97**
Dil. Factor: 505 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	5.1	21	2100	8700
C2 - C4** Hydrocarbons	5.1	9.2	Not Detected	Not Detected

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type:1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: SG-09-4ft (11896)
ID#: 9705071B-18A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053026 **Date of Collection: 5/5/97**
Dil. Factor: 50.5 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.051	0.16	5.6	18
Toluene	0.051	0.19	0.16	0.61
Ethyl Benzene	0.051	0.22	3.9	17
Total Xylenes	0.051	0.22	3.5	15
Methyl tert-Butyl Ether (MTBE)	0.051	0.19	0.45	1.6

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053026 **Date of Collection: 5/5/97**
Dil. Factor: 50.5 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.51	2.1	130	540
C2 - C4** Hydrocarbons	0.51	0.92	1.4	2.6

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: Method Spike
ID#: 9705071B-19A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053002 **Date of Collection: NA**
Dil. Factor: 1.00 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	% Recovery
Benzene	0.001	0.003	84
Toluene	0.001	0.004	86
Ethyl Benzene	0.001	0.004	85
Total Xylenes	0.001	0.004	86
Methyl tert-Butyl Ether (MTBE)	0.001	0.004	80

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053003 **Date of Collection: NA**
Dil. Factor: 1.00 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	% Recovery
TPH* (C5+ Hydrocarbons)	0.010	0.042	71
C2 - C4** Hydrocarbons	0.010	0.018	71

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: NA

AIR TOXICS LTD.

SAMPLE NAME: Lab Blank
ID#: 9705071B-20A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6053004 **Date of Collection: NA**
Dil. Factor: 1.00 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected
Methyl tert-Butyl Ether (MTBE)	0.001	0.004	Not Detected	Not Detected

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6053004 **Date of Collection: NA**
Dil. Factor: 1.00 **Date of Analysis: 5/30/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.010	0.042	Not Detected	Not Detected
C2 - C4** Hydrocarbons	0.010	0.018	Not Detected	Not Detected

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: NA

AIR TOXICS LTD.

SAMPLE NAME: Lab Blank
ID#: 9705071B-20B

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6060303 **Date of Collection: NA**
Dil. Factor: 1.00 **Date of Analysis: 6/3/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected
Methyl tert-Butyl Ether (MTBE)	0.001	0.004	Not Detected	Not Detected

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Gasoline)

File Name: 6060303 **Date of Collection: NA**
Dil. Factor: 1.00 **Date of Analysis: 6/3/97**

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.010	0.042	Not Detected	Not Detected
C2 - C4** Hydrocarbons	0.010	0.018	Not Detected	Not Detected

*TPH referenced to Gasoline (MW=100)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: NA

AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

CHAIN-OF-CUSTODY RECORD

Nº 010822

Contact Person: PEDRO MCNEEL
Company: WEISS ASSOCIATES
Address: 5500 SHELLMOUND ST City: EMERYVILLE State: CA Zip: 94608
Phone: 510-450-6147 FAX: 510 547 5043
Collected By: Signature:

Project info:
P.O. #: PI-1227-90.PO1
Project #: 81-1227-90
Project Name: Shell San Leandro

Turn Around Time:
☑ Normal
☐ Rush _____ Specify

Lab I.D.	Field Sample I.D. (Can #)	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt	
10A/AA	SG-07-2ft (12778)	5-MAY-97 1932	BTEX + TPH (TO-3)	25.0	AMB	0.2psi	✓
11A	SG-07-4ft (9435)	5-MAY-97 1942	" " "	28.4	AMB	0.2psi	✓
12A	SG-07-6ft (9440)	5-MAY-97 2003	" " "	28.8	AMB	0.2psi	✓
13A	SG-08-2ft (9315)	6-MAY-97 813	" " "	29.0	AMB	0.2psi	✓
14A	SG-08-4ft (9-1940)	6MAY97 835	" " "	29.6	AMB	0"Hg	✓
15A	SG-08-6ft (11475)	6MAY97 8:49	" " "	28.9	AMB	0.2psi	✓
16A	SG-06-4ft (12808)	5 MAY-97 910	" " "	28.3	AMB	0"Hg	✓
17A	SG-05-4ft (11434)	5MAY-97 1850	" " "	28.5	AMB	0"Hg	✓
18A	SG-09-4ft (11896	5MAY-97 1000	" " "	28.8	AMB	0"Hg	✓

PR 5/8/97

Relinquished By: (Signature) Date/Time: 6-MAY-97 11:45 Print Name:
Relinquished By: (Signature) Date/Time: Received By: (Signature) Date/Time:
Relinquished By: (Signature) Date/Time: Received By: (Signature) Date/Time: 5/7/97 1140

Notes: Return 3 Vacuum gauges
1 Flow controller
2 filters (one from previous job)

Lab Use Only	Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact?	Work Order #
	UPS			5/7/97 1140	AMBIEN	GOOD	Yes No (None) N/A	970507B1

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AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

CHAIN-OF-CUSTODY RECORD

Nº 010821

Contact Person: PLEAS McNeel
Company: Weiss Associates
Address: 5500 Shellmound St City: Emeryville State: CA Zip: 94608
Phone: 510-450-6147 FAX: 510-547-1026
Collected By: Signature: [signature] TLL

Project info:
P.O. #: 81-1227-90 PO#
Project #: 81-1227-90
Project Name: Shell/Sacramento

Turn Around Time:
☑ Normal
☐ Rush ____ Specify

Lab I.D.	Field Sample I.D. (CANISTER)	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt	
01A	AMB-01 (11303)	5-MAY-97 9AM-9PM	TPH+BETX (TO-14)	28"Hg	11.4"Hg	~~0~~"Hg	✓
02A	SG-01-4ft (9487)	5-MAY-97 9:20	TPH+,BTEX (TO-3)	28.5Hg	AMB	0"Hg	✓
03A	SG-02-4ft (11821) 2	5-MAY-97 15:05	" " "	28.8	AMB	0"Hg	✓
04A	SG-03-2ft (9533)	5MAY97 16:20	TPH + BTEX (TO-3)	28.5	AMB	0"Hg	✓
05A	SG-03-4ft (11414)	5MAY97 16:36		28.7	AMB	0"Hg	✓
06A	SG-03-6ft (11439)	5MAY97 16:52		28.6	AMB	0"Hg	✓
07A	SG-04-4ft (13898)	5MAY97 17:18		28.5	AMB	0.5"Hg	✓
08A	SG-04-2ft (9416)	5MAY97 17:30		28.8	AMB	0.5"Hg	✓
09A	SG-04-6ft (11512)	5MAY97 1800		28.7	AMB	0.5"Hg	✓

Relinquished By: (Signature) Date/Time 6-MAY-97 11:45 Print Name
Relinquished By: (Signature) Date/Time
Received By: (Signature) Date/Time
Relinquished By: (Signature) Date/Time
Received By: (Signature) Date/Time Scott Anderson AIR 5/7/97 1140

Notes: DID NOT USE CAN 12032 - Vac = 25"Hg
" " " " 12030 - Vac = 24.8

Lab Use Only	Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact?	Work Order #
	UPS		[signature]	5/7/97 1140	AMBIENT	GOOD	Yes No (None) N/A	970507 B

Form 1293 rev. 06

APPENDIX D

SEQUOIA ANALYTICAL LABORATORY
ANALYTICAL RESULTS FOR SOIL DATA

Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
404 N. Wiget Lane, Walnut Creek, CA 94598, (510) 988-9600, FAX (510) 988-9673
819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Weiss Associates	Client Project ID:	Shell 204-6852-1008	Sampled: May 5, 1997
5500 Shellmound	Sample Matrix:	Soil	Received: May 8, 1997
Emeryville, CA 94608	Analysis Method:	EPA 5030/8015 Mod./8020	Reported: May 23, 1997
Attention: Steve Long	First Sample #:	705-0548	

QC Batch Number: SP051497 8020EXA | SP051497 8020EXA | SP051497 8020EXA | SP051497 8020EXA | SP051497 8020EXA | SP051497 8020EXA

TOTAL PURGEABLE PETROLEUM HYDROCARBONS with BTEX DISTINCTION

Analyte	Reporting Limit mg/kg	Sample I.D. 705-0548 SG-03-0-4 ft.	Sample I.D. 705-0549 SG-03-4-6 ft. *	Sample I.D. 705-0550 SG-03-6-8 ft. *	Sample I.D. 705-0551 SG-04-0-2 ft.	Sample I.D. 705-0552 SG-04-2-4 ft.	Sample I.D. 705-0553 SG-04-4-6 ft.
Purgeable Hydrocarbons	1.0	23	4,200	3,600	2.0	9.0	410
Benzene	0.0050	0.26	10	6.3	0.013	0.055	0.36
Toluene	0.0050	0.11	3.7	5.9	N.D.	0.023	0.75
Ethyl Benzene	0.0050	0.21	52	47	0.021	0.15	0.72
Total Xylenes	0.0050	0.41	220	190	0.067	0.47	1.2
Chromatogram Pattern:		Gasoline & Unidentified Hydrocarbons >C8	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline & Unidentified Hydrocarbons >C8

Quality Control Data

Report Limit Multiplication Factor:	10	500	500	1.0	1.0	50
Date Analyzed:	5/14/97	5/14/97	5/14/97	5/14/97	5/14/97	5/14/97
Instrument Identification:	HP-5	HP-5	HP-5	HP-5	HP-5	HP-5
Surrogate Recovery, %: (QC Limits = 70-130%)	110	550	1200	96	79	128

Purgeable Hydrocarbons are quantitated against a fresh gasoline standard.
Analytes reported as N.D. were not detected above the stated reporting limit.

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer

Melissa A. Brewer
Client Services Representative

Please Note:
* Surrogate recovery is above control limits due to sample coelution.

Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
404 N. Wiget Lane, Walnut Creek, CA 94598, (510) 988-9600, FAX (510) 988-9673
819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Weiss Associates	Client Project ID:	Shell 204-6852-1008	Sampled: May 5-6, 1997
5500 Shellmound	Sample Matrix:	Soil	Received: May 8, 1997
Emeryville, CA 94608	Analysis Method:	EPA 5030/8015 Mod./8020	Reported: May 23, 1997
Attention: Steve Long	First Sample #:	705-0554	

TOTAL PURGEABLE PETROLEUM HYDROCARBONS with BTEX DISTINCTION

Analyte	Reporting Limit mg/kg	Sample I.D. 705-0554 SG-04-6-8 ft. *	Sample I.D. 705-0555 SG-07-0-2 ft.	Sample I.D. 705-0556 SG-07-2-4 ft.	Sample I.D. 705-0557 SG-07-4-6 ft.	Sample I.D. 705-0558 SG-07-6-8 ft. *	Sample I.D. 705-0559 SG-08-0-2 ft.
QC Batch Number:		SP051497 8020EXA	SP051497 8020EXA	SP051497 8020EXA	SP051497 8020EXA	SP051497 8020EXA	SP051497 8020EXA
Purgeable Hydrocarbons	1.0	140	5.1	27	26	840	N.D.
Benzene	0.0050	N.D.	0.22	0.34	0.31	N.D.	N.D.
Toluene	0.0050	0.27	0.0077	0.087	N.D.	3.0	N.D.
Ethyl Benzene	0.0050	0.81	0.67	1.1	0.66	12	N.D.
Total Xylenes	0.0050	1.4	0.17	0.18	0.12	N.D.	N.D.
Chromatogram Pattern:		Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	--

Quality Control Data

Report Limit Multiplication Factor:	50	1.0	10	10	500	1.0
Date Analyzed:	5/14/97	5/15/97	5/14/97	5/15/97	5/14/97	5/14/97
Instrument Identification:	HP-5	HP-5	HP-5	HP-5	HP-5	HP-5
Surrogate Recovery, %: (QC Limits = 70-130%)	140	94	123	101	300	96

Purgeable Hydrocarbons are quantitated against a fresh gasoline standard.
Analytes reported as N.D. were not detected above the stated reporting limit.

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer

Melissa A. Brewer
Client Services Representative

Please Note:
* Surrogate recovery is above control limits due to sample coelution.

Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
404 N. Wiget Lane, Walnut Creek, CA 94598, (510) 988-9600, FAX (510) 988-9673
819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Weiss Associates	Client Project ID:	Shell 204-6852-1008	Sampled: May 6, 1997
5500 Shellmound	Sample Matrix:	Soil	Received: May 8, 1997
Emeryville, CA 94608	Analysis Method:	EPA 5030/8015 Mod./8020	Reported: May 23, 1997
Attention: Steve Long	First Sample #:	705-0560	

QC Batch Number: SP051497 8020EXA | SP051497 8020EXA | SP051497 8020EXA

TOTAL PURGEABLE PETROLEUM HYDROCARBONS with BTEX DISTINCTION

Analyte	Reporting Limit mg/kg	Sample I.D. 705-0560 SG-08-2-4 ft.	Sample I.D. 705-0561 SG-08-4-6 ft.	Sample I.D. 705-0562 SG-08-6-8 ft. *
Purgeable Hydrocarbons	1.0	N.D.	390	1,200
Benzene	0.0050	N.D.	N.D.	N.D.
Toluene	0.0050	N.D.	N.D.	N.D.
Ethyl Benzene	0.0050	N.D.	N.D.	8.5
Total Xylenes	0.0050	0.0066	3.1	14
Chromatogram Pattern:		Gasoline	Gasoline Unidentified Hydrocarbons >C8	Gasoline

Quality Control Data

Report Limit Multiplication Factor:	1.0	250	500
Date Analyzed:	5/14/97	5/15/97	5/14/97
Instrument Identification:	HP-5	HP-5	HP-5
Surrogate Recovery, %: (QC Limits = 70-130%)	94	72	248

Purgeable Hydrocarbons are quantitated against a fresh gasoline standard.
Analytes reported as N.D. were not detected above the stated reporting limit.

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer

Melissa A. Brewer
Client Services Representative

Please Note:
* Surrogate recovery is above control limits due to sample coelution.

Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
404 N. Wiget Lane, Walnut Creek, CA 94598, (510) 988-9600, FAX (510) 988-9673
819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Weiss Associates
5500 Shellmound
Emeryville, CA 94608
Attention: Steve Long

Client Project ID: Shell 204-6852-1008
Sample Descript: Water
Analysis for: Percent Moisture
First Sample #: 705-0548

Sampled: May 5-6, 1997
Received: May 8, 1997
Analyzed: May 12, 1997
Reported: May 23, 1997

LABORATORY ANALYSIS FOR: Percent Moisture

Sample Number	Sample Description	Detection Limit	Sample Result %	QC Batch Number	Instrument ID
705-0548	SG-03-0-4 ft.	N/A	7.0	IN051297160300A	Manual
705-0549	SG-03-4-6 ft.	N/A	15	IN051297160300A	Manual
705-0550	SG-03-6-8 ft.	N/A	17	IN051297160300A	Manual
705-0551	SG-04-0-2 ft.	N/A	1.0	IN051297160300A	Manual
705-0552	SG-04-2-4 ft.	N/A	20	IN051297160300A	Manual
705-0553	SG-04-4-6 ft.	N/A	19	IN051297160300A	Manual
705-0554	SG-04-6-8 ft.	N/A	21	IN051297160300A	Manual
705-0555	SG-07-0-2 ft.	N/A	3.0	IN051297160300A	Manual
705-0556	SG-07-2-4 ft.	N/A	21	IN051297160300A	Manual
705-0557	SG-07-4-6 ft.	N/A	25	IN051297160300B	Manual
705-0558	SG-07-6-8 ft.	N/A	20	IN051297160300B	Manual

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer

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Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
404 N. Wiget Lane, Walnut Creek, CA 94598, (510) 988-9600, FAX (510) 988-9673
819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Weiss Associates	Client Project ID:	Shell 204-6852-1008	Sampled: May 6, 1997
5500 Shellmound	Sample Descript:	Water	Received: May 8, 1997
Emeryville, CA 94608	Analysis for:	Percent Moisture	
Attention: Steve Long	First Sample #:	705-0559	Analyzed: May 12, 1997
			Reported: May 23, 1997

LABORATORY ANALYSIS FOR: Percent Moisture

Sample Number	Sample Description	Detection Limit	Sample Result %	QC Batch Number	Instrument ID
705-0559	SG-08-0-2 ft.	N/A	15	IN051297160300B	Manual
705-0560	SG-08-2-4 ft.	N/A	16	IN051297160300B	Manual
705-0561	SG-08-4-6 ft.	N/A	25	IN051297160300B	Manual
705-0562	SG-08-6-8 ft.	N/A	19	IN051297160300B	Manual

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer

Melissa A. Brewer
Client Services Representative

Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
404 N. Wiget Lane, Walnut Creek, CA 94598, (510) 988-9600, FAX (510) 988-9673
819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Weiss Associates
5500 Shellmound
Emeryville, CA 94608
Attention: Steve Long

Client Project ID: Shell 204-6852-1008
Sample Descript: Water
Analysis for: Bulk Density
First Sample #: 705-0548

Sampled: May 5-6, 1997
Received: May 8, 1997
Analyzed: May 13, 1997
Reported: May 23, 1997

LABORATORY ANALYSIS FOR: Bulk Density

Sample Number	Sample Description	Detection Limit	Sample Result g/cm³	QC Batch Number	Instrument ID
705-0548	SG-03-0-4 ft.	N/A	2.4	IN051397213F00A	Manual
705-0549	SG-03-4-6 ft.	N/A	2.2	IN051397213F00A	Manual
705-0550	SG-03-6-8 ft.	N/A	2.0	IN051397213F00A	Manual
705-0551	SG-04-0-2 ft.	N/A	5.4	IN051397213F00A	Manual
705-0552	SG-04-2-4 ft.	N/A	1.9	IN051397213F00A	Manual
705-0553	SG-04-4-6 ft.	N/A	2.1	IN051397213F00A	Manual
705-0554	SG-04-6-8 ft.	N/A	1.9	IN051397213F00A	Manual
705-0555	SG-07-0-2 ft.	N/A	2.4	IN051397213F00A	Manual
705-0556	SG-07-2-4 ft.	N/A	1.9	IN051397213F00B	Manual
705-0557	SG-07-4-6 ft.	N/A	1.8	IN051397213F00B	Manual
705-0558	SG-07-6-8 ft.	N/A	4.7	IN051397213F00B	Manual

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer

Melissa A. Brewer
Client Services Representative

Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
404 N. Wiget Lane, Walnut Creek, CA 94598, (510) 988-9600, FAX (510) 988-9673
819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Weiss Associates	Client Project ID:	Shell 204-6852-1008	Sampled: May 6, 1997
5500 Shellmound	Sample Descript:	Water	Received: May 8, 1997
Emeryville, CA 94608	Analysis for:	Bulk Density	
Attention: Steve Long	First Sample #:	705-0559	Analyzed: May 13, 1997
			Reported: May 23, 1997

LABORATORY ANALYSIS FOR: Bulk Density

Sample Number	Sample Description	Detection Limit	Sample Result g/cm³	QC Batch Number	Instrument ID
705-0559	SG-08-0-2 ft.	N/A	5.1	IN051397213F00B	Manual
705-0560	SG-08-2-4 ft.	N/A	4.7	IN051397213F00B	Manual
705-0561	SG-08-4-6 ft.	N/A	4.5	IN051397213F00B	Manual
705-0562	SG-08-6-8 ft.	N/A	2.0	IN051397213F00B	Manual

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer

Melissa A. Brewer
Client Services Representative

Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
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819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Weiss Associates
5500 Shellmound
Emeryville, CA 94608
Attention: Steve Long

Client Project ID: Shell 204-6852-1008
Sample Descript: Water
Analysis for: Dry Bulk Density
First Sample #: 705-0548

Sampled: May 5-6, 1997
Received: May 8, 1997
Analyzed: May 22, 1997
Reported: May 23, 1997

LABORATORY ANALYSIS FOR: Dry Bulk Density

Sample Number	Sample Description	Detection Limit	Sample Result g/cm³	QC Batch Number	Instrument ID
705-0548	SG-03-0-4 ft.	N/A	1.8	IN052297213F00A	Manual
705-0549	SG-03-4-6 ft.	N/A	2.0	IN052297213F00A	Manual
705-0550	SG-03-6-8 ft.	N/A	2.1	IN052297213F00A	Manual
705-0551	SG-04-0-2 ft.	N/A	1.9	IN052297213F00A	Manual
705-0552	SG-04-2-4 ft.	N/A	2.0	IN052297213F00A	Manual
705-0553	SG-04-4-6 ft.	N/A	2.1	IN052297213F00A	Manual
705-0554	SG-04-6-8 ft.	N/A	2.1	IN052297213F00A	Manual
705-0555	SG-07-0-2 ft.	N/A	2.1	IN052297213F00A	Manual
705-0556	SG-07-2-4 ft.	N/A	1.8	IN052297213F00B	Manual
705-0557	SG-07-4-6 ft.	N/A	2.0	IN052297213F00B	Manual
705-0558	SG-07-6-8 ft.	N/A	2.2	IN052297213F00B	Manual

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer

Melissa A. Brewer
Client Services Representative

Sequoia Analytical

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819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Weiss Associates	Client Project ID:	Shell 204-6852-1008	Sampled: May 6, 1997
5500 Shellmound	Sample Descript:	Water	Received: May 8, 1997
Emeryville, CA 94608	Analysis for:	Dry Bulk Density	
Attention: Steve Long	First Sample #:	705-0559	Analyzed: May 22, 1997
			Reported: May 23, 1997

LABORATORY ANALYSIS FOR: Dry Bulk Density

Sample Number	Sample Description	Detection Limit	Sample Result g/cm³	QC Batch Number	Instrument ID
705-0559	SG-08-0-2 ft.	N/A	2.1	IN052297213F00B	Manual
705-0560	SG-08-2-4 ft.	N/A	1.7	IN052297213F00B	Manual
705-0561	SG-08-4-6 ft.	N/A	1.9	IN052297213F00B	Manual
705-0562	SG-08-6-8 ft.	N/A	2.1	IN052297213F00B	Manual

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer

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Weiss Associates
5500 Shellmound
Emeryville, CA 94608
Attention: Steve Long

Client Project ID: Shell 204-6852-1008
Sample Descript: Water
Analysis for: Fractional Organic Carbon
First Sample #: 705-0548

Sampled: May 5-6, 1997
Received: May 8, 1997
Analyzed: May 15, 1997
Reported: May 23, 1997

LABORATORY ANALYSIS FOR: Fractional Organic Carbon

Sample Number	Sample Description	Detection Limit %	Sample Result %	QC Batch Number	Instrument ID
705-0548	SG-03-0-4 ft.	0.20	1.3	IN051597WALK00A	Manual
705-0549	SG-03-4-6 ft.	0.040	0.37	IN051597WALK00A	Manual
705-0550	SG-03-6-8 ft.	0.040	0.30	IN051597WALK00A	Manual
705-0551	SG-04-0-2 ft.	0.20	3.4	IN051597WALK00A	Manual
705-0552	SG-04-2-4 ft.	0.20	1.2	IN051597WALK00A	Manual
705-0553	SG-04-4-6 ft.	0.040	0.38	IN051597WALK00A	Manual
705-0554	SG-04-6-8 ft.	0.040	0.28	IN051597WALK00A	Manual
705-0555	SG-07-0-2 ft.	0.040	0.65	IN051597WALK00A	Manual
705-0556	SG-07-2-4 ft.	0.040	0.68	IN051597WALK00A	Manual
705-0557	SG-07-4-6 ft.	0.040	0.33	IN051597WALK00A	Manual
705-0558	SG-07-6-8 ft.	0.040	0.28	IN051597WALK00A	Manual

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL, #1210

Melissa A. Brewer

Melissa A. Brewer
Client Services Representative

Sequoia Analytical

680 Chesapeake Drive, Redwood City, CA 94063, (415) 364-9600, FAX (415) 364-9233
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819 Striker Avenue, Suite 8, Sacramento, CA 95834, (916) 921-9600, FAX (916) 921-0100

Weiss Associates
5500 Shellmound
Emeryville, CA 94608
Attention: Steve Long

Client Project ID: Shell 204-6852-1008
Sample Descript: Water
Analysis for: Fractional Organic Carbon
First Sample #: 705-0559

Sampled: May 6, 1997
Received: May 8, 1997
Analyzed: May 15, 1997
Reported: May 23, 1997

LABORATORY ANALYSIS FOR: Fractional Organic Carbon

Sample Number	Sample Description	Detection Limit %	Sample Result %	QC Batch Number	Instrument ID
705-0559	SG-08-0-2 ft.	0.070	0.88	IN051597WALK00A	Manual
705-0560	SG-08-2-4 ft.	0.070	0.82	IN051597WALK00A	Manual
705-0561	SG-08-4-6 ft.	0.040	0.52	IN051597WALK00A	Manual
705-0562	SG-08-6-8 ft.	0.040	0.26	IN051597WALK00A	Manual

Analytes reported as N.D. were not present above the stated limit of detection.

SEQUOIA ANALYTICAL, #1210

Melissa A. Brewer

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Client Services Representative

Sequoia Analytical

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Weiss Associates
5500 Shellmound
Emeryville, CA 94608
Attention: Steve Long

Client Project ID: Shell 204-6852-1008
Matrix: Solid
QC Sample Group: 7050548-562

Reported: May 27, 1997

QUALITY CONTROL DATA REPORT

Analyte:	Benzene	Toluene	Ethyl Benzene	Xylenes
QC Batch#:	SP051497	SP051497	SP051497	SP051497
Analy. Method:	802005A EPA 8020	802005A EPA 8020	802005A EPA 8020	802005A EPA 8020
Prep. Method:	EPA 5030	EPA 5030	EPA 5030	EPA 5030
Analyst:	K. Nill	K. Nill	K. Nill	K. Nill
MS/MSD #:	7050617	7050617	7050617	7050617
Sample Conc.:	N.D.	N.D.	N.D.	N.D.
Prepared Date:	5/14/97	5/14/97	5/14/97	5/14/97
Analyzed Date:	5/14/97	5/14/97	5/14/97	5/14/97
Instrument I.D.#:	HP-5	HP-5	HP-5	HP-5
Conc. Spiked:	0.40 mg/kg	0.40 mg/kg	0.40 mg/kg	1.2 mg/kg
Result:	0.72	0.69	0.74	2.1
MS % Recovery:	180	173	185	175
Dup. Result:	0.68	0.64	0.69	2.0
MSD % Recov.:	170	160	173	167
RPD:	5.7	7.5	7.0	4.9
RPD Limit:	0-25	0-25	0-25	0-25

LCS #:	5LCS051497	5LCS051497	5LCS051497	5LCS051497
Prepared Date:	5/14/97	5/14/97	5/14/97	5/14/97
Analyzed Date:	5/14/97	5/14/97	5/14/97	5/14/97
Instrument I.D.#:	HP-5	HP-5	HP-5	HP-5
Conc. Spiked:	20 µg/L	20 µg/L	20 µg/L	60 µg/L
LCS Result:	20	18	19	57
LCS % Recov.:	100	90	95	95
MS/MSD LCS Control Limits	60-140	60-140	60-140	60-140

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer
Client Services Representative

Please Note:
The LCS is a control sample of known, interferent-free matrix that is analyzed using the same reagents, preparation, and analytical methods employed for the samples. The matrix spike is an aliquot of sample fortified with known quantities of specific compounds and subjected to the entire analytical procedure. If the recovery of analytes from the matrix spike does not fall within specified control limits due to matrix interference, the LCS recovery is to be used to validate the batch.

** MS = Matrix Spike, MSD = MS Duplicate, RPD = Relative % Difference

Sequoia Analytical

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Weiss Associates
5500 Shellmound
Emeryville, CA 94608
Attention: Steve Long

Client Project ID: Shell 204-6852-1008
Matrix: Solid
QC Sample Group: 7050548-562

Reported: May 27, 1997

QUALITY CONTROL DATA REPORT

Analyte:	Benzene	Toluene	Ethyl Benzene	Xylenes
QC Batch#:	SP051497	SP051497	SP051497	SP051497
	802005A	802005A	802005A	802005A
Analy. Method:	EPA 8020	EPA 8020	EPA 8020	EPA 8020
Prep. Method:	EPA 5030	EPA 5030	EPA 5030	EPA 5030
Analyst:	K. Nill	K. Nill	K. Nill	K. Nill
MS/MSD #:	7050617	7050617	7050617	7050617
Sample Conc.:	N.D.	N.D.	N.D.	N.D.
Prepared Date:	5/14/97	5/14/97	5/14/97	5/14/97
Analyzed Date:	5/14/97	5/14/97	5/14/97	5/14/97
Instrument I.D.#:	HP-5	HP-5	HP-5	HP-5
Conc. Spiked:	0.40 mg/kg	0.40 mg/kg	0.40 mg/kg	1.2 mg/kg
Result:	-	-	-	-
MS % Recovery:	-	-	-	-
Dup. Result:	-	-	-	-
MSD % Recov.:	-	-	-	-
RPD:	-	-	-	-
RPD Limit:	0-25	0-25	0-25	0-25

LCS #:	5LCS051597	5LCS051597	5LCS051597	5LCS051597
Prepared Date:	5/15/97	5/15/97	5/15/97	5/15/97
Analyzed Date:	5/15/97	5/15/97	5/15/97	5/15/97
Instrument I.D.#:	HP-5	HP-5	HP-5	HP-5
Conc. Spiked:	20 µg/L	20 µg/L	20 µg/L	60 µg/L
LCS Result:	17	16	17	49
LCS % Recov.:	85	80	85	82
MS/MSD LCS Control Limits	60-140	60-140	60-140	60-140

SEQUOIA ANALYTICAL, #1271

Melissa A. Brewer

Melissa A. Brewer
Client Services Representative

Please Note:
The LCS is a control sample of known, interferent-free matrix that is analyzed using the same reagents, preparation, and analytical methods employed for the samples. The matrix spike is an aliquot of sample fortified with known quantities of specific compounds and subjected to the entire analytical procedure. If the recovery of analytes from the matrix spike does not fall within specified control limits due to matrix interference, the LCS recovery is to be used to validate the batch.

** MS = Matrix Spike, MSD = MS Duplicate. RPD = Relative % Difference

Sequoia Analytical

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Weiss Associates
5500 Shellmound
Emeryville, CA 94608
Attention: Steve Long

Client Project ID: Shell 204-6852-1008
Matrix: Solid
QC Sample Group: 7050548-562
Reported: May 27, 1997

QUALITY CONTROL DATA REPORT

Analyte:	Percent Moisture	Percent Moisture	Bulk Density	Bulk Density	Dry Bulk Density	Dry Bulk Density	Functional Organic Carbon
QC Batch#:	IN051297	IN051297	IN051397	IN051397	IN052297	IN052297	IN051597
	160300A	160300B	213F00A	213F00B	213F00A	213F00B	WALK00A
Analy. Method:	EPA 160.3	EPA 160.3	SM213F	SM213F	SM213F	SM213F	Walkley-Black
Prep. Method:	EPA 160.3	EPA 160.3	SM213F	SM213F	SM213F	SM213F	-
Analyst:	Y. Borinshteyn	Y. Borinshteyn	Y. Borinshteyn	Y. Borinshteyn	Y. Borinshteyn	Y. Borinshteyn	C. Hirotsu
Duplicate Sample #:	7050556	7050562	7050555	7050562	7050555	7050562	9705563-07
Prepared Date:	5/12/97	5/12/97	5/13/97	5/13/97	5/20/97	5/20/97	5/15/97
Analyzed Date:	5/12/97	5/12/97	5/13/97	5/13/97	5/22/97	5/22/97	5/15/97
Instrument I.D.#:	Manual	Manual	Manual	Manual	Manual	Manual	Manual
Sample Concentration:	20%	19%	2.4 g/cm³	1.9 g/cm³	2.0 g/cm³	2.1 g/cm³	0.28%
Dup. Sample Concentration:	21%	19%	2.2 g/cm³	2.0 g/cm³	2.1 g/cm³	2.1 g/cm³	0.29%
RPD:	4.9	0.0	8.7	5.1	4.9	0.0	3.5
RPD Limit:	0-30	0-30	0-30	0-30	0-30	0-30	0-20

SEQUOIA ANALYTICAL, #1271
& #1210

Melissa A. Brewer
Client Services Representative

** RPD = Relative % Difference

SHELL OIL COMPANY
RETAIL ENVI[illegible] ENGINEERING - WEST

CHAIN OF CUSTODY RECORD
Serial No: _____

Date: 7-May-97
Page 1 of 2

Site Address: 15275 WOODSHINGTON/San Leandro
WIC#: 204-6852-1008
Shell Engineer: Alex Perez
Phone No.: Fax #:
Consultant Name & Address: WEISS ASSOCIATES 5500 SHELLMOUND ST EMERYVILLE CA 94608
Consultant Contact: WA JOB # 81-1227-72
Phone No.: (510) 450-6000 Fax #: 547-5043
Comments: Results to: Steve Long, Weiss Assoc.
Sampled by: PLEAS J MCNEEL
Printed Name:

LAB: _____

CHECK ONE (1) BOX ONLY	CT/DT
G.W. Monitoring	4461
Site Investigation	4441
Soil Classify/Disposal	4442
Water Classify/Disposal	4443
Soil/Air Rem. or Sys. O & M	4452
Water Rem. or Sys. O & M	4453
Other	

TURN AROUND TIME: 24 hours ☐ 48 hours ☐ 15 days ☑ (Normal) Other ☐ _____

NOTE: Notify Lab as soon as Possible of 24/48 hrs. TAT.

UST AGENCY: _____

Analysis Required: TPH (EPA 8015 Mod. Gas); TPH (EPA 8015 Mod. Diesel); BTEX (EPA 8020/602); Volatile Organics (EPA 8240); Test for Disposal; Combination TPH 8015 & BTEX 8020; Moisture/Fox (Walkley-Black); Wet + Dry Bulk Density; Asbestos; Container Size; Preparation Used; Composite Y/N

Sample ID	Date	Sludge	Soil	Water	Air	No. of conts.	Container Size	MATERIAL DESCRIPTION	SAMPLE CONDITION/ COMMENTS
SG-03-0-4ft	5/5/97		✓				7050548		
SG-03-4-6ft	"		✓				7050549		
SG-03 6-8ft	"		✓				7050550		
SG-04 0-2ft	"		✓				7050551		
SG-04 2-4ft	"		✓				7050552		
SG-04 4-6ft	"		✓				7050553		
SG-04 6-8ft	"		✓				7050554		

Relinquished By (signature):	Printed Name: 7-MAY-97	Date: 5/6/97 Time: 1000	Received (signature):
Relinquished By (signature):	Printed Name: NR Lvan Slambrook	Date: 5/6/97 Time: 1255	Received (signature):
Relinquished By (signature):	Printed Name:	Date: Time:	Received (signature):

Printed Name: NR Lvan Slambrook	Date: 5/6/97 Time: 1000
Printed Name:	Date: Time:
Printed Name: K R Grubb	Date: 5/8/97 Time: 1255

THE LABORATORY MUST PROVIDE A COPY OF THIS CHAIN-OF-CUSTODY WITH INVOICE AND RESULTS

Rev. 7/17/93

Shell Oil Chn of Custody

SHELL OIL COMPANY
RETAIL ENVIRONMENTAL ENGINEERING - WEST

CHAIN OF CUSTODY RECORD
Serial No: _____

Date: 9-MAY-97
Page 2 of 2

Site Address: 15275 WASHINGTON / San Leandro
WIC#: 204-6852-1008
Shell Engineer: Alex Perez
Phone No.: Fax #:
Consultant Name & Address: WEISS ASSOCIATES 5500 SHELLMOUND ST EMERYVILLE CA 94608
Consultant Contact: WA JOB # 81-1227-72
Phone No.: (510) 450-6000 Fax #: 547-5043
Comments: Results to: Steve Long, Weiss Assoc.
Sampled by: [signature] III
Printed Name: PLEAS J McNEEL III

Analysis Required

LAB: _____

CHECK ONE (1) BOX ONLY	CT/DT	TURN AROUND TIME
G.W. Monitoring	4461	24 hours
Site Investigation	4441	48 hours
Soil Classify/Disposal	4442	15 days (Normal)
Water Classify/Disposal	4443	Other
Soil/Air Rem. or Sys. O & M	4452	NOTE: Notify Lab as soon as Possible of 24/48 hrs. TAT.
Water Rem. or Sys. O & M	4453	
Other		

UST AGENCY: _____

Sample ID	Date	Sludge	Soil	Water	Air	No. of conts.	TPH (EPA 8015 Mod. Gas)	TPH (EPA 8015 Mod. Diesel)	BTEX (EPA 8020/602)	Volatile Organics (EPA 8240)	Test for Disposal	Combination TPH 8015 & BTEX 8020	Moisture (Facility Walkley Black)	Lucr + Dry Bulk density	Asbestos Soil grain density per S. Long 5/9/97	Container Size	Preparation Used	Composite Y/N	MATERIAL DESCRIPTION	SAMPLE CONDITION/ COMMENTS
SG-07 0-2ft	5/6/97		✓									✓	✓	✓	/		7050555			
SG-07 2-4ft	5/6/97		✓									✓	✓	✓	/		7050556			
SG-07 4-6ft	5/6/97		✓									✓	✓	✓	/		7050557			
SG-07 6-8ft	"		✓									✓	✓	✓	/		7050558			
SG-08 0-2ft	"		✓									✓	✓	✓	/		7050559			
SG-08 2-4'	"		✓									✓	✓	✓	/		7050560			
SG-08 4-6'	"		✓									✓	✓	✓	✓		7050561			
SG-08 6-8ft	"		✓									✓	✓	✓	✓		7050562			

Relinquished By (signature): [signature] III	Printed Name: PLEAS McNeel III	Date: 5/7/97 Time: 1600	Received (signature): [signature]	Printed Name: [illegible]	Date: 5/8/97 Time: 1000
Relinquished By (signature): [signature]	Printed Name: NEIL VAN SLAMBROOK	Date: 5/8/97 Time: 1255	Received (signature): [signature]	Printed Name:	Date: Time:
Relinquished By (signature):	Printed Name:	Date: Time:	Received (signature): [signature]	Printed Name: K P Grubb	Date: 5/8/97 Time: 1355

THE LABORATORY MUST PROVIDE A COPY OF THIS CHAIN-OF-CUSTODY WITH INVOICE AND RESULTS

Rev. 1/12/93

Shell Oil Chain of Custody

APPENDIX E

TIER 2 RISK-BASED CORRECTIVE ACTION EVALUATION

SUMMARY REPORT

❑ TIER 1 / ■ TIER 2 RBCA SITE EVALUATION

FORMER SHELL SERVICE STATION
15275 WASHINGTON AVENUE
SAN LEANDRO, CALIFORNIA

WIC #204-6852-1108

Weiss Associates, Emeryville, California

PREPARED BY

June 18, 1997

DATE ISSUED

REVIEWED BY Steven Lowy

DATE 6/20/97

RBCA SUMMARY REPORT

Table of Contents

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

TIER 1 / TIER 2 RBCA REPORT INDEX

			■ = ENCLOSED	
			Tier 1	Tier 2
1.0	**EXECUTIVE SUMMARY**			
1.2	Tier 2 Executive Summary Checklist	*		■
1.3	Executive Summary Discussion		❑	■ *(u)*
1.4	Baseline Exposure Pathway Flowchart		❑	❑ *(u)*
1.5	Comparison of Site Data to RBSLs/SSTLs - Commercial/Industrial Receptors		❑	❑ *(u)*
1.6	Comparison of Site Data to RBSLs/SSTLs - Residential Receptors		■	■ *(u)*
2.0	**SITE HISTORY**			
2.1	Site Description		❑	❑ *(u)*
2.2	Site Ownership & Activity Record		❑	❑ *(u)*
2.3	Past Releases or Source Areas		❑	❑ *(u)*
2.4	Summary of Current & Completed Site Activities		❑	❑ *(u)*
2.5	Summary of Potential Near-Term Site Activities		❑	❑ *(u)*
3.0	**SITE ASSESSMENT INFORMATION**			
3.1	Regional Hydrogeologic Conditions		❑	❑ *(u)*
3.2	Hydrogeologic Site Conditions		❑	❑ *(u)*
3.3	Beneficial Use Summary		❑	❑ *(u)*
3.4	Well Inventory Survey		❑	❑ *(u)*
3.5	Ecological Assessment Summary		❑	❑ *(u)*
4.0	**BASELINE EXPOSURE ASSESSMENT**			
4.1	Site Classification Summary		❑	■ *(u)*
4.2	Baseline Exposure Flowchart		❑	■ *(u)*
4.3	Tier 2 Exposure Factor Checklist	*	❑	■ *(u)*
4.4	Tier 2 Exposure Pathway Screening	*		■
4.5	Tier 2 Exposure Scenarios & Risk Goals	*		■
5.0	**SITE PARAMETERS**			
5.1	Site Parameter Checklist for RBSLs		❑	■ *(u)*
5.2	Summary of Media Investigation and Chemical Analyses		❑	■*(u)*
5.3	Summary of Source Zone Characteristics		❑	■ *(u)*
5.4	Surface Soil Concentration Data Summary		❑	❑ *(u)*
5.5	Subsurface Soil Concentration Data Summary		❑	■ *(u)*
5.6	Groundwater Concentration Data Summary		❑	■ *(u)*
5.7	Tier 2 Exposure Pathway Transport Parameters	*		■
6.0	**TIER 1 RISK-BASED SCREENING LEVEL EVALUATION**			
6.1	Tier 1 RBSL Evaluation: Surface Soil		❑	
6.2	Tier 1 RBSL Evaluation: Subsurface Soil		❑	
6.3	Tier 1 RBSL Evaluation: Groundwater		❑	

**** = Required for Tier 2 Evaluation only*** ***(u) = For Tier 2, update Tier 1 version as needed.***

TIER 1 / TIER 2 RBCA REPORT INDEX - *continued*

			■ = ENCLOSED	
			Tier 1	Tier 2
7.0	**NATURAL ATTENUATION FACTORS**			
7.1	Tier 2 NAF Calculation Methods & Results	*		❑
8.0	**TIER 2 SSTL EVALUATION**			
8.1	Surface Soil SSTL Values	*		❑
8.2	Subsurface Soil SSTL Values	*		■
8.3	Groundwater SSTL Values	*		■
ATTACHMENTS				
Figure 1	Site Location Map		❑	❑ *(u)*
Figure 2	Extended Site Map		❑	❑ *(u)*
Figure 3	Site Plan		❑	❑ *(u)*
Figure 4	Site Photos		❑	❑ *(u)*
Figure 5	Groundwater Plume Maps	*		❑
Figure 6	Groundwater Elevation Map		❑	❑ *(u)*
Figure 7	Soil Boring Location Map		❑	❑ *(u)*
APPENDICES				
Appendix A	SSTL Calculations		❑	■ *(u)*
Appendix B	SSTL Calculations		❑	■ *(u)*
Appendix C	Well Screen Intervals			■
	(SPECIFY)			

* = ***Required for Tier 2 Evaluation only*** ***(u) = For Tier 2, update Tier 1 version as needed.***

RBCA SUMMARY REPORT — Worksheet 1.2

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

TIER 2 EXECUTIVE SUMMARY

TIER 2 SSTL CALCULATION METHOD (■ OR ● TO SELECT)

SSTL Calculation Option

- ☐ Option 1: Site-Specific Screening Levels
- ■ Option 2: Individual Constituent SSTL Values
- ☐ Option 3: Cumulative Constituent SSTL Values

NAF Calculation Method

- ☐ Fate and Transport Modeling:
- ☐ ○ RBCA Spreadsheet System
- ☐ ○ Other Model(s)
- ■ Empirical NAF Calculation

SITE DATA INVENTORY

Source Zone Investigation Complete:

- ■ Surface Soil (e.g., < 3 ft BGS)
- ■ Subsurface Soil (e.g., > 3 ft BGS)
- ■ Groundwater

Exposure Pathway Information Compiled:

- ■ Air Pathway
- ■ Groundwater Pathway
- ■ Soil Pathway
- ☐ Surface Water Pathway
- ☐ Land Use Classification (on-site and off-site)

TASKS COMPLETED

- ■ Tier 1 Evaluation
- ☐ Tier 1 Interim Corrective Action
- ■ Tier 2 Evaluation
- ☐ Tier 2 Interim Corrective Action
- ☐ Tier 2 Final Corrective Action
- ☐ Tier 3 Evaluation

CURRENT SITE CLASSIFICATION

Classification No.	Scenario Description	Prescribed Interim Action	Date Implemented
3	Shallow ground water and subsurface soils are impacted. There are no domestic drinking water wells within 1/2 mile.	Evaluate remedial alternatives to reduce site concentrations to or below SSTLs	Planned for 1998

TIER 2 CORRECTIVE ACTION CRITERIA

Affected Medium	Tier 1 SSTL Exceeded ?		Applicable Excess Risk Limits (specify values)				Other Appicable Exposure Limits
	Yes	No	Indiv. Risk	Total Risk	Hazard Index	Hazard Quotent	*(specify, if any)*
• Surface Soil (≤ 3ft bgs)	☐	☐					
• Subsurface Soil (>3ft bgs)	■	☐	10^{-5}			1.0	
• Groundwater	■	☐	10^{-5}			1.0	MCLs at POE

PROPOSED ACTION

- ☐ ***No Action:*** Tier 2 SSTLs not exceeded. Apply for closure.
- ☐ ***Interim Corrective Action:*** Address principal, near-term risks sources.
- ■ ***Final Corrective Action:*** Remediate/control site to meet Tier 2 criteria.
- ☐ ***Tier 3 Evaluation:*** Improve baseline risk and SSTL estimates.

NOTE:

Rationale for proposed action documented on Worksheets 1.3 and 10.1-10.3.

ALL WORKSHEETS ENCLOSED IN THIS REPORT ARE IDENTIFIED ON THE TABLE OF CONTENTS FORM

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

EXECUTIVE SUMMARY

Instructions: ***Provide brief description of site history, hydrogeologic conditions, ecological assessment, possible exposure pathways, SSTL results, and the scope of work for proposed corrective action activity. Address proposed methods, implementation schedule, cost, and anticipated risk reduction at or near the site.***

SITE DESCRIPTION AND HISTORY

Update Site History from Tier 1, if necessary

No update from Tier 1.

SITE ASSESSMENT INFORMATION

GEOLOGIC AND HYDROGEOLOGIC SUMMARY

Update from Tier 1, if necessary

No update from Tier 1.

EXPOSURE ASSESSMENT

COMPLETE EXPOSURE PATHWAYS AND APPLICABLE RECEPTORS

Identify those pathway/contaminant pairs to be evaluated at Tier 2 (exceeded Tier 1 criteria)

In Tier 1, potentially complete current and/or future exposure pathways for human exposure were identified as:

- inhalation of indoor and outdoor air via volatilization from subsurface soils
- inhalation of indoor and outdoor air via volatilization from ground water
- leachate to ground water from subsurface soils for ingestion
- ground water ingestion at a hypothetical point of exposure closest to the area of impact.

Residential receptors were considered in the evaluations as the future use of the site is not determined and there is a residential area located adjacent to the site. Pathways involving exposure to surface soil were not considered in the initial Tier 1 evaluations due to lack of field data. In May 1997, a soil vapor survey and soil sampling investigation was conducted to further evaluate site conditions and to collect data for exposure pathways that were not considered in Tier 1 evaluations. These data were used to reevaluate Tier 1 screening levels and to evaluate pathways involving exposure to surface soils.

Potentially complete current and/or future exposure pathways in the updated Tier 1 evaluation were identified as:

- inhalation of indoor and outdoor air via volatilization from subsurface soils
- inhalation of indoor and outdoor air via volatilization from ground water
- inhalation, dermal contact and ingestion of vapors and particulates from surfacial soils
- leachate to ground water from subsurface soils for ingestion
- ground water ingestion at a hypothetical point of exposure closest to the area of impact.

Worksheet 1.6 shows the comparison of previous and updated site characterization data to RBSLs. Worst-case concentrations of toluene, ethylbenzene and xylenes were below relevant Tier 1 RBSLs. Therefore the presence of these COCs in site soils and/or ground water is not beleived to present a significant risk to human health or the environment. Worst-case benzene concentrations exceeded the conservative Tier 1 RBSLs for the following pathways, which are evaluated further in Tier 2:

- inhalation of *benzene* vapors via volatilization from subsurface soils into buildings and to outdoor air
- inhalation of *benzene* vapors via volatilization from ground water into buildings
- leachate of *benzene* to ground water from subsurface soils for ingestion
- ingestion of *benzene* via ground water at nearest off-site hypothetical point of exposure.

Assuming that leachate to ground water is a potentially complete exposure pathway is a conservative approach, because the ground water analytical results do not indicate any significant change in concentrations due to leaching from soils Ground water ingestion is also conservatively considered a potentially complete pathway and there are no known uses of shallow ground water in the area.

ECOLOGICAL ASSESSMENT SUMMARY

Update from Tier 1, if necessary

No update from Tier 1

EXECUTIVE SUMMARY *continued*

REPRESENTATIVE TIER 2 SSTL EVALUATION

COMPARISON TO SOURCE MEDIA CONCENTRATIONS

For pathways evaluated at Tier 2, compare representative source concentrations to applicable SSTL values.

SSTLs were calculated for inhalation and ground water ingestion exposure pathways using site-specific parameter values and site-specific fate and transport modeling. SSTL calculations and site-specific parameter values are found in Appendices A and B of this Tier 2 evaluation report. Worksheet 1.6 shows the comparison between SSTLs and site soil and ground water concentrations. Site concentrations exceeded Tier 2 SSTLs for the following exposure pathways:

- inhalation of *benzene* vapors via volatilization from subsurface soils into buildings.
- inhalation of *benzene* vapors via volatilization from ground water into buildings.

QUALITATIVE UNCERTAINTY ASSESSMENT

Discuss uncertainty / conservatism of the site data and calculation methods used in deriving SSTL values.

In calculating the SSTLs for soils and ground water, only a few site-specific parameters were used in place of Tier 1 default values. These parameters are discussed in Appendices A and B, and in Worksheet 5.1. The site representative concentrations were conservatively selected based on maximum detected concentrations. In addition, conservative assumptions were made for estimating plume thickness in ground water, thickness of contaminated soils and for the location of a hypothetical water supply well in the shallow water-bearing zone.

PROPOSED CORRECTIVE ACTION

Describe rationale for proposed action (i.e., no action, interim action, final action, or tier upgrade), considering site classification and land use. Discuss basis for remedy selection, if applicable.

Based on the results of the Tier 2 analysis, an evaluation of remedial alternatives is proposed to reduce concentrations to or below SSTLs.

REFERENCE DOCUMENTS

List the document sources for the data cited in this report.

See Section 5.0 of the attached report.

RBCA SUMMARY REPORT

Tier 1 Worksheet 1.6

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

RESIDENTIAL RECEPTORS: COMPARISON OF PREVIOUS AND UPDATED SITE CHARACTERIZATION DATA TO RBSLS

Media	Exposure Pathway	Potentially Complete?	Benzene			Toluene			Ethylbenzene			Xylenes		
			RBSL [1]	Representative Concentration[2]		RBSL[3]	Representative Concentration[2]		RBSL[3]	Representative Concentration[2]		RBSL[3]	Representative Concentration[2]	
				Tier 1	Update		Tier 1	Update		Tier 1	Update		Tier 1	Update
Soil (mg/kg)	**Volatilization to Outdoor Air**	Yes	**0.79**	**31**	**10**	RES[4]	170	5.9	RES	280	52	RES	560	220
	Vapor Intrusion to Buildings	Yes	**0.015**	**31**	**10**	20.6	170	5.9	427	280	52	RES	560	220
	Surficial Soil (0-3 ft depth): Ingestion/Dermal/Inhalation	Yes	16.8	no data	0.34	13,300	no data	0.11	7,830	no data	1.1	145,000	no data	0.47
	Leachate to Ground Water for Ingestion	Yes	**0.05**	**31**	**10**	129	170	5.9	575	280	52	RES	560	220
Ground Water (mg/l)	Volatilization to Outdoor Air	Yes	31.9	0.86	0.99	>S[5]	0.29	0.33	>S	1.5	1.5	>S	5.9	6.3
	Vapor Intrusion to Buildings	Yes	**0.069**	**0.86**	**0.99**	32.8	0.29	0.33	77.5	1.5	1.5	>S	5.9	6.3
	Ingestion	Yes	**0.0085**	**0.86**	**0.99**	7.3	0.29	0.33	3.65	1.5	1.5	73.0	5.9	6.3

Notes:

(1) The RBSLs used for benzene is based on a carcinogenic risk of 1 in 100,000 (10^{-5}), and corrected for the California cancer slope factor.
(2) Methodology for establishing representative COC concentrations shown on worksheets 5.3 - 5.6
(3) The RBSLs used for non-carcinogenic constituents of concern is a chronic hazard quotient of 1.0.
(4) RES = Selected risk level is not exceeded for pure compound present at any concentration in soil.
(5) >S = At pure component solubility (mg/l), selected risk level is not exceeded.

NA = Not applicable.
ND = Not detected
Boldface indicates exceedance on a potentially complete exposure pathway

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

RESIDENTIAL RECEPTORS: COMPARISON OF SITE CHARACTERIZATION DATA TO SSTLS

Media	Exposure Pathway	Potentially Complete?	Benzene	
			SSTL [1]	Representative Concentration [2]
Soil (mg/kg)	Volatilization to Outdoor Air	Yes	204	10
	Vapor Intrusion to Buildings	Yes	0.25	10
	Leachate to Ground Water for Ingestion	Yes	17 = S-9 sample	10
Ground Water (mg/l)	Vapor Intrusion to Buildings	Yes	0.86	1.4
	Ingestion	Yes	2.0	1.4

Notes:

(1) The SSTLs used for benzene is based on a carcinogenic risk of 1 in 100,000 (10^{-5}), and corrected for the California cancer slope factor.
(2) Methodology for establishing representative COC concentrations shown on worksheets 5.3 - 5.6
(3) The SSTLs used for non-carcinogenic constituents of concern is a chronic hazard quotient of 1.0.
(4) RES = Selected risk level is not exceeded for pure compound present at any concentration in soil.
(5) >S = At pure component solubility (mg/l), selected risk level is not exceeded.

NA = Not applicable.
ND = Not detected
Boldface indicates exceedance on a potentially complete exposure pathway

RBCA SUMMARY REPORT

Worksheet 4.1

Site Name: Former Shell Service Station, WIC #204-6852-1108 | Date Completed: June 18, 1997

Site Location: 15275 Washington Avenue, San Leandro, California | Completed By: Weiss Associates

RBCA SITE CLASSIFICATION SUMMARY

Instructions: ***Determine RBCA Site Classification using site classification flowcharts provided in Tier 1 RBCA Guidance Manual, as follows:***

Evaluate available information on site soils, vapors, groundwater, surface water, and miscellaneous impacts using the corresponding flowcharts. Record two-digit site classification number for each medium.

Compare numerical values from individual media to identify critical site classification(s) (i.e., lowest values).

Record critical site classification scenario and initial response action in space provided. If there is more than one number within the lowest classification group (e.g., Class 2), record both (e.g., 2.1, 2.3).

As site evaluation progresses, update site classification as appropriate by repeating Steps 1 - 3, based upon additional site data or completion of corrective measure.

SITE STATUS		MEDIUM-SPECIFIC CLASSIFICATION VALUES					CRITICAL CLASSIFICATION(S)	
Date	Status Description	Soil	Ground-water	Vapor	Surface Water	Misc.	Classification No. and Scenario	Prescribed Initial Response
INITIAL CLASSIFICATION:								
Aug 1996	Shallow soils and ground water impacted.	3	3	3	4	4	3. Potential for vapor migration, possible long-term threat to human or beneficial ground water use. 4. No potential threat to human health or beneficial ground water use.	Continue ground water monitoring, prepare workplan to collect soil vapor data. Perform Tier 2 evaluation No futher action.
REVISED CLASSIFICATION:								
Nov 1996	COC concentrations in soil and ground water exceed Tier 1 RBSLs.	3	3	3	4	4	3. Potential for vapor migration, possible long-term threat to human or beneficial ground water use. 4. No potential threat to human health or beneficial ground water use.	Continue ground water monitoring, prepare workplan to collect soil vapor data. Perform Tier 2 evaluation No further action.
June 1997	COC concentrations in soil exceed Tier 2 SSTLs	3	4	3	4	4	3. Potential for vapor migration, possible long-term threat to human or beneficial ground water use. 4. No potential threat to human health or beneficial ground water use.	Select remedial alternative to reduce soil concentration to/below SSTLs. No further action.

RBCA SUMMARY REPORT

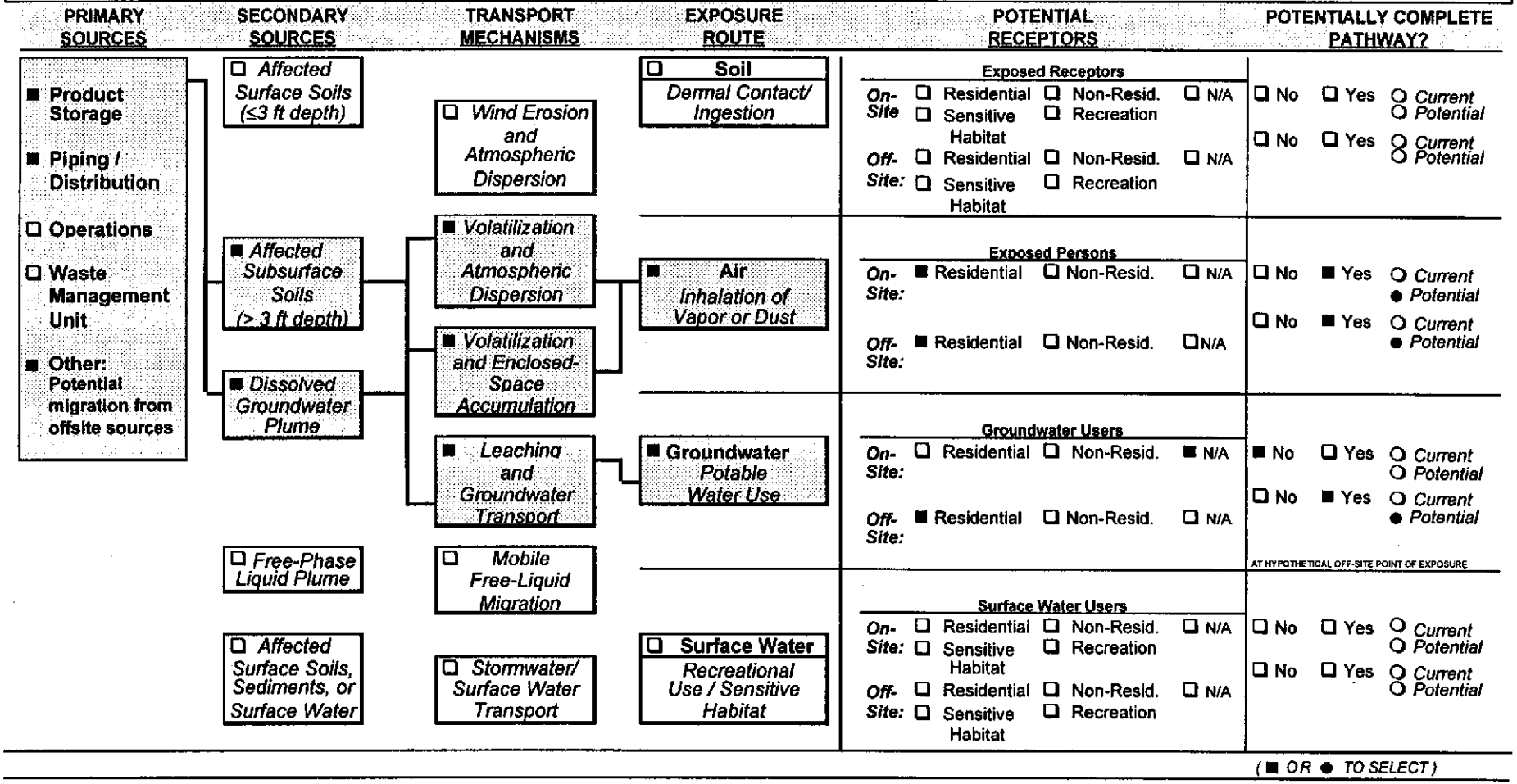
Worksheet 4.2

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

EXPOSURE FLOWCHART

This worksheet shows the Baseline Exposure Flowchart from the tier 1 Analysis.



(■ OR ● TO SELECT)

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: **June 18, 1997**

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: **Weiss Associates** *Page 1 of 1*

EXPOSURE FACTOR CHECKLIST

Instructions: • ***Tier 2 Evaluation:*** *Indicate use of either a Reasonable Maximum Exposure (RME) factor or a site-specific exposure factor for both residential and commercial / industrial points of exposure (POEs), as appropriate for each exposure pathway. For Tier 2, data is required for Global Factors and for complete pathways only (see Worksheet 4.4).*

	RESIDENTIAL POE		COMMERCIAL/ INDUSTRIAL POE	
	RME	Site-Specific	RME	Site-Specific
GLOBAL FACTORS	(■ *TO SELECT*)			
AT_c Averaging time for carcinogens	■ 70 yrs	☐ _____	☐ 70 yrs	☐ _____
Averaging time for non-carcinogens	■ = ED	☐ _____	☐ = ED	☐ _____
BW Body weight -Adult	■ 70 kg	☐ _____	☐ 70 kg	☐ _____
-Child (1-6 yrs)	■ 15 kg	☐ _____	☐ NA	☐ _____
ED Exposure duration	■ 30 yrs	☐ _____	☐ 25 yrs	☐ _____
AIR EXPOSURE FACTORS	■ COMPLETE (provide data)		☐ NOT COMPLETE (skip)	
EF Exposure frequency (inhalation)	■ 350 dy/yr	☐ _____	☐ 250 dy/yr	☐ _____
IR_{ai} Daily indoor inhalation rate	■ 15 m^3/dy (24-hr/dy)	☐ _____	☐ 20 m^3/dy (8-hr/dy)	☐ _____
IR_{ao} Daily outdoor inhalation rate	■ 20 m^3/dy (24-hr/dy)	☐ _____	☐ 20 m^3/dy (8-hr/dy)	☐ _____
POTABLE WATER USE EXPOSURE FACTORS	■ COMPLETE (provide data)		☐ NOT COMPLETE (skip)	
EF Exposure frequency (ingestion/showering)	■ 350 dy/yr	☐ _____	☐ 250 dy/yr	☐ _____
IR_w Daily water ingestion rate	■ 2 L/dy (24-hr/dy)	☐ _____	☐ 1 L/dy (8-hr/dy)	☐ _____
EP_{sh} Exposure period (showering)	■ 12 min/dy	☐ _____	☐ 12 min/da	☐ _____
SA_w Skin surface area (showering) -Adult (70 kg)	■ 0.86 m^2	☐ _____	☐ 0.86 m^2	☐ _____
SOIL EXPOSURE FACTORS	☐ COMPLETE (provide data)		■ NOT COMPLETE (skip)	
EF Exposure Frequency -Dermal Contact	☐ 350 dy/yr	☐ _____	☐ 40 dy/yr	☐ _____
-Soil ingestion	☐ 350 dy/yr	☐ _____	☐ 250 dy/yr	☐ _____
SA_s Skin surface area (soil contact) -Adult (18 to 31 yrs, 70 kg)	☐ 0.58 m^2	☐ _____	☐ 0.58 m^2	☐ _____
-Child (1 - 17 yrs, 35 kg)	☐ 0.20 m^2	☐ _____	☐ NA	☐ _____
M Soil to skin adherance factor	☐ 1.0 mg/cm^2	☐ _____	☐ 1.0 mg/cm^2	☐ _____
IR_s Soil ingestion rate - Age-adjusted average	☐ 114 mg-yr /kg-dy	☐ _____	☐ NA	☐ _____
-Adult (7 to 31 yrs, 70 kg)	☐ 100 mg/dy (24-hr/dy)	☐ _____	☐ 50 mg/dy (8-hr/dy)	☐ _____
-Child (1 - 6 yrs, 15 kg)	☐ 200 mg/dy (24-hr/dy)	☐ _____	☐ NA	☐ _____
SURFACE WATER EXPOSURE FACTORS	☐ COMPLETE (provide data)		■ NOT COMPLETE (skip)	
EF Exposure Frequency -Fish consumption	☐ 350 dy/yr	☐ _____	☐ NA	☐ _____
-Swimming	☐ 7 dy/yr	☐ _____	☐ NA	☐ _____
IR_f Daily fish intake rate -Freshwater	☐ 10 g/dy	☐ _____	☐ NA	☐ _____
-Saltwater	☐ 15 g/dy	☐ _____	☐ NA	☐ _____
SA_w Skin surface area (swimming) -Adult (70 kg)	☐ 0.86 m^2	☐ _____	☐ NA	☐ _____
EP_{sw} Exposure period (swimming)	☐ 2.6 hrs/dy	☐ _____	☐ NA	☐ _____

Site Name: [redacted] Date Completed: June 16, 1997

Site Location: 15275 Washington Avenue, San Leandro, California Completed By: Weiss Associates

SELECTION OF EXPOSURE PATHWAYS FOR TIER 2 EVALUATION

Instructions: *Exposure pathways selection of contaminant pairs for Tier 2 evaluation involves the following steps:*

1) Identify potentially complete exposure pathways from Tier 1.

2) Identify those pathways for which one or more COCs exceed the Tier 1 RBSLs

3) Fill in the COCs with RME concentrations exceeding the Tier 1 RBSLs

4) Check yes for each pathway that is potentially complete and has one or more COCs whose RME concentrations exceed the Tier 1 RBSL

Notes:
RBSL = Risk-Based Screening Level
POE = Point of Exposure
COC = Constituent of Concern
NM = Not Measured

PATHWAY	Potentially Complete Pathway?	Pathway Tier 1 RBSL Exceeded?	CONSTITUENTS Identify COCs > Tier 1 RBSL	Evaluate at Tier 2?
AIR EXPOSURE PATHWAYS (■ *TO SELECT*)				
1) Surface Soils: Vapor Inhalation and Dust Ingestion	☐ Current ■ Potential	☐ Yes ■ No ☐ NA	None	■ No ☐ Yes - Current ☐ Yes - Future
2) Subsurface Soils: Volatilization to Ambient Air	■ Current ■ Potential	■ Yes ☐ No ☐ NA	Benzene	☐ No ■ Yes - Current ■ Yes - Future
3) Subsurface Soils: Volatilization to Enclosed Space	■ Current ■ Potential	■ Yes ☐ No ☐ NA	Benzene	☐ No ■ Yes - Current ■ Yes - Future
4) Ground water: Volatilization to Ambient Air	■ Current ■ Potential	☐ Yes ■ No ☐ NA	None	■ No ☐ Yes - Current ☐ Yes - Future
5) Ground water: Volatilization to Enclosed Space	■ Current ■ Potential	■ Yes ☐ No ☐ NA	Benzene	☐ No ■ Yes - Current ■ Yes - Future
GROUND WATER EXPOSURE PATHWAYS				
6) Soil: Leaching to Ground water: Ingestion	■ Current ■ Potential	■ Yes ☐ No ☐ NA	Benzene	☐ No ■ Yes - Current ■ Yes - Future
7) Dissolved or Free-Phase Ground water Plume: Ingestion	■ Current ■ Potential	■ Yes ☐ No ☐ NA	Benzene	☐ No ■ Yes - Current ■ Yes - Future
SOIL EXPOSURE PATHWAY				
8) *Surface Soils:* Dermal Contact /Ingestion	■ Current ■ Potential	☐ Yes ■ No ☐ NA	None	■ No ☐ Yes - Current ☐ Yes - Future

NA = Not Applicable

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates *Page 1 of 1*

SITE PARAMETER CHECKLIST FOR RISK-BASED SCREENING LEVELS

Instructions: *For Tier 1 evaluation (generic screening levels), review specified default parameters (*) to ensure values are conservative for site. For Tier 2 Option 1 SSTL calculation (site-specific screening levels), provide site-specific values for sensitive parameters (§). Indicate parameter value used in evaluation by completing check box (■).*

Note: * **Confirm conservatism of these values for Tier 1 evaluation.**
§ **Provide site-specific measurement or estimate for Tier 2 evaluation.**

		Default Value Used		Site-Specific Value Used		
Soil Parameters						
	soil type	■	sandy/clayey soil	❑		*§
Θ_T	Soil porosity	❑	0.38 (dim)	■	0.25	§
Θ_{ws}	water content - vadose zone	❑	0.12 (dim)	■	0.04	§
Θ_{as}	air content - vadose zone ($=\Theta_T - \Theta_{ws}$)	❑	0.26 (dim)	■	0.21	
Θ_{wcap}	water content - capillary fringe	■	0.342 (dim)	❑		
Θ_{acap}	air content - capillary fringe ($=\Theta_T - \Theta_{wcap}$)	■	0.038 (dim)	❑		
ρ_s	Soil density	❑	1.7 g/cm^3	■	2.0	§
foc	mass fraction of organic carbon in soil	❑	0.01 (dim)	■	0.01	§
Ls	Depth to contaminated soil	❑	100 cm	■	122	§
Lgw	Depth to groundwater	❑	300 cm	■	305	§
h_{cap}	capillary zone thickness	■	5 cm	❑		
hv	vadose zone thickness ($=$ Lgw - hc)	❑	295 cm	■	300	
pH	Soil/water pH	■	6.5	❑		
Groundwater Parameters						
I	Water infiltration rate	■	30 cm/yr	❑		§
V_{gw}	groundwater velocity	❑	82.0 ft/yr	■	144	*§
δ_{gw}	groundwater mixing zone depth	■	200 cm	❑		*§
DF	aquifer dilution factor ($= 1 + V_{gw}\,\delta_{gw}/(IW)$)	■	12.1	❑		
Surface Parameters						
U_{air}	Amb. air velocity in mixing zone	■	225 cm/s	❑		*§
δ_{air}	Mixing zone height	■	200 cm	❑		*§
A	Contaminated Area	■	2250000 cm^2	❑		
W	Width of Contaminated Area	■	1500 cm	❑		§
d	Thickness of Surficial Soils	■	100 cm	❑		§
Pe	Particulate areal emission rate	■	2.17E-10 g/cm^2-s	❑		§
Building Parameters						
L_{crack}	Foundation crack thickness	■	15 cm	❑		
η	Foundation crack fraction	■	0.01 (dim)	❑		
Lb_r	Building Volume/Foundation Area Ratio (res.)	■	200 cm	❑		
Lb_c	Building Volume/Foundation Area Ratio (com./ind.)	■	300 cm	❑		
ER_r	Building vapor volume exchange rate (res.)	❑	12 dy^{-1}	❑		
ER_c	Building vapor volume exchange rate (com./ind.)	■	20 dy^{-1}	❑		

Discussion: *Provide rationale for default parameter revision; discuss additional site-specific features of note; etc.*

- Soil porosity, soil density, water and air contents were determined by soil property analysis of collected samples
- Depth to contaminated soil is 4 ft.
- Depth to ground water is 10 ft.

(continue on next page if needed)

RBCA SUMMARY REPORT — Worksheet 5.2

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

SUMMARY OF MEDIA INVESTIGATION & CHEMICAL ANALYSES

		Site Media Analyzed (■ *TO SELECT*)					
		Ground-water	Surface Soil	Subsurf. Soil	Soil Vapor	Ambient Vapor	Surface Water
	Applicable?	■	■	■	■	■	❑
	Sampled?	■	■	■	■	■	❑
Chemical Analysis	**EPA Analysis Method**	•ana. = chemical analyzed; •det. = chemical detected					
Organic Chemicals		ana./det.	ana./det.	ana./det.	ana./det.	ana./det.	ana./det.
Volatile Organics	*8240 / 624*	■ ■	❑ ❑	■ ■	❑ ❑	❑ ❑	❑ ❑
Semi-Volatile Organics	*8270 / 625*	❑ ❑	❑ ❑	❑ ❑	❑ ❑	❑ ❑	❑ ❑
Polynuclear Aromatic Hydrocarbons	*8310 / 8270*	❑ ❑	❑ ❑	❑ ❑	❑ ❑	❑ ❑	❑ ❑
Purgeable Aromatics	*8020 / 602*	■ ■	■ ■	■ ■	■ ■	■ ❑	❑ ❑
Total Petroleum Hydrocarbons (GC)	*8015G / 8015D*	■ ■	■ ■	■ ■	■ ■	■ ❑	❑ ❑
Halogenated Organic Chemicals		ana./det.	ana./det.	ana./det.	ana./det.	ana./det.	ana./det.
Halogenated Volatile Organics	*8010 / 601*	■ ❑	❑ ❑	❑ ❑	❑ ❑	❑ ❑	❑ ❑
Organochlorine & PCBs	*8080*	❑ ❑	❑ ❑	❑ ❑	❑ ❑	❑ ❑	❑ ❑
Inorganic Chemicals		ana./det.	ana./det.	ana./det.	ana./det.	ana./det.	ana./det.
Metals (Lead)	*6010 / 7xxx series*	■ ■	❑ ❑	■ ■	❑ ❑	❑ ❑	❑ ❑
Others		ana./det.	ana./det.	ana./det.	ana./det.	ana./det.	ana./det.
• Organic Lead		■ ■	❑ ❑	■ ■	❑ ❑	❑ ❑	❑ ❑
• Total Oil and Grease		❑ ❑	❑ ❑	■ ■	❑ ❑	❑ ❑	❑ ❑
• E-Coli form (total and fecal)		■ ■	❑ ❑	❑ ❑	❑ ❑	❑ ❑	❑ ❑
• Chloride,nitrate,TDS		■ ■	❑ ❑	❑ ❑	❑ ❑	❑ ❑	❑ ❑
• Physical Properties		❑ ❑	■ ❑	■ ❑	❑ ❑	❑ ❑	❑ ❑

DISCUSSION OF MEDIA INVESTIGATION & CHEMICAL ANALYSES

Items for discussion include: •Selection of sampled media •Selected analysis methods •Planned additional sampling

Items	
Soil	Soil samples from the waste oil tank area, the former UST area and from soil borings were analyzed for volatile organic carbons, purgeable aromatics, total petroleum hydrocarbons, organic lead, and total oil and grease prior to 1997.
Soil Vapor	Soil vapor samples were collected to define the extent of the source area in soils prior to 1997. A soil vapor profile survey was conducted in 1997 to assess the potential exposure due to vapors migrating to ground surface from soil and ground water beneath the site. Vapor samples were anlayzed for BTEX compounds, MTBE, petroleum hydrocarbons, and gas constituents
Ground Water	Ground water monitoring has been conducted at the site since 1989 to determine the extent and migration of of the hydrocarbon-impacted ground water. Additional water samples were collected in August 1996 and analyzed for E. Coliform (total and fecal), chloride, nitrate, total dissolved solids, and halogenated volatile organic carbons.
Surface and Sub-surface Soils	Soil samples were collected in 1997 to determine any impact to site soils. These soil samples were taken from across the site and analyzed for petroleum hydrocarbons, BTEX compounds, and physical properties.

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

SUMMARY OF SOURCE ZONE CHARACTERISTICS

Instructions: ***Provide information regarding presence and dimensions of affected soil and groundwater zones. For each affected medium, list constituents of concern (COCs) and representative concentration data on Worksheets 5.4 - 5.6. Reference figures and Sample #'s used to establish source are characteristics for each media***

AFFECTED SURFACE SOILS (≤ 3 ft BGS) (■ TO SELECT)

- ☐ Present
- ☐ Not Present
- ■ Not Measured

If present, complete the following[1]:

• Maximum areal extent (ft^2):		
• Width of affected zone (ft):		*(Provide COC data*
• Length of affected zone (ft) :		*on Worksheet 5.4)*
• Depth interval (ft,BGS):		

(1) **Surface soil concentrations did not exceed Tier 1 RBSLs.**

AFFECTED SUBSURFACE SOILS (> 3 FT BGS)

- ■ Present
- ☐ Not Present
- ☐ Not Measured

If present, complete the following[2]:

• Depth to top of affected soil (ft) (min. 3 ft, BGS):	4	*(Provide COC data*
• Depth to base of affected soil (ft, BGS):	10	*on Worksheet 5.5)*
• Maximum areal extent (ft^2):	28,800	(approx. 240 x 120 ft)

(2) **The maximum extent of impacted soils was conservatively determined by the area enclosed in between wells S-9, S-10, S-11, S-12, S-15, and S-16.**
The area that encloses the western product island, former waste oil tank and the former USTs is about 6,400 ft^2 (80 x 80 ft).

AFFECTED GROUNDWATER

- ■ Present
- ☐ Not Present
- ☐ Not Measured

If present, complete the following[3]:

• Maximum areal extent (ft^2):	57,600	(approx. 240 x 240 ft)
• Length of plume (ft):	240	*(Provide COC data*
• Width of plume (ft):	240	*on Worksheet 5.6)*
• Depth to top of affected water-bearing unit (ft, BGS):	10	
• Depth to base of plume (ft, BGS):	16	

(3) **The maximum areal extent of the impacted ground water was conservatively determined by the area enclosed by wells S-11, S-12, S-13, S-15, S-16, S-17, and S-18, which define the ND line.**

OTHER SOURCE MEDIUM

- ☐ Present
- ■ Not Present

If present, describe nature of material and dimensions:

(Provide COC data on separate table)

RBCA SUMMARY REPORT

Worksheet 5.5

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

SUBSURFACE SOIL CONCENTRATION DATA SUMMARY (>3 FT BGS)

Source of Data: Vadose Zone Characterization Report, June 1997, Weiss Associates.

Sample ID or Sample Set Used: **SG-03, SG-04, and SG-07 at multiple depths**

Worse Case Depth to Max. Impact 4 ft

Sample Date: May 5, 1997

Methodology for Establishing Representative Concentrations:

For site surface soils, the representative concentration selection is the Maximum of positively detected results from soil samples > 3 ft BGS within the known source area.

This method establishes a representative concentration appropriate to conservatively evaluate subsurface soil exposure pathways.

CONSTITUENTS DETECTED		ANALYTICAL METHOD		SAMPLE POPULATION		DETECTED CONCENTRATIONS			SELECTED REPRESENTATIVE CONC. (mg/kg)
CAS No.	Name	Method No.	Typical Detection Limit (mg/kg)	No. of Samples	No. of Detects	Max Conc. (mg/kg)	Mean Conc. (mg/kg)	UCL Conc. (mg/kg)	
71-43-2	Benzene	~~8020~~ ~~8010~~	0.005	8	4	10	4.2	NC	10

NC- Not Calculated.

RBCA SUMMARY REPORT

Worksheet 5.6

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

GROUNDWATER CONCENTRATION DATA SUMMARY

Source of Data: Quarterly Monitoring data from July 9, 1996 to April 8, 1997

Sample ID or Sample Set Used: S-1 through S-18 and SR-1

Worse Case Depth to Max. Impact 6 ft

Sample Date: April 8, 1997

Methodology for Establishing Representative Concentrations:

The representative concentration in ground water is the [Arithmetic] Mean of the last 4 quarters of monitoring data for the most highly impacted [onsite/offsite] within the known source area.

This method establishes a representative concentration appropriate to conservatively evaluate ground water exposure pathways.

CONSTITUENTS DETECTED		ANALYTICAL METHOD		SAMPLE POPULATION		DETECTED CONCENTRATIONS			SELECTED REPRESENTATIVE CONC. (mg/Lg)
CAS No.	Name	Method No.	Typical Detection Limit (mg/Lg)	No. of Samples	No. of Detects	Max Conc. (mg/Lg)	Mean Conc. (mg/Lg)	UCL Conc. (mg/Lg)	
71-43-2	Benzene	~~8010~~ 8020	0.0005	25	15	1.4	0.45	NC	1.4

NC - Not Calculated.

Site Name: Former Shell Service Station, WIC #204-6852-1108 Date Completed: June 18, 1997

Site Location: 15275 Washington Avenue, San Leandro, California Completed By: Weiss Associates

TIER 2 EXPOSURE PATHWAY TRANSPORT PARAMETERS

Instructions: ***For complete exposure pathways, provide site-specific values for transport parameters. In absence of direct measurements, default values may be selected for some parameters, as shown below. If no default value shown, site-specific value must be provided.***

TRANSPORT PARAMETER	SITE-SPECIFIC VALU (INPUT VALUE BELOW)	DEFAULT VALUE (■ TO SELECT)
AIR PARAMETERS		
δ_{air} Air mixing zone height (cm)		■ 200
U_{air} Ambient air velocity in mixing zone (cm/sec)		■ 225
Pe Soil particulate areal emission rate (g/cm^2-sec)		■ 2.17E-10
σ_y Transverse air dispersion coeff. (m)		■ 100
σ_z Vertical air dispersion coeff. (m)		■ 10
GROUNDWATER PARAMETERS		
δ_{gw} Groundwater mixing zone depth (cm)		■ 200
I Water infiltration rate (cm/yr)		■ 30
V_{gw} Groundwater Darcy velocity (ft/yr)	144	
K Saturated hydraulic conductivity (cm/sec)	0.0035	
i_{grad} Lateral groundwater flow gradient (dim)	0.004	
$(BC)_i$ Available biodegradation capacity of electron acceptors for constituent *i*		
x Distance to POE from point of maximum COC concentration in groundwater (ft)	180	
α_x Longitudinal groundwater dispersion coeff. (cm)		■ 10% of x
α_y Transverse groundwater dispersion coeff. (cm)		■ 33% of α_x
α_z Vertical groundwater dispersion coeff. (cm)		■ 5% of α_z
SOIL PARAMETERS		
Capillary zone thickness (cm)		■ 5
Vadose zone thickness (ft)	10 ft	
Soil bulk density (g/cm^3)	2.0	
Fraction organic carbon in soil leaching zone (dim)	0.01	
Fraction organic carbon in water-bearing unit (dim)		■ 0.001
Depth to groundwater (cm)	304.8	
Soil porosity (dim)	0.25	
Soil volumetric water content (dim)		
• Capillary zone		■ 0.342
• Vadose zone	0.04	❑ 0.12
• Foundation crack		■ 0.12

Site Name: Former Shell Service Station, WIC #204-6852-1108 Date Completed: June 18, 1997

Site Location: 15275 Washington Avenue, San Leandro, California Completed By: Weiss Associates

TIER 2 EXPOSURE PATHWAY TRANSPORT PARAMETERS *CONTINUED*

	TRANSPORT PARAMETER	SITE-SPECIFIC VALU *(INPUT VALUE BELOW)*	DEFAULT VALUE (■ TO SELECT)	
SOIL PARAMETERS (Continued)				
	Soil volumetric air content (dim)			
Θ_{acap}	•Capillary zone		■ 0.38	
Θ_{as}	•Vadose zone	0.21	❑0.26	
Θ_{acrack}	•Foundation crack		■ 0.26	
d	Thickness of surficial soil zone (cm)		■ 100 cm	
BUILDING PARAMETERS				
			Resid.	Comm/ Ind.
L_b	Building volume/area ratio (cm)		■ 200	■ 300
ER	Building air exchange rate (dy-1)		■ 12	■ 20
L_{crack}	Foundation crack thickness (cm)		■ 15	
η	Foundation crack fraction		■ 0.01	

Additional Information:

RBCA SUMMARY REPORT

Worksheet 8.2

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

SUBSURFACE SOIL SSTL VALUES (≥ 3 FT BGS) - COMMERCIAL/INDUSTRIAL OR RESIDENTIAL RECEPTORS

SSTL Calculation Option:

	TR	HI (or HQ)
❑ Option 1: Site-Specific Screening Level		
■ Option 2: Individual Constituent Limits	10^{-5} and MCL	
❑ Option 3: Cumulative Constituent Limits		

Instructions: *Specify target risk limits upon which Tier 2 site-specific screening levels (SSTLs) are based. Identify exposure pathways evaluated at Tier 2 for site (■ = complete). Record site sample measurements for constituents of concern (COCs) and corresponding SSTL values for complete pathways. Identify minimum SSTL value for each COC. Note whether site concentration exceeds minimum SSTL value.*

CONSTITUENTS OF CONCERN		REPRESENTATIVE CONC.	SSTL RESULTS FOR COMPLETE EXPOSURE PATHWAYS (■ IF COMPLETE)				
			■ Leaching to Grdwtr.	■ Vapor Inhal. Outdoor Air	■ Vapor Inhal. Indoor Air	Minimum Value	SSTL Exceeded?
CAS No.	Name	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	■ If yes
71-43-2	Benzene	10	17	204	0.25	0.25	■
							❑
							❑
							❑
							❑
							❑
							❑
							❑
							❑
							❑
							❑
							❑

Note: 1) See Worksheet 4.3 for identification of Complete Pathways.
2) See Worksheet 4.5 for applicable Exposure Scenarios and Risk Goals.
3) See Worksheet 5.4 for derivation of Representative Concentration for each COC in surface soil source zone.
TR = Target risk limit for excess lifetime carcinogenic risk.
HQ = Hazard quotient for individual constituent non-carcinogenic effects.
HI = Hazard index for cumulative constituent non-carcinogenic effects.
RGS = Selected risk level not exceeded for pur compound present at any concentration in soil.

RBCA SUMMARY REPORT

Worksheet 8.2

Site Name: **Former Shell Service Station, WIC #204-6852-1108** Date Completed: June 18, 1997

Site Location: **15275 Washington Avenue, San Leandro, California** Completed By: Weiss Associates

GROUNDWATER SSTL VALUES

SSTL Calculation Option:

	TR	HI (or HQ)
☐ Option 1: Site-Specific Screening Level		
■ Option 2: Individual Constituent Limits	10^{-5} and MCL	
☐ Option 3: Cumulative Constituent Limits		

Instructions: ***Specify target risk limits upon which Tier 2 site-specific screening levels (SSTLs) are based. Identify exposure pathways evaluated at Tier 2 for site (■ complete). Record site sample measurements for constituents of concern (COCs) and corresponding SSTL values for complete pathways. Identify minimum SSTL value for eac COC. Note whether site concentration exceeds minimum SSTL value.***

CONSTITUENTS OF CONCERN		REPRESENTATIV CONC.	SSTL RESULTS FOR COMPLETE EXPOSURE PATHWAYS (■ IF COMPLETE)				
			■ Grdwtr Ingestion	☐ Vol. to Ambient Air	■ Vol. to Indoor Air	Minimum Value	SSTL Exceeded?
CAS No.	Name	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	■ If yes
71-43-2	Benzene	1.4	2.0		0.86	0.86	■
							☐
							☐
							☐
							☐
							☐
							☐
							☐
							☐
							☐

Note: 1) See Worksheet 4.3 for identification of Complete Pathways.
2) See Worksheet 4.5 for applicable Exposure Scenarios and Risk Goals.
3) See Worksheet 5.6 for derivation of Representative Concentration for each COC in groundwater source zone.
TR = Target risk limit for excess lifetime carcinogenic risk.
HQ = Hazard quotient for individual constituent non-carcinogenic effects.
HI = Hazard index for cumulative constituent non-carcinogenic effects.
>S = At pure compound solubility, selected risk is not exceeded.

APPENDIX A

Parameters and calculations for evaluating exposure pathways via benzene volatilization from soil and ground water.

Parameters

The following soil properties were used in the calculations based on measurements for soil samples collected at the site.

Soil bulk density:	2,000	kg/m3
Soil porosity:	0.25	
Air content:	0.21	
Water content:	0.04	
Fraction organic carbon:	0.01	

Following parameters were used in the calculation as site representative conditions.

Depth to contamination in soil:	4 ft.	Boring SG-03-4-6
Vertical thickness of contaminated soil:	6 ft.	4 ft to minimum ground water level at 10 ft.
Thickness of shallow aquifer:	10 ft.	Maximum thickness based on water levels.

ASTM default parameters were used for other variables.

CALCULATIONS - Residential Receptor - Ground Water to Indoor Air SSTL - Benzene

Site Specific RBCA Tier 2 Analysis, Former Shell Service Station, WIC#204-6852-1108, 15275 Washinton Avenue, San Leandro, CA.
WA implementation of Jury model, from Sanders and Stern 1994.

Default Chemical and Soil Values (symbol notation from ASTM for consistency)

Source			
	Soil Specific Parameters		
Site Spec.	ρ_s	***2000***	Bulk Density(kg/m^3)
Site Spec.	θ_{as}	***0.21***	Air Content (v/v)
Site Spec.	θ_{ws}	***0.04***	Water Content (v/v)
Site Spec.	θ_t	***0.25***	Porosity (v/v)
	Chemical Specific Parameters	benzene	Chemical Name
ASTM 94	H	0.222	Henry's Constant
Howard	Thalf	***365***	Contaminant Half Life (d) in GW, Howard 1991
ASTM 94	D^{air}	9.30E-06	Air Diffusion Coefficient (m^2/s)
ASTM 94	D^{wat}	1.10E-09	Water Diffusion Coefficient (m^2/s)
Site Spec.	f_{oc}	***0.01***	Organic Carbon Fraction
ASTM 94	K_{oc}	0.038	Organic Carbon Partition Coefficient (m^3/Kg) (Log Koc = 1.58)
calc, Jury	D^{eff}	2.15E-07	Effective Diffusion Coefficient (m^2/s)

Site Specific Parameters (symbol notation consistent with Sanders and Stern)

C_{water}	***1.4***	Ground Water Concentration (mg/L)	S-9 (Max . benzene concentration in last 4 qtr.)
Co	0.31	(g/m^3)	Conc * Kh
L	***2.29***	Depth to Contamination (m)	Lowest depth to ground water = 6 ft
W	***3***	Thickness of Contamination Zone (m)	Thickness of saturated aquifer = 10 ft
A	***167***	Zone of Influence, Building Area (m^2)	Bldg 60'x30' (estimated building size)
Qb	168.56	Building Ventilation Rate (m^3/Hr)	ht= 200 cm, vent rate = .00014/sec (ASTM)
I	15	Inhalation volume (m^3/day)	15 m^3/day (ASTM)

Equation Parts a, b and c : a=x, b=y,c=z

x	0.83	x=(ln(2)/Thalf)^.5 (yr^-.5)
y	4.40E-01	y=L/(2*D^{eff}^.5) (yr^.5)
z	1.03E+00	z=(L+W)/(2*D^{eff}^.5) (yr^.5)

Integration Constants

ICs	0.301204	ICs=(Co*A*I*D^{eff}^.5)/(2*a''*Qb) (grams)

Formulas

$$D^{eff} = \frac{\left(\theta_{as}^{10/3} D^{air} H + \theta_{ws}^{10/3} D_{wat}\right) / \theta_t^{\,2}}{\left(\rho_s f_{oc} K_{oc} + \theta_{ws} + \theta_{as} H\right)}$$

$$dose = \frac{CoAI}{2xQb}\sqrt{De}\left[\exp(2yx)erf\left(x\sqrt{t} + \frac{y}{\sqrt{t}}\right) + \exp(-2yx)erf\left(x\sqrt{t} - \frac{y}{\sqrt{t}}\right)\right]_{\sqrt{t1}}^{\sqrt{t2}}$$

Integration (you need to understand the ERF function when entering values here)

0.0001 Lower Time Limit (yr)	***30*** Upper Time Limit (yr)
0.01 Sq root LTL (yr^.5)	5.48 Sq root UTL (yr^.5)
2.08E+00 Term 1	2.08E+00 Term 1
-4.81E-01 Term2	4.81E-01 Term2

Site dose (mg)=	289.6	=	1.6E-05 risk
Acceptable Dose (mg) =	178.85	=	1.0E-05 risk

SSTL BACK-CALCULATION ON NEXT PAGE

CALCULATIONS - Residential Receptor - Ground Water to Indoor Air SSTL - Benzene

Site Specific RBCA Tier 2 Analysis, Former Shell Service Station, WIC#204-6852-1108, 15275 Washinton Avenue, San Leandro, CA.

Backcalculate to acceptable concentration= SSTL

Default Chemical and Soil Values (symbol notation from ASTM for consistency)

Source			
	Soil Specific Parameters		
Site Spec.	ρ_s	***2000***	Bulk Density(kg/m^3)
Site Spec.	θ_{as}	***0.21***	Air Content (v/v)
Site Spec.	θ_{ws}	***0.04***	Water Content (v/v)
Site Spec.	θ_t	***0.25***	Porosity (v/v)
	Chemical Specific Parameters	benzene	Chemical Name
ASTM 94	H	0.222	Henry's Constant
S+S 94	Thalf	***365***	Contaminant Half Life (d) in GW (Howard, 1991)
ASTM 94	D^{air}	9.30E-06	Air Diffusion Coefficient (m^2/s)
ASTM 94	D^{wat}	1.10E-09	Water Diffusion Coefficient (m^2/s)
Site Spec.	f_{oc}	***0.01***	Organic Carbon Fraction
ASTM 94	K_{oc}	0.038	Organic Carbon Partition Coefficient (m^3/Kg) (Log Koc = 1.58)
calc, Jury	D^{eff}	2.15E-07	Effective Diffusion Coefficient (m^2/s)

Site Specific Parameters (symbol notation consistent with Sanders and Stern)

	SSTL (California Dose Response)		
C_{water}	***0.86***	Ground Water Concentration (mg/L)	
Co	0.19	(g/m^3)	Conc * Kh
L	***2.29***	Depth to Contamination (m)	Lowest depth to ground water = 6 ft
W	***3***	Thickness of Contamination Zone (m)	Thickness of saturated aquifer = 10 ft
A	***167***	Zone of Influence, Building Area (m^2)	Bldg 60'x30' (estimated building size)
Qb	169	Building Ventilation Rate (m^3/Hr)	ht= 200 cm, vent rate = .00014/sec (ASTM)
I	15	Inhalation volume (m^3/day)	15 m^3/day (ASTM)

Equation Parts a, b and c : a=x, b=y,c=z

x	8.33E-01	x=(ln(2)/Thalf)^.5 (yr^-.5)
y	4.40E-01	y=L/(2*D^{eff}^.5) (yr^.5)
z	1.03E+00	z=(L+W)/(2*D^{eff}^.5) (yr^.5)

Integration Constants

ICs	1.86E-01	ICs=(Co*A*I*D^{eff}^.5)/(2*a*Qb) (grams)

Formulas

$$D^{eff} = \frac{\left(\theta_{as}^{10/3} D^{air} H + \theta_{ws}^{10/3} D_{wat}\right) / \theta_t^{\,2}}{\left(\rho_s f_{oc} K_{oc} + \theta_{ws} + \theta_{as} H\right)}$$

$$dose = \frac{CoAI}{2xQb}\sqrt{De}\left[\exp(2yx)erf\left(x\sqrt{t} + \frac{y}{\sqrt{t}}\right) + \exp(-2yx)erf\left(x\sqrt{t} - \frac{y}{\sqrt{t}}\right)\right]_{\sqrt{t1}}^{\sqrt{t2}}$$

Integration (you need to understand the ERF function application when entering values here)

0.0001 Lower Time Limit (yr)	***30*** Upper Time Limit (yr)
0.01 Sq root LTL (yr^.5)	5.48 Sq root UTL (yr^.5)
2.08E+00 Term 1	2.08E+00 Term 1
-4.81E-01 Term2	4.81E-01 Term2

Site dose (mg)= 178.85 = 1.0E-05 risk

Acceptable Dose (mg) = 178.85 = 1.0E-05 risk

CALCULATIONS - Residential Receptor - Soil to Outdoor Air SSTL - Benzene

Site Specific RBCA Tier 2 Analysis, Former Shell Service Station, WIC#204-6852-1108, 15275 Washinton Avenue, San Leandro, CA.
WA implementation of Jury model, from Sanders and Stem 1994.

Default Chemical and Soil Values (symbol notation from ASTM for consistency)

Source			
	Soil Specific Parameters		
Site Spec.	ρ_s	***2000***	Bulk Density(kg/m^3)
Site Spec.	θ_{as}	***0.21***	Air Content (v/v)
Site Spec.	θ_{ws}	***0.04***	Water Content (v/v)
Site Spec.	θ_t	***0.25***	Porosity (v/v)
	Chemical Specific Parameters		
		benzene	Chemical Name
ASTM 95	H	0.222	Henry's Constant
ASTM 95	Thalf	***115***	Contaminant Half Life (d)
ASTM 95	D^{air}	9.30E-06	Air Diffusion Coefficient (m^2/s)
ASTM 95	D^{wat}	1.10E-09	Water Diffusion Coefficient (m^2/s)
Site Spec.	f_{oc}	***0.01***	Organic Carbon Fraction
ASTM 95	K_{oc}	0.038	Organic Carbon Partition Coefficient (m^3/Kg) (Log Koc = 1.58)
calc, Jury	D^{eff}	2.14783E-07	Effective Diffusion Coefficient (m^2/s)

Site Specific Parameters (symbol notation consistent with Sanders and Stem)

C_{soil}	***10***	Soil Concentration (mg/kg)	~~SB-09-4-6~~ @ 4-6 ft depth
Co	20	Soil Concentration by Volume (g/m^3)	using 2.0 density
L	***1.22***	Depth to Contamination (m)	4 ft
$W_{vertical}$	***1.83***	Vertical Thickness of Contamination Zone (m)	Depth of unsaturated zone = from 4 to 10 ft = 6 ft
$W_{horizontal}$	***15***	Width of Contamination Zone parallel to wind (m)	ASTM 95
δ_{air}	***2***	Ambient Air Mixing Height (m)	ASTM 95
U_{air}	***2.25***	Ambient Wind Speed (m/sec)	ASTM 95
I	20	Inhalation volume (m^3/day)	20 m^3/day(ASTM)

Equation Parts a, b and c : a=x, b=y,c=z

x	1.48E+00	x=(ln(2)/Thalf)^.5 (yr^-.5)
y	2.34E-01	y=L/(2*D^{eff}^.5) (yr^.5)
z	5.86E-01	z=(L+$W_{vertical}$)/(2*D^{eff}^.5) (yr^.5)

Integration Constants

ICs	1.35E-02	ICs=(Co*$W_{horizontal}$*I*(D^{eff})^.5)/(2*a**U_{air}*δ_{air}) (grams)

Formulas

$$D^{eff} = \frac{\left(\theta_{as}^{10/3} D^{air} H + \theta_{ws}^{10/3} D_{wat}\right) / \theta_t^{\,2}}{\left(\rho_s f_{oc} K_{oc} + \theta_{ws} + \theta_{as} H\right)}$$

$$dose = \frac{CoW_{horizontal}\, I}{2xU_{air}\delta_{air}} \sqrt{De} \left\{ \left[\exp(2yx)erf\left(x\sqrt{t} + \frac{y}{\sqrt{t}}\right) + \exp(-2yx)erf\left(x\sqrt{t} - \frac{y}{\sqrt{t}}\right) \right]_{\sqrt{i1}}^{\sqrt{i2}} - \left[\exp(2zx)erf\left(x\sqrt{t} + \frac{z}{\sqrt{t}}\right) + \exp(-2zx)erf\left(x\sqrt{t} - \frac{z}{\sqrt{t}}\right) \right]_{\sqrt{i1}}^{\sqrt{i2}} \right\}$$

Integration (you need to understand the ERF function application when entering values here)

0.0001	Lower Time Limit (yr)	30	Upper Time Limit (yr)
0.01	Sq root LTL (yr^.5)	5.48	Sq root UTL (yr^.5)
2.00E+00	Term 1	2.00E+00	Term 1
-4.99E-01	Term2	4.99E-01	Term2
-5.68E+00	Term3	-5.68E+00	Term3
1.76E-01	Term4	-1.76E-01	Term4

Site dose (mg)=	**8.7**	**=**	**4.89E-07 risk**
Acceptable Dose (mg) =	**178.85**	**=**	**1.00E-05 risk**

SSTL BACK-CALCULATION ON NEXT PAGE

CALCULATIONS - Residential Receptor - Soil to Outdoor Air SSTL - Benzene

Site Specific RBCA Tier 2 Analysis, Former Shell Service Station, WIC#204-6852-1108, 15275 Washinton Avenue, San Leandro, CA.
Backcalculate to acceptable concentration= SSTL

Default Chemical and Soil Values (symbol notation from ASTM for consistency)

Source			
	Soil Specific Parameters		
ASTM 95	ρ_s	***2000***	Bulk Density(kg/m^3)
ASTM 95	θ_{as}	***0.21***	Air Content (v/v)
ASTM 95	θ_{ws}	***0.04***	Water Content (v/v)
ASTM 95	θ_t	***0.25***	Porosity (v/v)
	Chemical Specific Parameters	***benzene***	Chemical Name
ASTM 95	H	0.222	Henry's Constant
ASTM 95	Thalf	***115***	Contaminant Half Life (d)
ASTM 95	D^{air}	9.30E-06	Air Diffusion Coefficient (m^2/s)
ASTM 95	D^{wat}	1.10E-09	Water Diffusion Coefficient (m^2/s)
Cal EPA	f_{oc}	***0.01***	Organic Carbon Fraction
ASTM 95	K_{oc}	0.038	Organic Carbon Partition Coefficient (m^3/Kg) (Log Koc = 1.58)
calc, Jury	D^{eff}	2.14783E-07	Effective Diffusion Coefficient (m^2/s)

Site Specific Parameters (symbol notation consistent with Sanders and Stern)

	SSTL (California Dose Response)		
C_{soil}	**204**	Soil Concentration (mg/kg)	
Co	409	Soil Concentration by Volume (g/m^3)	using 2.0 density
L	***1.22***	Depth to Contamination (m)	4 ft
$W_{vertical}$	***1.83***	Vertical Thickness of Contamination Zone (m)	Depth of unsaturated zone = from 4 to 10 ft = 6 ft
$W_{horizontal}$	***15***	Width of Contamination Zone parallel to wind (m)	ASTM 95
δ_{air}	***2.0***	Ambient Air Mixing Height (m)	ASTM 95
U_{air}	***2.25***	Ambient Wind Speed (m/sec)	ASTM 95
I	20	Inhalation volume (m^3/day)	20 m^3/day(ASTM)

Equation Parts a, b and c : a=x, b=y,c=z

x	1.48E+00	x=(ln(2)/Thalf)^.5 (yr^.5)
y	2.34E-01	y=L/(2*D^{eff}^.5) (yr^.5)
z	5.86E-01	z=(L+W)/(2*D^{eff}^.5) (yr^.5)

Integration Constants

ICs	2.77E-01	ICs=(Co*A*I*D^{eff}^.5)/(2*a''Qb) (grams)

Formulas

$$D^{eff} = \frac{\left(\theta_{as}^{10/3} D^{air} H + \theta_{ws}^{10/3} D_{wat}\right) / \theta_t^{\,2}}{\left(\rho_s f_{oc} K_{oc} + \theta_{ws} + \theta_{as} H\right)}$$

$$dose = \frac{CoW_{horizontal}\, I}{2xU_{air}\,\delta_{air}} \sqrt{De} \left\{ \left[\exp(2yx)\, erf\left(x\sqrt{t} + \frac{y}{\sqrt{t}}\right) + \exp(-2yx)\, erf\left(x\sqrt{t} - \frac{y}{\sqrt{t}}\right) \right]_{\sqrt{t1}}^{\sqrt{t2}} - \left[\exp(2zx)\, erf\left(x\sqrt{t} + \frac{z}{\sqrt{t}}\right) + \exp(-2zx)\, erf\left(x\sqrt{t} - \frac{z}{\sqrt{t}}\right) \right]_{\sqrt{t1}}^{\sqrt{t2}} \right\}$$

Integration (you need to understand the ERF function application when entering values here)

0.0001	Lower Time Limit (yr)	30	Upper Time Limit (yr)
0.01	Sq root LTL (yr^.5)	5.48	Sq root UTL (yr^.5)
2.00E+00	Term 1	2.00E+00	Term 1
-4.99E-01	Term2	4.99E-01	Term2
-5.68E+00	Term3	-5.68E+00	Term3
1.76E-01	Term4	-1.76E-01	Term4

Site dose (mg)= 176.85 = 1.0E-05 risk
Acceptable Dose (mg) = 176.85 = 1.0E-05 risk

CALCULATIONS - Residential Receptor - Soil to Indoor Air SSTL - Benzene

Site Specific RBCA Tier 2 Analysis, Former Shell Service Station, WIC#204-6852-1108, 15275 Washinton Avenue, San Leandro, CA.
WA Implementation of Jury model, from Sanders and Stem 1994.

Default Chemical and Soil Values (symbol notation from ASTM for consistency)

Source	Soil Specific Parameters	
Site Spec. ρ_s	***2000***	Bulk Density(kg/m^3)
Site Spec. θ_{as}	***0.21***	Air Content (v/v)
Site Spec. θ_{ws}	***0.04***	Water Content (v/v)
Site Spec. θ_t	***0.25***	Porosity (v/v)

	Chemical Specific Parameters	
	benzene	Chemical Name
ASTM 94 H	0.222	Henry's Constant
ASTM 94 Thalf	***115***	Contaminant Half Life (d)
ASTM 94 D^{air}	9.30E-06	Air Diffusion Coefficient (m^2/s)
ASTM 94 D^{wat}	1.10E-09	Water Diffusion Coefficient (m^2/s)
Site Spec. f_{oc}	***0.01***	Organic Carbon Fraction
ASTM 94 K_{oc}	0.038	Organic Carbon Partition Coefficient (m^3/Kg) (Log Koc = 1.58)
calc, Jury D^{eff}	2.14783E-07	Effective Diffusion Coefficient (m^2/s)

Site Specific Parameters (symbol notation consistent with Sanders and Stem)

C_{soil}	***10***	Soil Concentration (mg/kg)	~~SG-03-4-6 @ 4-6 ft depth~~
Co	20	Soil Concentration by Volume (g/m^3)	using 2.0 density
L	***1.22***	Depth to Contamination (m)	4 ft
W	***1.83***	Thickness of Contamination Zone (m)	Depth of unsaturated zone = from 4 to 10 ft = 6 ft
A	***167***	Zone of Influence, Building Area (m^2)	Bldg 60'x30' (estimated building size)
Qb	169	Building Ventilation Rate (m^3/Hr)	ht= 200 cm, vent rate = .00014/sec (ASTM)
I	15	Inhalation volume (m^3/day)	15 m^3/day(ASTM)

Equation Parts a, b and c : a=x, b=y,c=z

x	1.48E+00	x=(ln(2)/Thalf)^.5 (yr^-.5)
y	2.34E-01	y=L/(2*D^{eff}^.5) (yr^.5)
z	5.86E-01	z=(L+W)/(2*D^{eff}^.5) (yr^.5)

Integration Constants

ICs	1.09E+01	ICs=(Co*A*I*D^{eff}^.5)/(2*a**Qb) (grams)

Formulas

$$D^{eff} = \frac{\left(\theta_{as}^{10/3} D^{air} H + \theta_{ws}^{10/3} D_{wat}\right) / \theta_t^{\,2}}{\left(\rho_s f_{oc} K_{oc} + \theta_{ws} + \theta_{as} H\right)}$$

$$dose = \frac{CoAI}{2xQb}\sqrt{De}\left\{\left[\exp(2yx)erf\left(x\sqrt{t}+\frac{y}{\sqrt{t}}\right)+\exp(-2yx)erf\left(x\sqrt{t}-\frac{y}{\sqrt{t}}\right)\right]_{\sqrt{t1}}^{\sqrt{t2}} - \left[\exp(2zx)erf\left(x\sqrt{t}+\frac{z}{\sqrt{t}}\right)+\exp(-2zx)erf\left(x\sqrt{t}-\frac{z}{\sqrt{t}}\right)\right]_{\sqrt{t1}}^{\sqrt{t2}}\right\}$$

Integration (you need to understand the ERF function application when entering values here)

1E-04 Lower Time Limit (yr)	30 Upper Time Limit (yr)
0.01 Sq root LTL (yr^.5)	5.48 Sq root UTL (yr^.5)
2.00E+00 Term 1	2.00E+00 Term 1
-4.99E-01 Term2	4.99E-01 Term2
-5.68E+00 Term3	-5.68E+00 Term3
1.76E-01 Term4	-1.76E-01 Term4

Site dose (mg)= 7030.9 = 3.9E-04 risk
Acceptable Dose (mg) = 178.85 = 1.0E-05 risk

SSTL BACK-CALCULATION ON NEXT PAGE

CALCULATIONS - Residential Receptor - Soil to Indoor Air SSTL - Benzene

Site Specific RBCA Tier 2 Analysis, Former Shell Service Station, WIC#204-6852-1108, 15275 Washinton Avenue, San Leandro, CA.
Backcalculate to acceptable concentration= SSTL

Default Chemical and Soil Values (symbol notation from ASTM for consistency)

Source			
Soil Specific Parameters			
Site Spec.	ρ_s	***2000***	Bulk Density(kg/m^3)
Site Spec.	θ_{as}	***0.21***	Air Content (v/v)
Site Spec.	θ_{ws}	***0.04***	Water Content (v/v)
Site Spec.	θ_t	***0.25***	Porosity (v/v)
Chemical Specific Parameters		benzene	Chemical Name
ASTM 94	H	0.222	Henry's Constant
S+S 94	Thalf	***115***	Contaminant Half Life (d)
ASTM 94	D^{air}	9.30E-06	Air Diffusion Coefficient (m^2/s)
ASTM 94	D^{wat}	1.10E-09	Water Diffusion Coefficient (m^2/s)
Site Spec.	f_{oc}	***0.01***	Organic Carbon Fraction
ASTM 94	K_{oc}	0.038	Organic Carbon Partition Coefficient (m^3/Kg) (Log Koc = 1.58)
calc, Jury	D^{eff}	2.14783E-07	Effective Diffusion Coefficient (m^2/s)

Site Specific Parameters (symbol notation consistent with Sanders and Stern)

	SSTL (California Dose Response)		
C_{soil}	**0.25**	Soil Concentration (mg/kg)	
Co	0.508753	Soil Concentration by Volume (g/m^3)	using 2.0 density
L	***1.22***	Depth to Contamination (m)	4 ft
W	***1.83***	Thickness of Contamination Zone (m)	Depth of unsaturated zone = from 4 to 10 ft = 6 ft
A	***167***	Zone of Influence, Building Area (m^2)	Bldg 60'x30' (estimated building size)
Qb	169	Building Ventilation Rate (m^3/Hr)	ht= 200 cm, vent rate = .00014/sec (ASTM)
I	15	Inhalation volume (m^3/day)	15 m^3/day(ASTM)

Equation Parts a, b and c : a=x, b=y,c=z

x	1.48E+00	x=(ln(2)/Thalf)^.5 (yr^-.5)
y	2.34E-01	y=L/(2*D^{eff}^.5) (yr^.5)
z	5.86E-01	z=(L+W)/(2*D^{eff}^.5) (yr^.5)

Integration Constants

ICs	2.77E-01	ICs=(Co*A*I*D^{eff}^.5)/(2*a**Qb) (grams)

Formulas

$$D^{eff} = \frac{\left(\theta_{as}^{10/3} D^{air} H + \theta_{ws}^{10/3} D_{wat}\right) / \theta_t^{\,2}}{\left(\rho_s f_{oc} K_{oc} + \theta_{ws} + \theta_{as} H\right)}$$

$$dose = \frac{CoAI}{2xQb}\sqrt{De}\left\{\left[\exp(2yx)erf\left(x\sqrt{t}+\frac{y}{\sqrt{t}}\right)+\exp(-2yx)erf\left(x\sqrt{t}-\frac{y}{\sqrt{t}}\right)\right]_{\sqrt{t1}}^{\sqrt{t2}} - \left[\exp(2zx)erf\left(x\sqrt{t}+\frac{z}{\sqrt{t}}\right)+\exp(-2zx)erf\left(x\sqrt{t}-\frac{z}{\sqrt{t}}\right)\right]_{\sqrt{t1}}^{\sqrt{t2}}\right\}$$

Integration (you need to understand the ERF function application when entering values here)

1E-04 Lower Time Limit (yr)	**30** Upper Time Limit (yr)
0.01 Sq root LTL (yr^.5)	5.48 Sq root UTL (yr^.5)
2.00E+00 Term 1	2.00E+00 Term 1
-4.99E-01 Term2	4.99E-01 Term2
-5.68E+00 Term3	-5.68E+00 Term3
1.76E-01 Term4	-1.76E-01 Term4

Site dose (mg)= 178.85 = 1.0E-05 risk
Acceptable Dose (mg) = 178.85 = 1.0E-05 risk

APPENDIX B

Parameters and calculations for evaluating exposure pathways via ingestion of benzene from leachate to ground water and ground water.

Parameters

Saturated hydraulic conductivity:	3.5E-03	cm/sec
Ground water gradient:	4.0E-02	
Effective porosity:	0.25	
Distance to hypothetical water supply well in the shallow water-bearing zone:		
	180	ft. downgradient of site.

ASTM default parameters were used for other variables.

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Former Shell Service Station Job Identification: 81-1227-72
Site Location: 15275 Washington Av., San L[illegible] Date Completed: 6/18/97
Completed By: wa

Software: GSI RBCA Spreadsheet
Version: v 1.0

NOTE: values which differ from Tier 1 default values are shown in bold italics and underlined.

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
ATc	Averaging time for carcinogens (yr)	70				
ATn	Averaging time for non-carcinogens (yr)	30	6	16	25	1
BW	Body Weight (kg)	70	15	35	70	
ED	Exposure Duration (yr)	30	6	16	25	1
EF	Exposure Frequency (days/yr)	350			250	180
EF.Derm	Exposure Frequency for dermal exposure	350			250	
IRgw	Ingestion Rate of Water (l/day)	2			1	
IRs	Ingestion Rate of Soil (mg/day)	100	200		50	100
IRadj	Adjusted soil ing. rate (mg*yr/kg*d)	1.1E+02			9.4E+01	
IRa.in	Inhalation rate indoor (m^3/day)	15			20	
IRa.out	Inhalation rate outdoor (m^3/day)	20			20	10
SA	Skin surface area (dermal) (cm^2)	5.8E+03		2.0E+03	5.8E+03	5.8E+03
SAadj	Adjusted dermal area (cm^2*yr/kg)	2.1E+03			1.7E+03	
M	Soil to Skin adherence factor	1				
AAFs	Age adjustment on soil ingestion	FALSE			FALSE	
AAFd	Age adjustment on skin surface area	FALSE			FALSE	
tox	Use EPA tox data for air (or PEL based)	TRUE				
gwMCL?	Use MCL as exposure limit in groundwater?	TRUE				

Matrix of Exposed Persons to Complete Exposure Pathways		Residential	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
Groundwater Pathways:				
GW.i	Groundwater Ingestion	TRUE	FALSE	
GW.v	Volatilization to Outdoor Air	FALSE	FALSE	
GW.b	Vapor Intrusion to Buildings	FALSE	FALSE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	FALSE	FALSE	
SS.v	Volatiles and Particulate Inhalation	FALSE	FALSE	FALSE
SS.d	Direct Ingestion and Dermal Contact	FALSE	FALSE	FALSE
S.l	Leaching to Groundwater from all Soils	TRUE	FALSE	
S.b	Intrusion to Buildings - Subsurface Soils	FALSE	FALSE	

Matrix of Receptor Distance and Location on- or off-site		Residential Distance	Residential On-Site	Commercial/Industrial Distance	Commercial/Industrial On-Site
GW	Groundwater receptor (cm)	5.5E+03	FALSE	5.5E+03	FALSE
S	Inhalation receptor (cm)		FALSE		FALSE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	***1.0E-05***	
TRc	Target Risk (class C carcinogens)	1.0E-05	
THQ	Target Hazard Quotient	1.0E+00	
Opt	Calculation Option (1, 2, or 3)	2	
Tier	RBCA Tier	2	

Surface Parameters	Definition (Units)	Residential	Commercial/Industrial Chronic	Commercial/Industrial Construction
t	Exposure duration (yr)	30	25	1
A	Contaminated soil area (cm^2)	2.2E+06		1.0E+06
W	Length of affected soil parallel to wind (cm)	1.5E+03		1.0E+03
W.gw	Length of affected soil parallel to groundwater (c	1.5E+03		
Uair	Ambient air velocity in mixing zone (cm/s)	2.3E+02		
delta	Air mixing zone height (cm)	2.0E+02		
Lss	Definition of surficial soils (cm)	1.0E+02		
Pe	Particulate areal emission rate (g/cm^2/s)	2.2E-10		

Groundwater	Definition (Units)	Value
delta.gw	Groundwater mixing zone depth (cm)	***2.0E+02***
I	Groundwater infiltration rate (cm/yr)	***3.0E+01***
Ugw	Groundwater Darcy velocity (cm/yr)	***4.4E+03***
Ugw.tr	Groundwater Transport velocity (cm/yr)	***1.8E+04***
Ks	Saturated Hydraulic Conductivity(cm/s)	3.5E-03
grad	Groundwater Gradient (cm/cm)	4.0E-02
Sw	Width of groundwater source zone (cm)	1.8E+03
Sd	Depth of groundwater source zone (cm)	3.0E+02
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	TRUE
phi.eff	Effective Porosity in Water-Bearing Unit	2.5E-01
foc.sat	Fraction organic carbon in water-bearing unit	1.0E-03

Soil	Definition (Units)	Value		
hc	Capillary zone thickness (cm)	5.0E+00		
hv	Vadose zone thickness (cm)	3.0E+02		
rho	Soil density (g/cm^3)	***2***		
foc	Fraction of organic carbon in vadose zone	0.01		
phi	Soil porosity in vadose zone	***0.25***		
Lgw	Depth to groundwater (cm)	3.0E+02		
Ls	Depth to top of affected soil (cm)	1.0E+02		
Lsubs	Thickness of affected subsurface soils (cm)	2.0E+02		
pH	Soil/groundwater pH	6.5		
		capillary	vadose	foundation
phi.w	Volumetric water content	0.342	***0.04***	0.12
phi.a	Volumetric air content	0.038	***0.21***	0.26

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)		
ER	Building air exchange rate (s^-1)		
Lcrk	Foundation crack thickness (cm)		
eta	Foundation crack fraction		

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)	5.5E+02	
ay	Transverse dispersion coefficient (cm)	1.8E+02	
az	Vertical dispersion coefficient (cm)	2.7E+01	
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

RBCA SITE ASSESSMENT

Tier 2 Worksheet 9.3

Site Name: Former Shell Service Station
Site Location: 15275 Washington Av., San Leandro, CA

Completed By: wa
Date Completed: 6/18/1997

GROUNDWATER SSTL VALUES

Target Risk (Class A & B) 1.0E-5
Target Risk (Class C) 1.0E-5
Target Hazard Quotient 1.0E+0

■ MCL exposure limit?
☐ PEL exposure limit?

Calculation Option: 2

SSTL Results For Complete Exposure Pathways ("x" if Complete)

CONSTITUENTS OF CONCERN		Representative Concentration	X	Groundwater Ingestion			Groundwater Volatilization to Indoor Air		Groundwater Volatilization to Outdoor Air		Applicable SSTL	Exceeded ?	Required CRF
CAS No.	Name	(mg/L)		Residential: 180 feet	Commercial: 180 feet	Regulatory(MCL): 180 feet	Residential: (on-site)	Commercial: (on-site)	Residential (on-site)	Commercial: (on-site)	(mg/L	"■" If yes	Only if "yes" left
71-43-2	Benzene	1.4E+0		1.7E+1	NA	2.0E+0	NA	NA	NA	NA	2.0E+0	☐	<1

Software: GSI RBCA Spreadsheet
Version: v 1.0

Serial: G-201-BPX-156

RBCA SITE ASSESSMENT

Tier 2 Worksheet 9.2

Site Name: Former Shell Service Station
Site Location: 15275 Washington Av., San Leandro, CA

Completed By: wa
Date Completed: 6/18/1997

SUBSURFACE SOIL SSTL VALUES (> 3 FT BGS)

Target Risk (Class A & B) 1.0E-5
Target Risk (Class C) 1.0E-5
Target Hazard Quotient 1.0E+0

■ MCL exposure limit?
☐ PEL exposure limit?

Calculation Option: 2

SSTL Results For Complete Exposure Pathways ("x" if Complete)

CONSTITUENTS OF CONCERN		Representative Concentration	X Soil Leaching to Groundwater			Soil Volatilization to Indoor Air		Soil Volatilization to Outdoor Air		Applicable SSTL	Exceeded ?	Required CRF
CAS No.	Name	(mg/kg)	Residential: 180 feet	Commercial: 180 feet	Regulatory(MCL): 180 feet	Residential: (on-site)	Commercial: (on-site)	Residential: (on-site)	Commercial: (on-site)	(mg/kg)	"■" If yes	Only if "yes" left
71-43-2	Benzene	1.0E+1	1.5E+2	NA	1.7E+1	NA	NA	NA	NA	1.7E+1	☐	<1

Software: GSI RBCA Spreadsheet
Version: v 1.0

Serial: G-201-BPX-156

APPENDIX C

Well Screen Intervals

Former Shell Service Station
15275 Washington Avenue
San Leandro, California
WIC #204-6852-1108

Well	Screen Interval	Comments
S-1	4.0 - 19.0	
S-2	4.0 - 18.5	Destroyed during UST removal
S-3	4.0 - 16.5	
S-4	4.0 - 18.0	Destroyed during UST removal
S-5	3.5 - 18.5	
S-6	3.0 - 24.5	
S-7	3.0 - 24.5	
S-8	3.0 - 24.5	
S-9	3.0 - 18.0	
S-10	3.0 - 18.0	
S-11	3.5 - 25.0	
S-12	3.0 - 24.5	
S-13	4.0 - 24.0	
S-14	4.0 - 24.0	
S-15	4.0 - 24.0	
S-16	4.0 - 24.0	
S-17	4.0 - 24.0	
S-18	4.0 - 18.0	
SR-1	6.5 - 21.5	