RO#0000224

TOXICHEM
Management
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Environmental & Occupational Health Services

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Exposure Assessment/Estimation
Quantitative Risk Assessments
Industrial Hygiene
Regulatory Compliance Programs
Real Property Environmental Assessments
Compliance Audits
Air Pollution Dispersion Modeling
Hazardous Waste Management
Air Sampling and Analysis

[redacted]

Mr. Amir K. Gholami, REHS
Alameda County Environmental Health Services
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

~~LGMEM~~
EM@BROWN-SULLIVAN.COM
ELSIE MATSUNO

Re: Site Specific Risk Assessment
Beck Roofing Facility
21123 Meekland Avenue, Hayward, CA

DANH@TOXICHEM.COM

Dear Mr. Gholami:

The attached report, prepared by Toxichem Management Systems, Inc. (TOXICHEM), presents a site specific risk assessment for the above referenced property. The objective of the risk assessment was to quantify potential human health risks and to evaluate the possibility of site closure pursuant to the Alameda County Health Care Services letter directive dated April 12, 2000.

The results of the risk assessment justify site closure. Using conservative methods (ASTM) and assumptions, site risks were found to be below the acceptable range and were estimated to fall between 7×10^{-7} to 1.3×10^{-6}. In addition to ASTM modeling, US EPA methods were also used to predict risks associated with the migration of vapor phase contaminants into occupied spaces. The results of this modeling compared favorably with the ASTM results and produced lower risk estimates in the range of 5×10^{-7} to 9.7×10^{-7}.

Based on the results, we recommend that your office close the site with no further action required. I may be reached at (408) 292- 3266 with questions concerning our report.

Sincerely,

Daniel W. Hernandez MPH, CIH, REA
President

reviewed and find consistent. residual concentrations are below acceptable risk levels.
Ravi 11/28/00

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Site Specific Risk Assessment
Beck Roofing Facility
21123 Meekland Avenue
Hayward, CA

Prepared For:
Brown and Sullivan, LLP
2320 Blanding Avenue, Suite 201
Alameda, CA 94501

Prepared by:

Toxichem Management Systems, Inc.
1461 Newport Avenue
San Jose, CA 95125

Daniel W. Hernandez, MPH, CIH, REA

May 09, 2000

1.0 EXECUTIVE SUMMARY

This report presents a human health risk appraisal (HRA) for the property located at 21123 Meekland Avenue in Hayward, California. The objective of this appraisal was to evaluate the potential human health risks posed by the petroleum hydrocarbon compounds detected in soils and groundwater at the subject property. The chemicals evaluated in this assessment included the gasoline range petroleum hydrocarbons benzene, toluene, ethyl benzene, and xylenes.

Conservative assumptions and methods were used in the HRA to develop estimates of carcinogenic and non-carcinogenic risks for the chemicals of concern. Cancer risk findings are compared to a range of acceptable risk levels, 1×10^{-6} to 1×10^{-4}, cited in the EPA National Contingency Plan (NCP) in order to place the risk estimates in perspective. A 1×10^{-6} cancer risk represents a one in one million additional probability that an individual may develop cancer over a 70-year lifetime as a result of the exposure conditions evaluated.

Unlike carcinogenic effects, noncancer effects are not expressed as a probability. Instead, these effects are expressed as the ratio (HI) of the estimated exposure over a specified time period to a reference dose (RfD) derived for a similar exposure period. Exposures resulting in a HI that are ≤ 1 are very unlikely to result in noncancer adverse health effects.

The principal findings of the HRA follow:

Commercial Use Scenario— For the current commercial use exposure scenario, the estimated excess cancer risks was estimated at 7 x 10^{-7} to 1.3 x 10^{-6}, which is within the US EPA's acceptable risk range cited in the NCP. Non-carcinogenic risks, expressed as a HI, were estimated to be less than unity.

Cancer risk (Compare to 10^{-5} for county

~~[illegible]~~ if HI ≤ 1 No noncancer adverse health effect

Noncancer risk (Compare Estimating exposure over specified time to RfD calculated ~~derived~~ for a similar exposure period

(Calculate RfD for specific time)

(Estimate exposure for specific time)

Now compare

2.0 INTRODUCTION

The objective of this human health risk appraisal (HRA) is to evaluate the potential health risks posed by petroleum hydrocarbon chemical constituents found in soils and groundwater including: benzene, toluene, ethyl benzene, and xylenes. Within this HRA report, chemicals of potential concern are identified for relevant receptors, exposure to potential chemicals of concern are assessed, and the risks associated with potential exposures to these chemicals are quantified. The remaining sections of the HRA are organized according to steps common to most risk assessments including, identification of chemicals of potential concern, exposure assessment, and risk characterization.

3.0 METHODS USED

This section describes the calculation of chemical specific human health risks for chemicals detected in Site soils. Calculation of the health risks incorporates exposure assumptions, exposure point estimation, and toxicity values for each chemical of interest, for all pathways of concern. The primary guidance used in the development of this HRA was taken from Risk Assessment Guidance (RAGS) (U.S. EPA 1989a), Department of Toxic Substances Control (DTSC) supplemental guidance (CALEPA 1992), and Risk-Based Corrective Action (RBCA) applied at petroleum release sites (ASTM 1994). The chemicals of concern, exposure scenarios, exposure assumptions, methods of calculation, and parameter values used are described below.

3.1 CHEMICALS OF CONCERN

Previous environmental investigations have shown that Site soils and groundwater have been impacted by gasoline range hydrocarbons including benzene, toluene, ethyl benzene, and xylenes (BTEX) and total petroleum hydrocarbons as gasoline (TPHg). This assessment incorporates ASTM methods i.e., BTEX target compounds to evaluate the potential risks associated with exposure to fuel related hydrocarbons.

3.2 EXPOSURE ASSESSMENT

3.2.1 EXPOSURE SETTING OVERVIEW

Located at 2113 Meekland Avenue, in Hayward, California, the subject property is approximately 3/4 acre in size and is currently occupied by a 4600 square foot commercial building consisting of office and warehouse space. Beck Roofing, a commercial roofing business currently occupies the site. During May of 1991, a 1000 gallon underground gasoline storage tank was removed from the site. Several stages of soil and groundwater investigation and remediation followed the removal of the tank. According to information developed by Lush Geosciences, two excavations have been completed onsite. The initial excavation of impacted soil about the former tank measured approximately 20 ft x 20 ft and extended to a maximum depth of 24 ft below ground surface (bgs). A second excavation, measuring approximately 30 ft by 30 ft and roughly centered over the former tank location was excavated during 1994 to an average depth of 31 ft.

According to site investigators, soil and groundwater in the vicinity of the former underground fuel tank are impacted by gasoline range hydrocarbons. Based on site investigations conducted by others, the impacted area is located at the central portion of the Site, south of the existing structure. The horizontal extent of affected soil and groundwater is approximated at 6400 square feet in size.

Site stratigraphy is described in the numerous boring logs prepared during various site investigations. Based on Toxichem's review of 15 boring logs prepared by a consulting engineering geologist, soils underlying the site the appear to be characterized as moist dusky yellow silty clays from near surface to approximately 5 feet bgs. Moist yellow brown sandy clays with 35% very fine sand, were encountered between approximately 5 ft bgs to 10-13 feet bgs. Below 10 ft bgs, fine grained, pale yellow brown silty sands were encountered to approximately 19 to 20ft bgs. Below 20 ft bgs, clay was primarily encountered. The clay unit was described as clay; silty, low to medium plasticity, moist, and yellow brown to olive gray. Site related boring logs are presented in Appendix B of this report.

Depth to groundwater onsite has decreased from 31 ft bgs during 1992 to approximately 25 ft bgs during 1999. Figure 1 shows a depth to groundwater trend line that was derived from available depth to groundwater measurements collected at monitoring wells MW-1 through MW-3. Information provided to Toxichem indicates that the groundwater flow direction is reported as west to southwest, and that the aquifer is partially confined.

With respect to the vertical extent of soil impact, the data provided to Toxichem indicates that the petroleum hydrocarbons are confined to subsurface soils between 18 ft to 30 ft bgs. Since current measurements indicate that groundwater is approximately 25 feet bgs, site contaminants are confined to the saturated and semi-saturated zones.

Table 1 below summarizes analytical data within the area of concern from soil samples retained from the 18 to 30 ft depth horizon. In addition, the benzene data includes analytical results from sidewall samples collect during the final excavation. The area of soil impact is defined by MW-1 through MW-3, B-1, B-2, and G1 through G3. The locations of these borings are depicted in Heilshorn Figures 2 and 5 which are attached to this report.

With respect to groundwater impact, Table 2 below summarizes analytical data provided by Heilshorn Environmental Engineering.

Table 1. Soil Analytical Data

Chemical	Frequency of Detection	Range (mg/kg)	Location of the Max.	Average (mg/kg)	UCL (mg/kg)
benzene	20/30	<0.005 - 5.7	SW-7	0.347	0.668
toluene	16/20	<0.005 - 1.2	B-2	0.140	0.257
ethyl benzene	13/20	<0.005 - 1.0	G-2	0.107	0.194
xylenes	16/20	<0.005 - 2.0	G-2	0.295	0.515

Table notes: UCLs (95% upper bound estimate of the mean) calculated with censored data (non - detects) assumes the chemical is present at ½ the detection limit.

Table 2. Ground Water Analytical Data

Chemical	Frequency of Detection	Range (ug/l)	Location of the Max.	Average (ug/l)	UCL (ug/l)
benzene	18/28	<0.30 - 242	MW-3	25.5	47
toluene	18/28	<0.30 - 36	MW-3	4.1	8.3
ethyl benzene	16/28	<0.30 - 93	MW-3	7.8	21
xylenes	19/28	<0.30 - 116	MW-3	10.5	23.4

Table notes: Data from January 1996 through January 1999. UCLs (95% upper bound estimate of the mean) calculated with censored data (non - detects) assumes the chemical is present at ½ the detection limit.

3.2.2 Exposure Scenarios and Hypothetical Receptors

An exposure pathway is the course a chemical takes from a source to an exposed organism. Exposure pathways include the following four elements: (1) a source; (2) a mechanism for release, retention, or transport of a chemical in a given medium (e.g., air, water, soil); (3) a point of contact with the affected medium; and (4) an exposure route at the point of contact (e.g., ingestion, inhalation). If any of these elements is missing, the pathway is considered "incomplete" (i.e., it does not present a means of exposure).

This report addresses the potential risks associated with contaminant volatilization from impacted soil and groundwater. There are no other complete exposure pathways.

For selected chemicals, this assessment will address the following:

- For an onsite commercial receptor, inhalation of chemicals volatilizing from Site soils and groundwater and migrating into occupied spaces, and ambient inhalation exposure to chemicals volatilizing from Site soils and groundwater.

3.2.3 Exposure Assumptions

Exposure estimates (intakes or administered doses) of Site-related chemicals are defined as the mass of a substance taken into the body, per unit of body weight, per unit of time. Methods used to calculate chemical intakes for chronic exposure, or chronic daily intakes (CDIs), are described in Risk Assessment Guidance (RAGS) (U.S. EPA 1989a) and Department of Toxic Substances Control (DTSC) supplemental guidance (CALEPA 1992). Estimates of chemical intake are based on exposure concentrations at the exposure point (exposure point concentrations) and on the estimated magnitude of exposure to affected media.

For this assessment, DTSC (1992) and U.S. EPA (1989a; 1991a) guidance were the primary sources used for exposure quantification. Exposure factors (body weights, breathing rates, etc.) used in the exposure algorithms were also taken from DTSC (1992) and U.S. EPA (1994). For all exposure pathways, a default adult body weight of 70 kg and default exposure duration of 25 years is used.

The averaging time used to determine the chronic daily intake (CDI) of a chemical is dependent on the type of toxic effect being assessed. For assessing carcinogenic effects, CDIs are calculated by prorating the exposure period cumulative dose over a lifetime; the average lifespan is assumed to be 70 years (U.S. EPA 1991a). For assessing noncancer effects, CDIs are calculated by averaging intakes only over the period of exposure.

The following subsections describe exposure parameters and assumptions used to calculate CDIs for each exposure pathway. The exposure algorithms used in this assessment are presented in Appendix A of this document.

3.2.3.1 INHALATION PATHWAY ASSUMPTIONS

Onsite receptors are assumed to be exposed to volatile chemicals volatilizing from subsurface soils and groundwater. Table A1 (Appendix A) shows the exposure algorithm for potential exposures to chemicals in indoor and/or ambient air. An inhalation rate of 20 m^3/day is assumed for adults, and the exposure frequency for this pathway is 250 days per year for an exposure duration of 25 years.

3.2.3.2 SUMMARY OF EXPOSURE VARIABLES

Table 5 below summarizes key exposure variables for onsite receptors.

Table 3 . Exposure Variables

	Breathing Rate (m^3/d) ambient	Exposure Duration (yrs)	Pathways
Onsite: **Resident**	20 adult	25 adult	soil volatilization, groundwater volatilization

Table notes: Units: (m^3/d)=cubic meters per day, yrs = years.

3.2.4 EXPOSURE POINT ESTIMATION

Exposure point concentrations (EPCs) are the concentrations of chemicals at the point of exposure. As a conservative measure, for the inhalation pathway, vapor concentrations are calculated from the 95% UCL soil and groundwater concentrations.

3.2.4.1 VOLATILIZATION FACTORS

Volatilization factors (VF) are used to address the soil to air pathway and the groundwater to air pathway for volatile chemicals. These factors relate soil chemical concentrations to air chemical concentrations that may be inhaled onsite.The mathematical expressions for VFs are presented in Appendix A of this document. This section describes volatilization factors and underlying assumptions in their use.

VF Assumptions

Volatilization factor calculations assume (1) chemical concentrations in Site soil and groundwater over time remain constant, (2) isotropic soils, and (3) linear equilibrium partitioning within the soil matrix between sorbed, dissolved and vapor phases. The calculations incorporate site specific source parameters, diffusion paths, and default building parameters.

Volatilization from Subsurface Soils and Groundwater to Indoor Air

To estimate chemical volatilization from subsurface soils and groundwater with vapor migration into indoor air spaces, the subsurface groundwater volatilization model from ASTM is used with modifications for soil bound contaminants. A modification is required since site contaminants are primarily confined to the saturated and semi saturated zones. In the saturated zone, the soil bound chemical is not available to partition to the vapor phase since there are no air filled pore spaces with in the soil matrix (the chemical is available to dissolve in the soil moisture). However, within the semi-saturated zone (capillary fringe) the chemical is available to partition into the vapor phase within the air filled pore spaces of the soil. Transport (migration) to surface level occupied spaces requires that the chemical diffuse through the capillary fringe, vadose zone, and through the foundation of the building.

The ASTM groundwater volatilization factor (VFgw) for the groundwater to indoor and ambient air exposure pathways estimates vapor flux by incorporating the capillary fringe, the vadose zone, and the building foundation pad to the diffusion path of the chemical. Within this VF expression, there is a partitioning model which, based on a chemical's groundwater concentration (dissolved phase), predicts the vapor phase concentration within the soil pore space. Similarly, in the ASTM VF for subsurface soil volatilization, there is a partitioning model which, based on a chemical's soil concentration (sorbed phase), predicts the vapor phase concentration within the soil pore space. This partitioning expression is substituted into the VFgw to evaluate soil volatilization.

For ambient air exposures (groundwater volatilization), the foundation pad (and building) are removed from the path of diffusion, and areal extent and ambient ventilation parameters are incorporated into the model.

Volatilization from Subsurface Soils to Ambient Air

To address the soil to ambient air pathway for volatile chemicals, the VF_s from U.S. EPA 1996 PRGs is used to risks. The VF_s equation is broken into two separate models: an emission model to estimate emissions of the chemical from the soil, and a dispersion model to simulate the dispersion of the chemical in the atmosphere. The emission term used in the VF_s is based on Jury 1984 and describes the vapor phase diffusion of the chemicals to the soil surface to replace that lost by volatilization to the atmosphere. The major assumptions of this model include: (1) chemicals are uniformly incorporated in the soils to an infinite depth, (2) isotropic soils, (3) no water flux through the soil, (4) bare, uncovered soils, and (5) linear equilibrium partitioning within the soil matrix between sorbed, dissolved and vapor phases. The basic principle of the VF_s model is applicable only if the soil chemical concentration is at or below soil saturation.

The dispersion term within the VF is derived from a modeling exercise by U.S. EPA using meteorological data from 29 locations across the United States. The dispersion model used by the U.S. EPA is the AREA-ST, an updated version of the Office of Air Quality Planning and Standards, Industrial Source Complex Model, ISC2. U.S. EPA has selected Los Angeles as the 90th percentile data set for volatiles and a default source size of 0.5 acres was chosen for the PRG calculations. According to U.S. EPA Region 9, this is consistent with the default exposure area over which Region 9 typically averages chemical concentrations in soils (U.S. EPA 1996 PRGs).

3.2.5 SOIL AND CHEMICAL PARAMETERS

This section describes key data used for the calculation process, and identifies physico-chemical parameters and toxicity constants used.

3.2.5.1 PHYSICAL PARAMETERS FOR SOILS

The key factors relative to vapor transport through the capillary fringe and vadose zone include thickness of the fringe and the moisture and density profile of the soils within the path of diffusion. With respect to vapor transport through the capillary fringe, the ASTM expression assumes a fringe thickness of 5 cm, which is characteristic of a porous media.

The capillary fringe is known to retard vapor mass transport (EPA1992, McCarthy, RWQCB 1997), and the ASTM VF predicts an exponential decay of vapor concentration above the fringe with increasing fringe thickness. Site specifically, the fringe thickness is unknown, however, it can be assumed that it is greater than 5 feet in thickness because of the clay soils encountered below 20 ft bgs. For the soil volatilization pathway, this HRA assumes a capillary fringe thickness of 2.5 feet, and a vadose zone path length of 20 feet. For the groundwater volatilization pathway, this HRA assumes a capillary fringe thickness of 3.0 feet, and a vadose zone path length of 22 feet, and the depth to groundwater at 25 feet below ground surface.

Vapor transport through the vadose zone is most sensitive to air filled porosity, thus vapor flux increases exponentially with incremental increases in air filled porosity. ASTM uses default factors characteristic of porous media including 0.38, 0.12, and 0.26 for volumetric total porosity, moisture content, and air filled porosity respectively. Bay Area soils are typically less porous and generally consist of finer grained media. Table 4 below summarizes measured values for moisture content, total porosity and organic content for six Bay Area locations. Based on Bay Area conditions, this assessment assigns representative vadose zone soil parameters and ASTM default capillary fringe parameters for the fate and transport modeling.

Table 4. Soil Parameters

Location	Moisture Content cm^3/cm^3	Organic Carbon	Total Porosity cm^3/cm^3	Air filled Porosity cm^3/cm^3	Particle Bulk Density
ASTM Default	.12	.01	.38	.26	2.65

Location	Moisture Content cm^3/cm^3	Organic Carbon	Total Porosity cm^3/cm^3	Air filled Porosity cm^3/cm^3	Particle Bulk Density
Industrial Road[1] San Carlos	.353	.023	.373	.02 (calculated)	2.71g/cm^3 (calculated)
Velcon Filters[2] Junction Ave San Jose	.322	.029	.391	.069 (calculated)	2.71g/cm^3 (calculated)
202 Lewis Road San Jose[3]	.31	.02	.364	.052 (calculated)	2.69g/cm^3 (calculated)
300 Broadway Oakland[4]	0.307	0.016	0.354	0.047 (calculated)	2.71g/cm^3 (calculated)
3601 El Camino Real Palo Alto[5]	0.336	.001	0.389	0.053 (calculated)	2.77 g/cm3
2122 Davis Street San Leandro[6]	0.375	0.02	0.407	0.032 (calculated)	2.7g/cm3
Assumed Site Parameters	0.32	.01	0.38	0.06	2.7 g/cm3

Table notes: 1. Average of 4 samples between 3- 6.5ft. BGS 2. Average of 15 vadose zone samples. 3. One sample. 4. Average of 3 samples collected at 5 ft bg. 5. Average of 4 vadose zone samples collected between 5.5 to 11.0 ft bgs. 6. Average of 3 samples collected within the capillary fringe.

3.2.5.2 PHYSICO-CHEMICAL PARAMETERS

The Physico-chemical parameters used in this assessment and the sources of the information are summarized in the Table 5 below.

Table 5. Physico-Chemical Parameters

	Henry's Constant Dimensionless	Koc (cm^3/g)	Diffusivity air (cm^2/s)	Diffusivity Water (cm^2/s)
benzene	.22	58.9	.087	9.8E-06
toluene	.27	260	7.8E-02	8.6E-06
ethyl benzene	.32	220	7.5E-02	7.8E-06
xylenes	.29	240	7E-02	8.4E-06

Table notes: Henry's Constant, Koc, and diffusivities are from U.S.EPA 1996 PRGs unless otherwise specified below. Diffusivities for benzene are from U.S. EPA 1996b. Koc for benzene is from U.S. EPA 1998 and 1994.

3.2.5.3 TOXICITY PARAMETERS

EPA-derived toxicity values used in risk assessments are termed slope factors and reference doses (RfDs). Slope factors are used to estimate the incremental lifetime risk of developing cancer corresponding to CDIs calculated in the exposure assessment. The potential for noncancer health effects is evaluated by comparing estimated daily intakes with reference doses (RfDs) or reference concentrations (RfCs), which represent daily intakes at which no adverse effects are expected to occur over a lifetime of exposure. Both slope factors and RfDs are specific to the route of exposure [e.g., inhalation, or ingestion (oral) exposure]. For assessing noncarcinogenic effects associated with inhalation exposures, EPA has begun issuing reference concentrations (RfCs) that represent exposure concentrations at which no adverse effects are expected to occur. Where the California cancer potency factors are more stringent than those derived by EPA, the California values are used in the HRA to estimate potential cancer risks from exposure to chemicals at the site.

The toxicity parameters (slope factors and reference doses) used in the risk calculations are summarized in Table 6 below.

Table 6. Toxicity Parameters

	SFo per mg/kg-day	**Sfi per mg/kg-day**	**RFDi mg/kg-day**	**RFDo mg/kg-day**
benzene	0.1c	0.1c		
toluene	NA	NA	0.11	0.2
ethyl benzene	NA	NA	0.29	0.1
xylenes	NA	NA	0.2	2

Table notes: c = California Value. All other values from U.S. EPA 1996 PRGs. NA =not applicable

4.0 RESULTS

Cancer risks for a single carcinogen are calculated by multiplying the carcinogenic CDI of the chemical by its slope factor. A 1×10^{-6} cancer risk represents a one in one million additional probability that an individual may develop cancer over a 70-year lifetime as a result of the exposure conditions evaluated. For the residential exposure scenario total cancer risks are summed to determine the total cancer risk for the population of concern.

Unlike carcinogenic effects, noncancer effects are not expressed as a probability. Instead, these effects are expressed as the ratio (HI) of the estimated exposure over a specified time period to the RfD derived for a similar exposure period (e.g., CDI:chronic RfD). This ratio is termed a hazard quotient. If the CDI exceeds the RfD (i.e., hazard quotient > 1), there may be concern for noncancer adverse health effects. Exposures resulting in a hazard quotient ≤ 1 are very unlikely to result in noncancer adverse health effects. Hazard quotients for individual chemicals are conservatively summed for each exposure pathway to determine a hazard index. Calculation results and risk presentation tables are provided in Appendix A. .

4.1 CALCULATED RISKS

Exposure point concentrations were used to calculate the chronic daily intake (dose). The resultant dose, for the exposure conditions examined were then multiplied by a carcinogenic potency factor or compared to a reference dose for non-carcinogenic risks. Table 7 below summarizes the estimated risk posed by the site chemicals.

Table 7. Risk Summary - Commercial Exposure Scenario

Source	Average Carcinogenic Risks	Maximum Carcinogenic Risks	Maximum Non-carcinogenic Risks
Soil to Indoor Air	7E-07	1.3E-06	<<<1
Soil to Ambient Air	NC	1.4E-07	<<<1
Groundwater to Indoor Air	NC	6.9E-08	<<<1
Groundwater to Ambient Air	NC	1.3E-10	<<<1

Table notes: Average risks are calculated using average media concentrations, maximum risks are calculated using the 95% UCL. NC = not calculated.

4.2 CONCLUSIONS

Soil Volatilization

Using the conservative methods and assumptions described in this report, the estimated maximum carcinogenic risks due to the inhalation of benzene volatilizing from subsurface soil and migrating to indoor air (assuming a structure is placed directly over impacted soil) is estimated at 1.3E-06. Non-carcinogenic risks, expressed as a hazard quotient, are less than unity. In addition, the ambient inhalation risks for this pathway are estimated at 1.4E-07. The estimated risks are well within the acceptable range.

Since the ASTM Groundwater volatilization method was modified to account for site specific conditions, an alternative model was selected to provide a point of comparison. The Johnson and Ettinger Model For Subsurface Vapor Intrusion Into Buildings (US EPA Version 2 1998) was used in screening mode to evaluate soil volatilization. The results compared favorably and are summarized in the Table below. Modeling output is also provided in Appendix A.

Table 8. Johnson and Ettinger Model For Subsurface Vapor Intrusion Into Buildings

Source	Average Carcinogenic Risks	Maximum Carcinogenic Risks
Soil to Indoor Air	5.0E-07	9.67E-07

Groundwater Volatilization
With respect to groundwater volatilization, the ASTM methods for evaluating indoor and ambient exposure pathways, yielded risk estimates far below levels of concern.

Use of Conservative Asumptions and Methods

For both soil and groundwater contaminants, this assessment has incorporated conservative assumptions and parameters into the estimation of risk. The most sensitive parameters for inhalation exposure point estimates include soil concentration and depth to contamination, soil moisture content (air filled porosity), total organic carbon in the soils, assumed aerial extent of foundation cracks, and the assumption of an infinite source of contamination.

The source terms used in this assessment included mean and upper bound estimates of mean soil concentrations for chemicals confined in the soils between 18 and 30 feet below ground surface. This conservative treatment of data likely results in the overestimation of risk for several reasons. First, the hydrocarbon compounds trapped in the saturated zone are unavailable for volatilization until dissolved in the soil moisture. For chemicals in the capillary fringe, there is limited air filled porosity for volatilization, and the capillary fringe retards mass transport. For fine grained media such as fine silt, the capillary rise is expected to be 200 + centimeters (Fetter 1993). We note that clays are characteristically of a smaller grain size than that of silt. Therefore, the thickness of the fringe is expected to be substantial. The 95%UCL concentration of benzene at the 20 ft depth horizon (arguably most representative of current site conditions) is 100 ug/kg. This assessment used a 95%UCL concentration of 668 ug/kg. Finally, the soil data set used to calculate vapor flux included side wall samples (1994) which skewed the data set. One side wall soil sample (SW-7) from the 1994 excavation, contained 5.7 mg/kg of benzene. Since the excavation resulted in primary source removal with clean fill replacement, the side wall data points should not be considered as representative of site conditions. Removing SW-7 would result in a reduction of risk by a factor of 3.

With respect to soil properties, porosity parameters based on Bay Area measurements were used. Use of standard default soil properties that are characteristic of dry permeable soils would increase risk estimates. However, the porosity parameters used are consistent with Bay Area clayey soils. In additon, as a conservative measure, the ASTM default parameter for organic carbon content was used in the assessment. Vapor partitioning is sensitive to organic carbon content. Higher organic content reduces vapor concentrations thus reduces risk. The ASTM default parameter would be considered conservative.

ASTM conservatively assumes the aerial extent of cracks (AEC) in a foundation is 1% of the foundation area. This parameter determines the resistance of mass transport through the foundation slab, thus the exposure point concentration within the occupied structure. As a point of comparison, the Regional Water Quality Board (RWQCB) has routinely approved risk based closures where assessments assume AEC factors of 0.01% for new construction.

Finally, a conservative constant source volatilization model was used for the assessment. The ASTM model assumes that no source depletion occurs over the 25 year exposure period. This is an extremely conservative assumption since mass loss of onsite chemicals will occur due to volatilization and biodegradation.

LIMITATIONS

This report was prepared with generally accepted standards of environmental practice in California at the time of its preparation. Evaluation of the chemical conditions of the site media for purposes of this assessment is made from a limited number of observations. There are no representations, warranties, or guaranties that the chemical information relied upon in the preparation of this report, are a complete and accurate representation of the site conditions.

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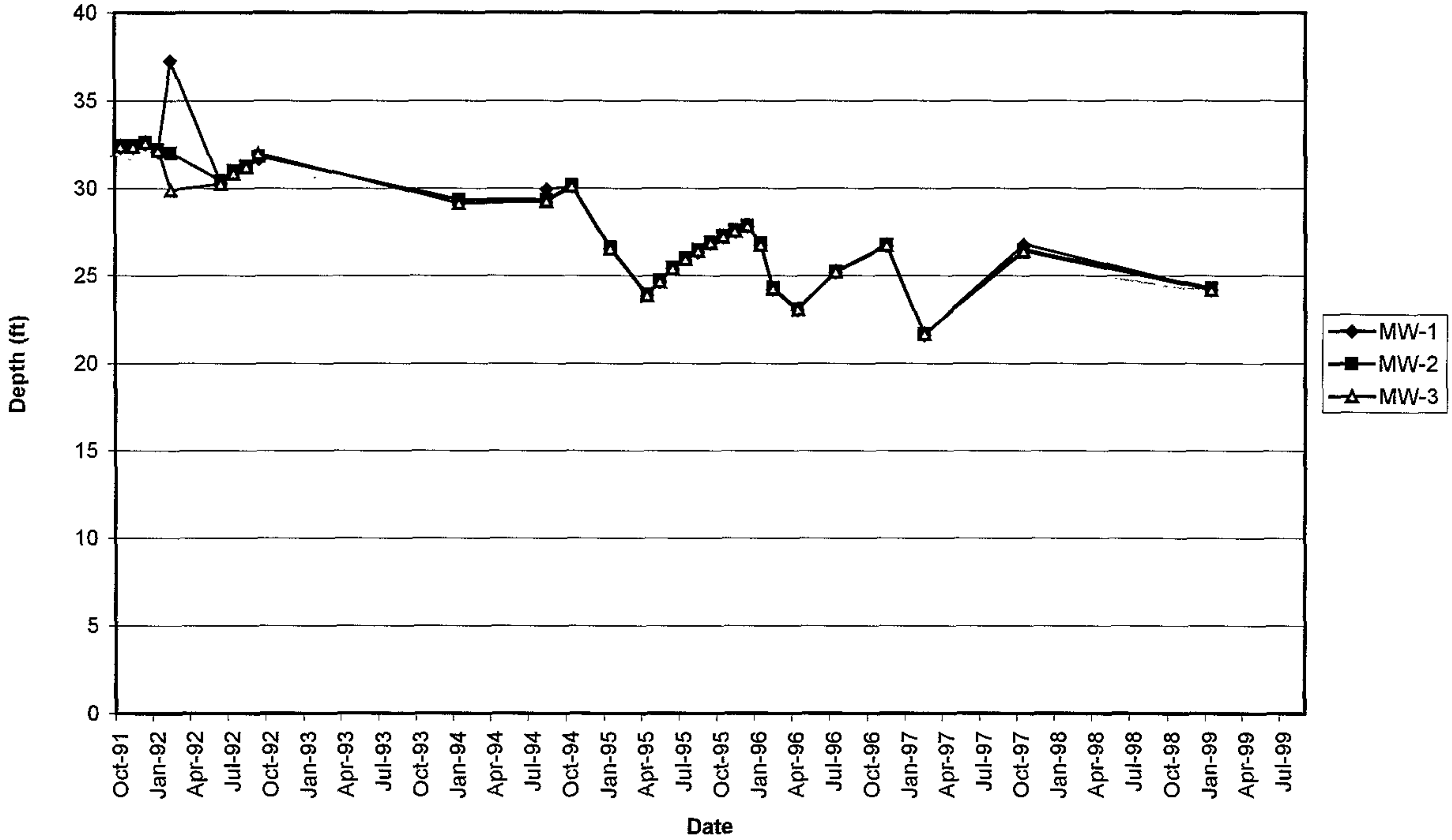
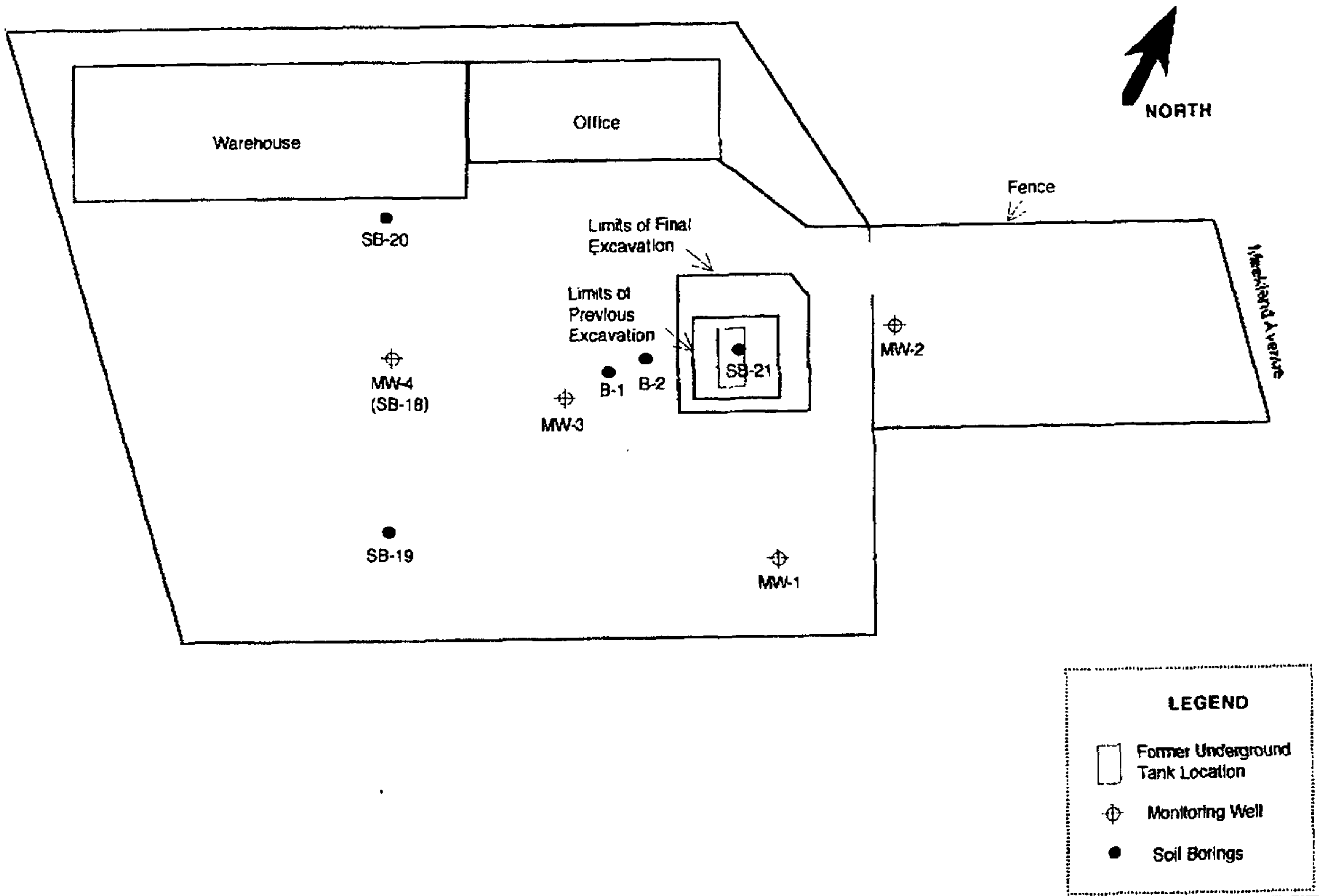
Figure 1
Depth to Groundwater





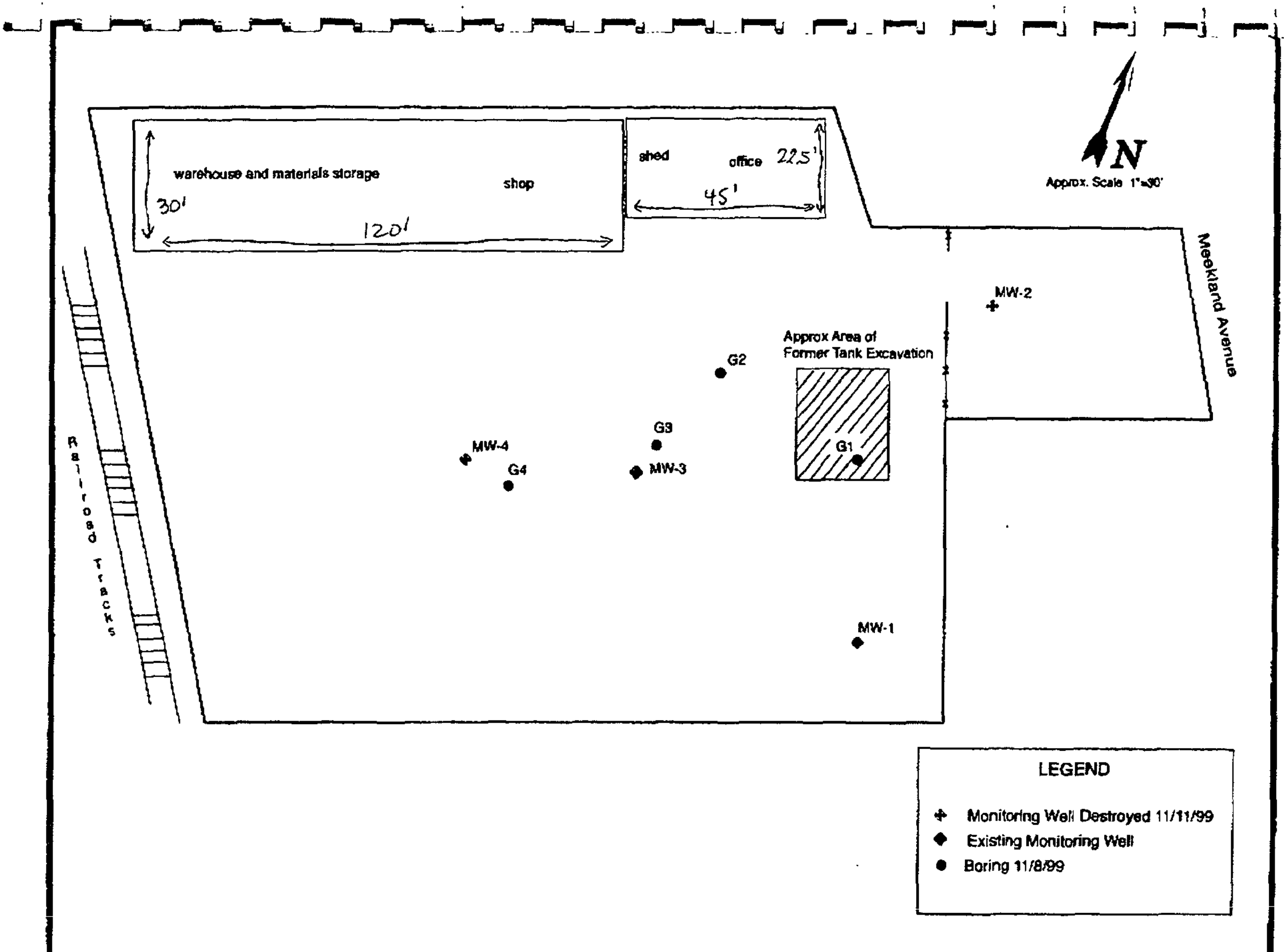
Source: Adapted from Lush Geosciences, Inc., Quarterly Monitoring Report, Figure 2, March 6, 1997

Beck Roofing Company, Hayward, CA

FIGURE 2 Site Plan Pre 1999

H²E
HEILSHORN ENVIRONMENTAL ENGINEERING
P.O. Box 20546, El Sobrante, CA
(510) 222-7968 Fax (510) 222-8573

Rev. 3
Date: 11/29/99



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BECK ROOFING COMPANY

Figure 5 Site Plan November 1999

11/23/99
R1

APPENDIX A

Exposure Algorithms, Volatilization Models, Input Parameters, Model Output, Risk Presentation Tables, Soil and Groundwater Data

TABLE A1. INHALATION EXPOSURE ALGORITHM

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times EF \times ED}{BW \times AT}$$

where:

CA = chemical concentration in air (mg/m^3)
IR = inhalation rate (m^3/day)
EF = exposure frequency (days/years)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time(days)
- carcinogenic effects:70-year lifetime × 365 days/year
- noncarcinogenic effects: ED × 365 days/year

Exposure Assumptions[a]

Parameter	Commercial Scenario
CA	Chemical Specific
IR	20 adult
EF	250
ED	25
BW	70 adult

[a] See text Section

ASTM SOIL TO INDOOR AIR VOLATILIZATION FACTOR

$$VF\ \frac{(mg/m3)}{(mg/kg)} = \frac{((H\rho_s)/(\theta_{ws}+k_s\rho_s+H\theta_{as}))((D^{effsoil}/L_s)/ERL_B))}{1+((D^{effsoil}/L_s)/(ERL_B))+((D^{effsoil}/L_s)/(D^{effcrack}/L_{crack})\eta)} x(10^3 cm3\text{-}kg/m3\text{-}g)$$

ASTM GROUNDWATER TO INDOOR AIR VOLATILIZATION FACTOR

$$VF\ \frac{(mg/m3)}{(mg/L)} = \frac{H((D^{effws}/L_{GW})/ERL_B))}{1+((D^{effws}/L_{GW})/(ERL_B))+((D^{effws}/L_{GW})/(D^{effcrack}/L_{crack})\eta)} x(10^3 L/m3)$$

MODIFIED ASTM VOLATILIZATION FACTOR FOR SEMI-SATURATED ZONE SOIL CONTAMINANTS

$$VF\ \frac{(mg/m3)}{(mg/kg)} = \frac{((H\rho_s)/(\theta_{ws}+k_s\rho_s+H\theta_{as}))((D^{effws}/L_s)/ERL_B))}{1+((D^{effws}/L_s)/(ERL_B))+((D^{effws}/L_s)/(D^{effcrack}/L_{crack})\eta)} x(10^3 cm3\text{-}kg/m3\text{-}g)$$

ASTM GROUNDWATER TO AMBIENT AIR VOLATILIZATION FACTOR

$$VF\ \frac{(mg/m3)}{(mg/L)} = \frac{H}{1+[\frac{U_a\delta_a L_{GW}}{WD_{effws}}]} x\ (10^3 L/m3)$$

where:

$$D^{effcrack}(cm2/s) = D^{air}\frac{\theta crack^{3.33}}{\theta T^2} + D^{wat}(1/H)\frac{\theta wcrack^{3.33}}{\theta T^2}$$

$$D^{effsoil}(cm2/s) = D^{air}\frac{\theta as^{3.33}}{\theta T^2} + D^{wat}(1/H)\frac{\theta ws^{3.33}}{\theta T^2}$$

USEPA SOIL TO AMBIENT AIR VOLATILIZATION FACTOR (VF_s)

$$D^{effws}\ (cm^2/s) = (h_{capf} + h_v)[\frac{h_{capf}}{D^{effcap}} + \frac{h_v}{D^{effs}}]$$

$$D^{effcap}(cm2/s) = D^{air}\frac{\theta acap^{3.33}}{\theta T^2} + D^{wat}(1/H)\frac{\theta wcap^{3.33}}{\theta T^2}$$

$$VF_s(m^3/kg) = (Q/C)\ x\ \frac{(3.14\ x\ D_A\ x\ T)^{1/2}}{(2\ x\ \rho_b\ x\ D_A)}\ x\ 10^{-4}(m^2/cm^2)$$

where:

$$D_A = \frac{[(\Theta_{as}^{10/3} D_i H + \Theta_{ws}^{10/3} D_w)/n^2]}{\rho_B K_d + \Theta_{ws} + \Theta_{as} H}$$

VF Parameters:

Parameter	Definition (units)	Value
VF_s	Volatilization factor (m^3/kg)	Calculation
D_A	Apparent diffusivity (cm^2/s)	Calculation
Q/C	Inverse of the mean conc. at the center of a 0.5-acre square source (g/m^2-s per kg/m^3)	68.81 (U.S. EPA 1996 PRGs
T	Exposure interval (s)	7.8×10^8
ρ_b	Dry soil bulk density (g/cm^3)	1.7
Θ_{as}	Air filled soil porosity (L_{air}/L_{soil})	0.06
n	Total soil porosity (L_{pore}/L_{soil})	0.38
Θ_{ws}	Water-filled soil porosity (L_{water}/L_{soil})	0.32
ρ_s	Soil particle density (g/cm^3)	2.65
Di	Diffusivity in air (cm^2/s)	Chemical-specific
H	Dimensionless Henry's Law constant	Chemical -specific
D_w	Diffusivity in water (cm^2/s)	Chemical-specific
K_d	Soil-water partition coefficient (cm^3/g) = $K_{oc} f_{oc}$	Chemical-specific
K_{oc}	Soil organic carbon-water partition coefficient (cm^3/g)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.01(ASTM)
Θ_{acrack}	Air filled porosity (L_{air}/L_{soil}) of crack soil	0.26 (ASTM)
Θ_{wcrack}	Water-filled porosity (L_{water}/L_{soil}) of crack soil	0.12(ASTM)
Θ_{acap}	Air filled porosity (L_{air}/L_{soil}) in capillary fringe	0.0391(ASTM)
Θ_{wcap}	Water-filled porosity (L_{water}/L_{soil}) in capillary fringe	0.352(ASTM)
η	areal fraction of cracks in foundation	0.01
ER	enclosed space air exchange rate (L/s)	0.00023
L_{GW}	depth to groundwater ($h_{capf} + h_v$, cm)	762
L_s	depth to soil contamination (cm)	609.6
h_v	capillary fringe thickness (cm)	91.44 (gw vol) 76.2 (soil vol)
δ	ambient mixing zone height (cm)	200
U_a	wind speed (cm/s)	225
W	width of source area parallel to wind (cm)	1500

Semi-Sat Zone Contamination to Enclosed Space
Industrial/Comercial

				Benzene	Toluene	ebenzene	Xylene
H(cm3-H2o)/cm3-air, henry's		*		0.22	0.26	0.36	0.229
Ps(g-soil/cm3-soil), bulk density			1.7	1.7	1.7	1.7	1.7
Theta-ws(cm3-h2o/cm3-soil), vol. h2o content		water	0.12	0.32	0.32	0.32	0.32
ks(cm3h2o/g-soil), foc*koc, carbon-water sorptionK				0.589	1.349	2.2	2.4
Theta as(cm3-air/cm3-soil)		air	0.26	0.06	0.06	0.06	0.06
foc			0.01	0.01	0.01	0.01	0.01
koc	benz	*	38	58.9	134.9	220	240
Kd							
Theta t (cm3/cm3-soil)(total soil porosity)		total	0.38	0.38	0.38	0.38	0.38
Di(cm2/s)	benz	*	0.093	0.087	0.085	0.075	0.087
Deffs(cm2/s)#1****				0.000059	0.000055	0.000048	0.000057
Dw (cm2/s) dif in h2o		*		0.000011	0.000009	0.000008	0.000008
theta- wcap vol. h20 content in cap fringe(cm3h20/cm3 total vol)				0.342	0.342	0.342	0.342
theta-acap as above volumetric air(.038 re, .38indus***)				0.038	0.038	0.038	0.038
Deffcap				0.000020	0.000018	0.000014	0.000018
hv thichness of vadose zone(cm)				609.6	609.6	609.6	609.6
hcap thickness of cap fringe(cm)				76.2	76.2	76.2	76.2
deffws eff di between gw & surface				0.000049	0.000045	0.000038	0.000046
				0.280254	0.168131	0.149941	0.088201
Term 1				2.92E-07	1.61E-07	1.20E-07	8.65E-08
ER(1/s) enclosed space air exchange rate	0.00014			0.00023	0.00023	0.00023	0.00023
Lb(cm) enclosed space volume/infiltration area ratio				300	300	300	300
Term#2				1.000009	1.000008	1.000007	1.000008
Term#3				1.59E-02	1.49E-02	1.42E-02	1.49E-02
Deff crack(cm2/s)#1****				0.006789	0.006633	0.005852	0.006789
Deffcrack#2				2.97E-07	2.15E-07	1.40E-07	2.21E-07
Theta a crack (cm3/cm3) vol air in found. wall crack			0.26	0.26	0.26	0.26	0.26
L crack (cm) foundation thickness			15	15	15	15	15
N(cm2crack/cm2total area)			0.01	0.01	0.01	0.01	0.01
Theta w crack (cm3 h20/cm3)			0.12	0.12	0.12	0.12	0.12
Vfcap(mg/m3air)/(mg/kg)				2.87E-04	1.59E-04	1.19E-04	8.52E-05
soilconc(mg/kg)				0.668	0.257	0.194	0.515
	air conc(ug/m3)			1.92E-01	4.08E-02	2.30E-02	4.39E-02

ASTM GWVol to Enclosed Space

				Benzene	Toluene	ebenzene	Xylene
H(cm3-H2o)/cm3-air, henry's		*		0.22	0.26	0.36	0.229
Ps(g-soil/cm3-soil), bulk density			1.7	1.7	1.7	1.7	1.7
Theta-ws(cm3-h2o/cm3-soil), vol. h2o content		water	0.12	0.32	0.32	0.32	0.32
ks(cm3h2o/g-soil), foc*koc, carbon-water sorptionK				0.589	1.349	2.2	2.4
Theta as(cm3-air/cm3-soil)		air	0.26	0.06	0.26	0.26	0.26
foc			0.01	0.01	0.01	0.01	0.01
koc	benz	*	38	58.9	134.9	220	240
Theta t (cm3/cm3-soil)(total soil porosity)		total	0.38	0.38	0.38	0.38	0.38
Di(cm2/s)	benz	*	0.093	0.093	0.085	0.075	0.087
Deffs(cm2/s)#1****				0.000062	0.006638	0.005856	0.006794
Dw (cm2/s) dif in h2o		*		0.000011	0.000009	0.000008	0.000008
theta- wcap vol. h20 content in cap fringe(cm3h20/cm3 total vol)				0.342	0.342	0.342	0.342
theta-acap as above volumetric air(.038 re, .38indus***)				0.038	0.038	0.038	0.038
Deffcap				0.000021	0.000018	0.000014	0.000018
hv thichness of vadose zone(cm)				670.56	670.56	670.56	670.56
hcap thickness of cap fringe(cm)				91.44	91.44	91.44	91.44
deffws eff di between gw & surface				0.000051	0.000147	0.000116	0.000150
Term 1				0.000000	0.000000	0.000000	0.000000
ER(l/s) enclosed space air exchange rate	0.00014			0.00023	0.00023	0.00023	0.00023
Lb(cm) enclosed space volume/infiltration area ratio				300	300	300	300
Term#2				1.000008	1.000023	1.000018	1.000023
Term#3				1.39E-02	4.37E-02	3.93E-02	4.37E-02
Deff crack(cm2/s)#1****				0.007257	0.006633	0.005852	0.006789
Deffcrack#2				2.97E-07	2.15E-07	1.40E-07	2.21E-07
Theta a crack (cm3/cm3) vol air in found. wall crack			0.26	0.26	0.26	0.26	0.26
L crack (cm) foundation thickness			15	15	15	15	15
N(cm2crack/cm2total area)			0.01	0.01	0.01	0.01	0.01
Theta w crack (cm3 h20/cm3)			0.12	0.12	0.12	0.12	0.12
Vfwesp(mg/m3air)/(mg/l-water)				2.11E-04	6.97E-04	7.70E-04	6.29E-04
water conc(mg/l)				0.047	0.0083	0.021	0.0234
	air conc(ug/m3)			9.93E-03	5.79E-03	1.62E-02	1.47E-02

Volatilization from GW to Ambient Air

	Benzene	Toluene	Ethylbenz	Xylenes
H!	0.22	0.27	0.32	0.29
Uair	225	225	225	225
SigAir	200	200	200	200
LGW	762	762	762	762
W	1500	1500	1500	1500
Deffws	0.000041	0.000034	0.000031	0.000031
U*Sig*Lgw	34290000	34290000	34290000	34290000
Wdeffws	0.062755	0.052259	0.046809	0.047097
VF(mg/m3)/(mg/l)	4.03E-07	4.11E-07	4.37E-07	3.98E-07

Soil Volatilization to Ambient Air

		Default Param.		Benz	tol	ebenzen	xylene
Henry's							
Henry's Dimensionless	H			0.22	0.27	0.32	0.29
Diff Air cm2/s	di cm2/s			0.087	0.078	0.075	0.07
Dif Watercm2/s	dw cm2/s			0.000009	0.000008	0.000007	0.000008
Koc cm3/g	Koc			58.9	260	220	240
	S mg/l	EPA	ASTM	1780			
foc	Foc	0.006	0.01	0.01	0.01	0.01	0.01
Kd soil water partition coeffcm3/g	Kd			0.589	2.6	2.2	2.4
Total Porosity	Tp	0.43	0.38	0.38	0.38	0.38	0.38
Moisture Content cm3 h2o/cm3-soil	Tm	0.15	0.12	0.32	0.32	0.32	0.32
Air filled porosity cm3air/cm3 soil	Ta	0.28	0.26	0.06	0.06	0.06	0.06
Dry Bulk Density g/cm3	Bd	1.5	1.7	1.7	1.7	1.7	1.7
Particalbulk density g/cm3	Pd	2.65	2.65	2.65	2.65	2.65	2.65
Q/C (replaces box)		68.81		69.55	69.55	69.55	69.55
T exposure interval (sec)		9.5E+08		7.9E+08	7.9E+08	7.9E+08	7.9E+08
	sat mg/kg			1397.3	0	0	0
Apparent Diffusivity Da	Da			9.54E-06	2.87E-06	3.74E-06	2.99E-06

Vf(mg3/kg)=(Q/C)*(3.14*Da*T)^1/2)/(2*Pb*Da)* 10E-04(m2/cm2)

		Benz	tol	ebenzen	xylene
Ambient	Vf(m3/kg)	3.29E+04	6.00E+04	5.26E+04	5.89E+04

	VF	CDI (mg/kg-day)	SF (kg-day/mg)	Carcinogenic Risk	CDI (mg/kg-day)	RFD (mg/kg-day)	Hazard Quotient
Soil to Indoor Air Max Case							
Adult/indoor/inhal.	VF[mg/m3/mg/kg]						
benzene	2.87E-04	1.34E-05	0.1	1.34E-06			
toluene	1.59E-04				8.33E-06	0.11	7.57E-05
ethylbenzene	1.19E-04				4.71E-06	0.29	1.62E-05
xylenes	8.52E-05				8.94E-06	0.2	4.47E-05
Soil to Indoor Air Average Case							
Adult/indoor/inhal.	VF[mg/m3/mg/kg]						
benzene	2.87E-04	6.96E-06	0.1	6.96E-07			
toluene	1.59E-04				4.54E-06	0.11	4.13E-05
ethylbenzene	1.19E-04				2.60E-06	0.29	8.95E-06
xylenes	8.52E-05				5.12E-06	0.2	2.56E-05
Soil to Ambient Air Max Case							
Adult/ambient/inhal.	VF[m3/kg]						
benzene	3.29E+04	1.42E-06	0.1	1.42E-07			
toluene	6.00E+04				8.73E-07	0.11	7.94E-06
ethylbenzene	5.26E+04				7.52E-07	0.29	2.59E-06
xylenes	5.89E+04				1.78E-06	0.2	8.91E-06
Groundwater to Indoor Air Max Case							
Adult/indoor/inhal.	VF[mg/l/mg/m3]						
benzene	2.11E-04	6.93E-07	0.1	6.93E-08			
toluene	6.97E-04				1.14E-06	0.11	1.03E-05
ethylbenzene	7.70E-04				3.30E-06	0.29	1.14E-05
xylenes	6.29E-04				2.95E-06	0.2	1.47E-05
Groundwater to Ambient Air Max Case							
Adult/ambient/inhal.	VF[mg/l/mg/m3]						
benzene	4.00E-07	1.31E-09	0.1	1.31E-10			
toluene	4.10E-07				6.69E-10	0.11	6.08E-09
ethylbenzene	4.40E-07				1.88E-09	0.29	6.50E-09
xylenes	3.98E-07				1.87E-09	0.2	9.33E-09

Beck Soil Data

			TPHg mg/kg	benzene ug/kg	toluene ug/kg	ethyl benzene ug/kg	xylene ug/kg
mw3	pre99	20	2.9	21	17	6	25
mw3	pre99	25	6.2	48	22	12	56
		30	9.8	250	15	48	260
mw1	pre99	20	nd	2.5	10	2.5	6
mw1	pre99	25	nd	2.5	24	2.5	7
		30	nd	2.5	11	2.5	6
mw2	pre99	20		2.5	2.5	2.5	2.5
mw2	pre99	25	1.4	100	85	14	90
		30	nd	44	8	2.5	2.5
b1	pre99	20	5.7	250	600	100	570
b1	pre99	25	8.8	240	600	126	760
b2	pre99	20		46	11	14	40
b2	pre99	25	35	440	1200	320	1800
		30	36	270	87	37	2.1
g1	Nov99	20	10	7	14	68	39
g2	Nov99	20		2.5	2.5	2.5	2.5
	Nov99	25	58	120	75	1000	2000
		30	7.9	23	10	60	100
g3	Nov99	25	nd	2.5	2.5	2.5	2.5
		30	22	63	2.5	320	120
sw-1	1994	30		520			
sw2		25		430			
sw-3		25		1500			
sw-4		30		170			
sw-5		25		140			
Sw-7		25		5700			
sw-9		25		2.5			
SW-11		18		2.5			
Sw-12		18		2.5			
sw-13		18		2.5			

	TPHg mg/kg	benzene ug/kg	toluene ug/kg	ethyl benzene ug/kg	xylene ug/kg
avg	11.98	346.90	139.95	107.13	294.56
n		30	20	20	20
t		1.699	1.729	1.729	1.729
s		1034.706	299.2490	225.1303	570.7179
ucl		667.8592	255.6445	194.1640	515.2037
#		20	16	13	16

Beck's Groundwater Data

		Ben	Tol	Eben	Xylene
mw-1	Jan-96	0.15	0.15	0.15	0.15
	Apr-96	0.15	0.15	0.15	0.15
	Jul-96	1.3	2.1	0.64	3
	Nov-96	2.2	7.3	2.2	23.1
	Feb-97	2	3.9	2.3	9.2
	Sep-97	0.15	0.15	0.15	0.15
	Jan-99	0.15	0.15	0.15	0.15
mw-2	Jan-96	0.15	0.15	0.15	0.67
	Apr-96	0.29	0.68	0.15	0.66
	Jul-96	3.4	5.6	1.7	9.3
	Nov-96	9.3	29.3	5.7	57
	Feb-97	2.8	5	3.7	9.4
	Sep-97	0.15	0.15	0.15	0.15
	Jan-99	0.15	0.15	0.15	0.15
mw-3	Jan-96	0.15	0.15	0.15	0.15
	Apr-96	1.2	0.33	0.45	0.48
	Jul-96	240	8.2	14	9.1
	Nov-96	242	36	70	116
	Feb-97	36.2	1	10.7	8.9
	Sep-97	160	0.65	93	26
	Jan-99	6.2	0.15	7.3	0.15
mw-4	Jan-96	2.1	4	0.15	0.79
	Apr-96	0.42	1.1	0.39	0.79
	Jul-96	0.97	1.7	0.67	3
	Nov-96	1.3	2.7	1.8	7.5
	Feb-97	1.3	2.7	1.8	7.5
	Sep-97	0.15	0.15	0.15	0.15
	Jan-99	0.15	0.15	0.15	0.15
	Avg	25.51714	4.068214	7.791071	10.49607
	st dev	66.81757	8.290509	20.94237	23.44029
	n	28	28	28	28
	t	1.703	1.703	1.703	1.703
	UCL	47.02149	6.736405	14.5311	18.04002
	#	18	18	16	19

USER'S GUIDE FOR
THE JOHNSON AND ETTINGER (1991) MODEL
FOR SUBSURFACE VAPOR INTRUSION
INTO BUILDINGS

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Contract No. 68-D30035
Work Assignment No. III-106
PN 5099-6

For Submittal to

Janine Dinan, Work Assignment Manager

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF EMERGENCY AND REMEDIAL RESPONSE
TOXICS INTEGRATION BRANCH (5202G)
401 M STREET, S.W.
WASHINGTON, D.C. 20450

September 1997

DATA ENTRY SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
71432	668	Benzene

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	609 6	10	CL		

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
1 7	0 38	0.32	0 01

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based soil concentration

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm³/cm³)	Vadose zone effective total fluid saturation, S_{te} (cm³/cm³)	Vadose zone soil intrinsic permeability, k_i (cm²)	Vadose zone soil relative air permeability, k_{rg} (cm²)	Vadose zone soil effective vapor permeability, k_v (cm²)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (μg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm³/s)
594.6	0.060	0.789	9.64E-10	0.369	3.55E-10	3,844	668	5.63E+04

Area of enclosed space below grade, A_B (cm²)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ve. groundwat temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m³/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm²/s)	Diffusion path length, L_d (cm)
9.24E+05	4.16E-04	15	8,122	2 69E-03	1.16E-01	1.75E-04	6.52E-05	594.6

Convection path length, L_p (cm)	Soil-water partition coefficient, K_d (cm³/g)	Source vapor conc., C_{source} (μg/m³)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm³/s)	Crack effective diffusion coefficient, D^{crack} (cm²/s)	Area of crack, A_{crack} (cm²)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (μg/m³)
15	5.89E-01	9.90E+04	0.10	3.43E-01	6.52E-05	3.84E+02	1.89E+89	1.39E-06	1.37E-01

Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m³)
8.3E-06	NA

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	1.37E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.8E-07	NA

APPENDIX B

Boring Logs

Boring Log No. B-3

PROJECT: Beck Roofing Co., Hayward, CA | **DATE:** 07/14/93 | **LOGGED BY:** LAR

DRILL RIG: Hollow Stem Auger | **HOLE DIA.:** 8 in. | **SAMPLER:** California

INITIAL GW DEPTH: Not Enc. | **FINAL GW:** Not Enc. | **HOLE ELEV.:** NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
6" of Baserock at surface	CL		0			
SILTY CLAY Medium plastic, minor fine sand; moist, dusky yel. brown (10YR 2/2)			1			
			2			
			3			
			4			
SANDY CLAY Low to med. plastic, approx. 35% very fine sand moist, moderate yel. brown (10YR 5/4).			5	X		
			6	X	23	
			7			
			8			
			9			
- Greenish gray at 10'.			10	X		Product odor noted in bottom of sample at 11.5'.
			11	X	12	
Hole Abandoned at 11.5' and backfilled with neat cement grout			12			
			13			
			14			
			15			
			16			
			17			
			18			
			19			
			20			
			21			
			22			
			23			
			24			
			25			
			26			
			27			
			28			
			29			
			30			
			31			
			32			
			33			
			34			
			35			

LOUIS A. RICHARDSON

Consulting Engineering Geologist
Mountain View, California

Notes:

BORING NO. B-3: Located on northern side of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

Boring Log No. B-4

PROJECT: Beck Roofing Co., Hayward, CA | **DATE:** 07/14/93 | **LOGGED BY:** LAR
DRILL RIG: Hollow Stem Auger | **HOLE DIA.:** 8 in. | **SAMPLER:** California
INITIAL GW DEPTH: Not Enc. | **FINAL GW:** Not Enc. | **HOLE ELEV.:** NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
6" of Baserock at surface SILTY CLAY Medium plastic minor fine sand: moist. dusky yel brown (10YR 2/2).	CL		0–4			
SANDY CLAY Low to med plastic approx 35% very fine sand moist, moderate yel brown (10YR 5/4)			5–6	X	19	
			10–11	X	12	
SILTY SAND Fine grained pale yellow brown (10YR 6/2).	SM		13–15			
			15–16	X	10	Product odor noted in sample at 15'.
Hole Abandoned at 16.5 and backfilled with neat cement grout			17–35			

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Notes:
BORING NO. B-4: Located on northern side of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

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Boring Log No. B-5

PROJECT: Beck Roofing Co., Hayward, CA	**DATE:** 07/14/83	**LOGGED BY:** LAR
DRILL RIG: Hollow Stem Auger	**HOLE DIA.:** 8 In.	**SAMPLER:** California
INITIAL GW DEPTH: Not Enc.	**FINAL GW:** Not Enc.	**HOLE ELEV.:** NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
6" of Baserock at surface. SILTY CLAY. Medium plastic, minor fine sand; moist; dusky yel. brown (10YR 2/2).	CL		0–5			
SANDY CLAY. Low to med. plastic, approx. 35% very fine sand moist moderate yel. brown (10YR 5/4)			5–10	X (5–6.5)	18	
SILTY SAND. Fine grained, pale yellow brown (10YR 6/2), approx. 50% silty fines	SM		10–16.5	X (10–11.5); X (15–16.5)	12; 13	Product odor noted in sample at 15'.
Hole Abandoned at 16.5 and backfilled with neat cement grout			16.5–35			

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Notes:

BORING NO. B-5. Located on northern side of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward Calif.

Project No. 539.44

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Boring Log No. B-6

PROJECT: Beck Roofing Co., Hayward, CA | **DATE:** 07/14/93 | **LOGGED BY:** LAR
DRILL RIG: Hollow Stem Auger | **HOLE DIA.:** 8 in. | **SAMPLER:** California
INITIAL GW DEPTH: Not Enc. | **FINAL GW:** Not Enc. | **HOLE ELEV.:** NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
2" of Baserock at surface SILTY CLAY Medium plastic, minor fine sand moist, dusky yel. brown (10YR 2/2)	CL		0–4.5			
SANDY CLAY Low to med. plastic, approx. 35% very fine sand moist; moderate yel. brown (10YR 5/4).			4.5–10	☒ (5–6.5)	18	
SILTY SAND Fine grained, pale yellow brown (10YR 6/2); approx. 50% silty fines	SM		10–15	☒ (10–11.5)	12	
– Color at 15' is olive gray (5Y 4/1)			15–16.5	☒ (15–16.5)	9	Product odor noted in sample at 15'
Hole Abandoned at 16.5' and backfilled with neat cement grout			16.5–35			

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Notes:
BORING NO. B-6: Located on northern side of slurry-filled excavation from gasoline tank removal at Beck Roofing Co 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

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Boring Log No. B-7

PROJECT: Beck Roofing Co., Hayward, CA | **DATE:** 07/14/93 | **LOGGED BY:** LAR

DRILL RIG: Hollow Stem Auger | **HOLE DIA.:** 8 In. | **SAMPLER:** California & Continuous

INITIAL GW DEPTH: Not Enc. ft. | **FINAL GW:** Not Enc. ft. | **HOLE ELEV.:** NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
6" of Baserock at surface	CL		0			
SILTY CLAY. Medium plastic, minor fine sand, moist; dusky yel. brown (10YR 2/2).			1–4			
SANDY CLAY: Low to med. plastic, approx. 35% very fine sand, moist, moderate yel. brown (10YR 5/4).			5–6	X	16	
			10–11	X	11	
SILTY SAND: Fine grained, pale yellow brown (10YR 6/2), approx. 15% silty fines.	SM		13–16	X	11	Continuous sampler used below 16.5'
- Color at 17.7' is dark green-gray (5G 4/1)			17–20	continuous		Product odor evident at 20'.
CLAY: Silty; low plasticity; moist, dark yel. brown mottled med. yel. brown.	CL		20–23	continuous		Pocket penetrometer reading is 0.5 TSF.
Hole Abandoned at 23' and backfilled with neat cement grout			23–35			

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Notes:

BORING NO. B-7: Located on northern side of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

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Boring Log No. B-8

PROJECT: Beck Roofing Co., Hayward, CA
DATE: 07/15/93
LOGGED BY: LAR
DRILL RIG: Continuous Flight Auger
HOLE DIA.: 6 in.
SAMPLER: None
INITIAL GW DEPTH: Not Enc.
FINAL GW: Not Enc.
HOLE ELEV.: NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
4" of Baserock at surface. SILTY CLAY: Medium plastic, minor fine sand; moist; dusky yel. brown (10YR 2/2)	CL		0–4.5			Boring advanced with continuous flight auger until product odor was noted in cuttings.
SANDY CLAY. Low to med. plastic; approx. 35% very fine sand moist moderate yel. brown (10YR 5/4)			4.5–13			
SILTY SAND Fine grained, pale yellow brown (10YR 6/2), approx. 15% silty fines	SM		13–18			Product odor evident at 17'
Hole Abandoned at 18' and backfilled with neat cement grout			18–35			

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Notes:
BORING NO. B-8. Located west of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

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Boring Log No. B-9

PROJECT: Beck Roofing Co., Hayward, CA | **DATE:** 07/15/93 | **LOGGED BY:** LAR

DRILL RIG: Continuous Flight Auger | **HOLE DIA.:** 6 in. | **SAMPLER:** None

INITIAL GW DEPTH: Not Enc. | **FINAL GW:** Not Enc. | **HOLE ELEV.:** NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
6" of Baserock at surface. SILTY CLAY. Medium plastic; minor fine sand; moist; dusky yel brown (10YR 2/2).	CL		0–4			Boring advanced with continuous flight auger until product odor was noted in cuttings.
SANDY CLAY. Low to med. plastic; approx. 35% very fine sand; moist; moderate yel brown (10YR 5/4)			4.5–13			
SILTY SAND. Fine grained, pale yellow brown (10YR 6/2); approx. 15% silty fines.	SM		13–19			Product odor evident at 18'.
Hole abandoned at 19' and backfilled with neat cement grout.			19–35			

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Notes:
BORING NO. B-9: Located west of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

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Boring Log No. B-10

PROJECT: Beck Roofing Co., Hayward, CA	**DATE:** 07/15/93	**LOGGED BY:** LAR
DRILL RIG: Continuous Flight Auger	**HOLE DIA.:** 8 in.	**SAMPLER:** None
INITIAL GW DEPTH: Not Enc.	**FINAL GW:** Not Enc.	**HOLE ELEV.:** NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
[illegible] of Baserock at surface. SILTY CLAY Medium plastic, minor fine sand, moist, dusky yel brown (10YR 2/2)	CL		0–4			Boring advanced with continuous flight auger until product odor was noted in cuttings.
SANDY CLAY Low to med. plastic, approx 35% very fine sand moist moderate yel brown (10YR 5/4)			4½–13			
SILTY SAND Fine grained pale yellow brown (10YR 6/2), approx 15% silty fines.	SM		13–19			Product odor evident at 18'.
Hole Abandoned at 19' and backfilled with neat cement grout.			19–35			

LOUIS A. RICHARDSON

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Notes:

BORING NO. B-10: Located west of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

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Boring Log No. B-11

PROJECT: Beck Roofing Co., Hayward, CA | DATE: 07/15/83 | LOGGED BY: LAR
DRILL RIG: Continuous Flight Auger | HOLE DIA.: 6 in. | SAMPLER: None
INITIAL GW DEPTH: Not Enc. | FINAL GW: Not Enc. | HOLE ELEV.: NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
5" of Baserock at surface SILTY CLAY Medium plastic, minor fine sand; moist, dusky yel. brown (10YR 2/2)	CL		0–4			Boring advanced with continuous flight auger until product odor was noted in cuttings.
SANDY CLAY Low to med. plastic; approx. 35% very fine sand; moist moderate yel. brown (10YR 5/4).			4.5–13			
SILTY SAND Fine grained, pale yellow brown (10YR 6/2); approx. 15% silty fines.	SM		13–19			Product odor evident at 18'.
Hole abandoned at 19' and backfilled with neat cement grout			19–35			

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Notes:
BORING NO. B-11 Located west of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

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Boring Log No. B-12

PROJECT: Beck Roofing Co., Hayward, CA	**DATE:** 07/15/93	**LOGGED BY:** LAR
DRILL RIG: Continuous Flight Auger	**HOLE DIA.:** 6 in.	**SAMPLER:** None
INITIAL GW DEPTH: Not Enc.	**FINAL GW:** Not Enc.	**HOLE ELEV.:** NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
8" of Baserock at surface. SILTY CLAY: Medium plastic, minor fine sand; moist, dusky yel. brown (10YR 2/2).	CL		0–4			Boring advanced with continuous flight auger until product odor was noted in cuttings.
SANDY CLAY: Low to med. plastic, approx. 35% very fine sand, moist, moderate yel. brown (10YR 5/4)			4–13			
SILTY SAND: Fine grained, pale yellow brown (10YR 6/2); approx. 15% silty fines.	SM		13–23			
SANDY CLAY: Med. plastic approx. 20% fine sand, mod yel. brn.	CL		23–25			Slight product odor evident at 25'.
Hole Abandoned at 25' and backfilled with neat cement grout			25–35			

LOUIS A. RICHARDSON Consulting Engineering Geologist Mountain View, California	*Notes:* *BORING NO. B-12: Located west of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Neekland Ave., Hayward, Calif.*	**Project No.** 539 44 ***Page 1 of 1***

Boring Log No. B-13

PROJECT: Beck Roofing Co., Hayward, CA
DATE: 07/16/93
LOGGED BY: LAR
DRILL RIG: Continuous Flight Auger
HOLE DIA.: 6 in.
SAMPLER: None
INITIAL GW DEPTH: Not Enc.
FINAL GW: Not Enc.
HOLE ELEV.: NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
6" of Baserock at surface. SILTY CLAY. Medium plastic, minor fine sand, moist; dusky yel. brown (10YR 2/2).	CL		0–8			Boring advanced with continuous flight auger until product odor was noted in cuttings.
CLAYEY SAND. Fine-grained with 10% fine gravel, 10-15% fines, slightly moist, moderate yel. brown (10YR 5/4).	SC		8–18			
SANDY CLAY. Med. plastic, approx. 20% fine sand, mod. yel. brn.	CL		18–25			Slight product odor evident at 25'
Hole Abandoned at 25' and backfilled with neat cement grout			25–35			

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Notes:
BORING NO. B-13: Located south of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

Boring Log No. B-14

PROJECT: Beck Roofing Co., Hayward, CA | **DATE:** 07/15/93 | **LOGGED BY:** LAR
DRILL RIG: Hollow Stem Auger | **HOLE DIA.:** 8 in. | **SAMPLER:** California & Continuous
INITIAL GW DEPTH: 28.5 ft. | **FINAL GW:** 28.5 ft. | **HOLE ELEV.:** NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
6" of Baserock at surface. SILTY CLAY Medium plastic minor fine sand, moist, mod yel brown (10YR 5/4).	CL		0–8	5–6.5	16	TPH = ND @ 5'.
CLAYEY SAND Fine-grained with 10% fine gravel; approx 10% clayey fines, moist, moderate yel brown (10YR 5/4)	SC		8–17.5	10–11.5; 15–16.5	20; 17	TPH = ND @ 10'; TPH = ND @ 15'
SILT Mod yel. orn. mottled dark yel. brown, v. moist	ML		17.5–19			Continuous sampler used from 16.5 to 33'.
CLAY Low to medium plasticity; moist, olive gray mottled :: olive brown, moist.	CL		19–			TPH = ND @ 19'
- 3" sand lens at 22	SP lens		22			TPH = 2.7 ppm @ 22'
- color below 21 is dark yel. orn with greenish gray vertical pores	CL					Pocket penetrometer reads 1.5 TSF in clay.
			26–28.5			TPH = 23 ppm @ 26'; TPH = 4.1 ppm @ 27'; TPH = 91 ppm @ 28.5'
- color is lt. olive gray (5Y 5/2) below 28'			–33			▼ Groundwater encountered at 28.5'. Water sample taken.
Hole Terminated at 33' and backfilled with neat cement grout.			33–35			

LOUIS A. RICHARDSON
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Mountain View, California

Notes:

BORING NO. B-14: Located on south side of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

Page 1 of 1

Boring Log No. B-15

PROJECT: Beck Roofing Co., Hayward, CA | **DATE:** 07/15/93 | **LOGGED BY:** LAR
DRILL RIG: Hollow Stem Auger | **HOLE DIA.:** 8 in. | **SAMPLER:** California & Continuous
INITIAL GW DEPTH: Not Enc. | **FINAL GW:** Not Enc. | **HOLE ELEV.:** NA

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
6" of Baserock at surface SILTY CLAY. Medium plastic; minor fine sand, moist; dusky yel. brown (10YR 2/2)	CL		0–4			
SANDY CLAY. Low to med. plastic; approx. 35% very fine sand, moist; moderate yel. brown (10YR 5/4).			4–13	5–6.5 10–11.5	27 28	
SILTY SAND. Fine grained; pale yellow brown (10YR 6/2); approx. 15% silty fines.	SM		13–18	15–16.5	27	
- Dark green-gray (5G 4/1) silty clay lens at 18 – 19', very moist	CL		18–19	18–23 (continuous)		Continuous sampler used below 18. Slight product odor evident at 19'.
	SM		19–21			
CLAY. Silty, low plasticity, moist, dark yel. brown mottled mod. yel. brown.	CL		21–23			
Hole Abandoned at 23' and backfilled with neat cement grout			23–35			

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Notes:
BORING NO. B-15: Located west of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

Boring Log No. B-16

PROJECT: Beck Roofing Co., Hayward, CA
DRILL RIG: Hollow Stem Auger
INITIAL GW DEPTH: 28.7 ft.

DATE: 07/15/93
HOLE DIA.: 8 in.
FINAL GW: 28.7 ft.

LOGGED BY: LAR
SAMPLER: California & Continuous
HOLE ELEV.: NA

DESCRIPTION	USCS CLASS	DEPTH	BLOWS/FT.	REMARKS
2" of Baserock at surface.		0		
SILTY CLAY Medium plastic, minor fine sand, moist, dusky yel. brown (10YR 2/2)	CL	0–4.5		
SANDY CLAY Low to med. plastic, approx. 35% very fine sand, moist, moderate yel. brown (10YR 5/4).		4.5–13	24	TPH = ND @ 5'
			26	TPH = ND @ 10'
SILTY SAND Fine grained, pale yellow brown (10YR 6/2), approx. 15% silty fines	SM	13–18	28	TPH = ND @ 15'
				Continuous sampler used from 18' to 30'
- Dark green-gray (5G 4/1) silty clay lens at 18 - 19'; very moist	CL	18–19		
	SM	19–20.5		
CLAY Silty; low plasticity, moist, dark yel. brown mottled mod. yel. brown.	CL	20.5–33		TPH = 6.9 ppm @ 23'
				TPH = 37 ppm @ 24'
- Slightly porous below 25' with lt. gray color at pores.				TPH = 48 ppm @ 26'
				TPH = 23 PPM @ 28'
				▽ Groundwater encountered at 28.7'; product odor evident.
				TPH = 64 ppm @ 29'
				Groundwater sample taken
Hole Terminated at 33' and backfilled with neat cement grout		33		

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Notes:
BORING NO. B-16: Located west of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

Boring Log No. B-17

PROJECT: Beck Roofing Co., Hayward, CA
DATE: 07/16/93
LOGGED BY: LAR
DRILL RIG: Hollow Stem Auger
HOLE DIA.: 8 in.
SAMPLER: California & Continuous
INITIAL GW DEPTH: 29 ft.
FINAL GW: 29 ft.
HOLE ELEV.: NA

DESCRIPTION	USCS CLASS	DEPTH	BLOWS/FT.	REMARKS
6" of Baserock at surface	CL	0		
SILTY CLAY Medium plastic; minor fine sand; moist, dusky yel. brown (10YR 2/2)		1–4		
SANDY CLAY Low to med plastic; approx. 35% very fine sand, moist; moderate yel brown (10YR 5/4).		5	14	TPH = ND @ 5'.
		10	10	TPH = ND @ 10'
SILTY SAND Fine grained, pale yellow brown (10YR 6/2), approx 15% silty fines.	SM	13		
		15	15	TPH = ND @ 15'
		18		Continuous sampler used from 18' to 28'
- Color is dark green-gray at 20'.		20		Pocket penetrometer reading is 1.0 TSF in clay.
CLAY Silty; low to medium plasticity moist; dark yel. brown mottled mod. yel brown.	CL	21		
		22		TPH = 2.4 ppm @ 22'
		24		TPH = 44 ppm @ 24'
		25.5		TPH = 170 ppm @ 25.5'
		27		TPH = 11 ppm @ 27'
		28.5		TPH = 56 ppm @ 28.5'
		29		▼ Groundwater encountered at 29'
		31		Water sample taken.
Hole Abandoned at 33' and backfilled with neat cement grout		33		

LOUIS A. RICHARDSON
Consulting Engineering Geologist
Mountain View, California

Notes:
BORING NO. B-17: Located on northern side of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539.44

Boring Log No. B-18

PROJECT: Beck Roofing Co., Hayward, CA
DRILL RIG: Hollow Stem Auger
INITIAL GW DEPTH: 29 ft.

DATE: 07/16/93
HOLE DIA.: 8 in.
FINAL GW: 29 ft.

LOGGED BY: LAR
SAMPLER: California & Continuous
HOLE ELEV.: NA

DESCRIPTION	USCS CLASS	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
5" of Concrete at surface SILT. Dusky yellow brown (10YR 2/2) topsoil.	SM/ML	0–4			
SILTY CLAY: Med. plastic, moist; mod. yel. brown (10YR 5/4)	CL	4–9	5–6.5	35	TPH = ND @ 5'
SILTY SAND: Fine-grained with minor gravel, sl. moist, moderate yel. brown (10YR 5/4), approx. 15% fines	SM	9–20	10–11.5	20	TPH = ND @ 10'
			15–16.5	8	TPH = ND @ 15'
			18–30		Continuous sampler used from 18' to 30'.
CLAY. Silty, lt. olive gray (5Y 5/2) mottled mod. yel. brown, moist, low to med. plastic.	CL	20–33			TPH = 20 ppm @ 23' TPH = 43 ppm @ 24'
- dark yel. brn. with lt. gray vertical pores at 26 to 28'.					TPH = 87 ppm @ 26'
- contains some fine sand below 28'					TPH = 23 PPM @ 28' TPH = 61 PPM @ 28.5' Groundwater encountered at 29', product odor evident. Groundwater sample taken.
Hole Terminated at 33' and backfilled with neat cement grout.		33–35			

LOUIS A. RICHARDSON
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Notes:
BORING NO. B-18: Located east of slurry-filled excavation from gasoline tank removal at Beck Roofing Co. 21123 Meekland Ave., Hayward, Calif.

Project No. 539 44

Page 1 of 1

LOG OF BORING: SB-18

Beck Roofing	File: 3288-44
Date: 1 August 1994	Elevation: feet
Surface:	Water: None encountered

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS & BLOW COUNTS	Sample Number	USCS	Material Description and Remarks	Dry Density (pcf)	Moisture Content (%)	Phi	C (ksf)
0			CL	Dark grey, moist, medium stiff, silty Clay - some fine Sand				
5.5	11/6	SB18-1						
7.5			ML CL	Yellow brown, moist, medium stiff, clayey Silt/silty Clay				
10.5	9/6	SB18-2						
13.5			SP	Light brown, moist, loose-medium dense, medium coarse, Sand				
20			ML-CL	Olive-mottled, moist, soft to medium soft, clayey silt/silty Clay				

Site description and comments:

ANDERSON CONSULTING GROUP

Boring. SB-18
Depth: 40.0 ft

LOG OF BORING: SB-18 (Continued)

Beck Roofing

File: 3288-44

ELEV / DEPTH	Soil Symbols, Sampler Symbols & Blow Counts	Sample Number	USCS	Material Description and Remarks	Dry Density (pcf)	Moisture Content (%)	Phi	C (ksf)
22								
23								
24			CL	Olive, moist, stiff, mottled Clay with trace of silt and rhizomes				
25	10/6	SB18-3						
28				Saturated				
31	9/6	SB18-4						
36	9/6	SB18-5						
40				Boring terminated at 40 feet				

ANDERSON CONSULTING GROUP

Boring: SB-18
Depth: 40.0 ft
Figure:

LOG OF BORING: SB-20

Project: Back Roofing | **File:** 3288-44

Date: 1 August 1994 | **Elevation:** feet

Surface: | **Water:** None encountered

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS & BLOW COUNTS	Sample Number	USCS	Material Description and Remarks	Dry Density (pcf)	Moisture Content (%)	Phi	C (ksf)
0			CL	Dark brown, moist, soft to mediumstiff silty sandy Clay				
6.7			CL-ML	Yellow brown, moist, soft to medium stiff, silty clay/clayey silt				
16.5			SP	Light brown, damp, medium dense, Sand				
21	4/6	SB20-1						

Site description and comments:

ANDERSON CONSULTING GROUP

Boring: SB-20
Depth: 36.5 ft
Figure:

LOG OF BORING: SB-20 (Continued)

Project: Beck Roofing **File:** 3288-44

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS & BLOW COUNTS	Sample Number	USCS	Material Description and Remarks	Dry Density (pcf)	Moisture Content (%)	Phi	C (ksf)
22–25								
25.5	6/6	SB20-2						
28			SM	Grey brown, saturated, medium dense silty sand with gravel to 3/8"				
30.5	3/6	SB20-3						
35.5	3/6	SB20-4						

Boring terminated at 36.5 feet

ANDERSON CONSULTING GROUP

Boring: SB-20
Depth: 36.5 ft
Figure:

LOG OF BORING: SB-18

Project: Beck Roofing

File: 3288-44

Date: 1 August 1994

Elevation: feet

Surface:

Water: None encountered

ELEV / DEPTH	Soil Symbols, Sampler Symbols & Blow Counts	Sample Number	USCS	Material Description and Remarks	Dry Density (pcf)	Moisture Content (%)	Phi	C (ksf)
0		---	CL	Dark grey, moist, medium stiff, silty Clay - some fine Sand				
5.5	11/6	SB18-1						
7.5			ML-CL	Yellow brown, moist, medium stiff, clayey Silt/silty Clay				
10.5	9/6	SB18-2						
13.5			SP	Light brown, moist, loose-medium dense, medium coarse, Sand				
20			ML-CL	Olive-mottled, moist, soft to medium soft, clayey silt/silty Clay				

Site description and comments:

ANDERSON CONSULTING GROUP

Boring: SB-18
Depth: 40.0 ft
Figure:

LOG OF BORING: SB-19

Project: Beck Roofing | **File:** 3288-44

Date: 1 August 1994 | **Elevation:** feet

Surface: | **Water:** None encountered

ELEV / DEPTH	Soil Symbols Sampler Symbols & Blow Counts	Sample Number	USCS	Material Description and Remarks	Dry Density (pcf)	Moisture Content (%)	Phi	C (ksf)
0			ML-CL	Dark grey, damp, soft to medium stiff, silty Clay/clayey Silt				
11	5/6	SB19-1						
15			SP	Light brown, damp, medium dense, medium coarse, Sand				
16	9/6	SB19-2						
17			CL	Olive-mottled, moist, soft to medium stiff, Clay				
20			CL	Olive brown, moist, medium stiff, silty Clay				
21	4/6	SB19-3						

Site description and comments:

ANDERSON CONSULTING GROUP

Boring: SB-19
Depth: 40.0 ft
Figure:

LOG OF BORING: SB-19 (Continued)

Project: Beck Roofing **File:** 3288-44

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS & BLOW COUNTS	Sample Number	USCS	Material Description and Remarks	Dry Density (pcf)	Moisture Content (%)	Phi	C (ksf)
22								
23								
24								
25								
26	12/6	SB19-4						
27								
28				Saturated				
29								
30								
31		SB19-5						
32								
33								
34								
35								
36		SB19-6						
37								
38								
39								
40								

Boring terminated at 40 feet

ANDERSON CONSULTING GROUP

Boring: SB-19
Depth: 40.0 ft
Figure:

LOG OF BORING: SB-21

Project: Beck Roofing | **File:** 3288-44

Date: 1 August 1994 | **Elevation:** feet

Surface: | **Water:** None encountered

ELEV / DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS & BLOW COUNTS	Sample Number	USCS	Material Description and Remarks	Dry Density (pcf)	Moisture Content (%)	Phi	C (ksf)
0–24			FILL	0 to 24 feet cement grout backfill				
24–30		SB21-1 SB21-2 SB21-3	CL	Olive brown-mottled, wet, medium stiff, silty Clay				

Boring terminated at 30 feet

Site description and comments:

ANDERSON CONSULTING GROUP

Boring: SB-21
Depth: 30.0 ft

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
					0	
						Brown sandy silty clay, moist, no odor, medium plasticity.
2116-5-B1	12	CL	910		5	Brown sandy silty clay, stiff, moist, no odor, low plasticity.
		SC				Brown clayey sand, fine-grained, moist, no odor, grades downward to a silty clay.
2116-10-B1	10	CL	915		10	Brown sandy silty clay, stiff, moist, no odor, low plasticity.
2116-15-B1	12	SP	927		15	Brown sand, fine-grained, medium dense, moist, no odor.
2116-20-B1	8	CL	940		20	Brown sandy silty clay, medium stiff, moist, odor.

L & W Environmental Services, Inc. 2111 Jennings Street San Francisco, California	**Log of Boring Number: B1** **Sheet 1 of 2** Beck Roofing 21123 Meekland Avenue Hayward, California
Project Number: 2116	Date: December, 1991 / Figure Number: 7

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
2116-25-B1	10	CL	950		25	Brown sandy silty clay, stiff, moist, strong odor, medium plasticity.

Boring terminated at 25.5 feet.
Groundwater not encountered.
Boring drilled 10/31/91 with CME 75 rig.

L & W Environmental Services, Inc. 2111 Jennings Street San Francisco, California	**Log of Boring Number: B1** **Sheet 2 of 2** Beck Roofing 21123 Meekland Avenue Hayward, California
Project Number: 2116	Date: December, 1991 | Figure Number: 7

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
					0	
2116-5-B2	16	CL	1050		5	Brown silty sandy clay, very stiff, moist, no odor, medium plasticity.
2116-10-B2	10	SM	1112		10	Brown silty sand, fine-grained, loose to medium dense, moist, no odor.
2116-15-B2	9	SP	1120		15	Brown sand, fine-grained, loose, moist, no odor.
2116-20-B2	7	CL	1130		20	Brown silty clay, medium stiff, moist, no odor, medium plasticity.

L & W Environmental Services, Inc.

2111 Jennings Street
San Francisco, California

Log of Boring Number: B2
Sheet 1 of 2
Beck Roofing
21123 Meekland Avenue
Hayward, California

Project Number: 2116

Date: December, 1991

Figure Number. 8

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
2116-25-B2	9	CL	1136		25	Brown sandy silty clay, stiff, moist, strong odor, medium plasticity.
2116-30-B2	8	CL	1145		30	Same.

Boring terminated at 30.5 feet.
Groundwater not encountered.
Boring drilled 10/31/91 with CME 75 rig.

L & W Environmental Services, Inc. 2111 Jennings Street San Francisco, California	Log of Boring Number: B2 Sheet 2 of 2 Beck Roofing 21123 Meekland Avenue Hayward, California	
Project Number: 2116	Date: December, 1991	Figure Number: 8

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
					0	
						Brown sandy silty clay, moist, no odor, medium plasticity.
2116-5-MW1	20	CL	911		5	Brown sandy silty clay, very stiff, moist, no odor, low plasticity.
2116-10-MW1	15	SM	917		10	Brown silty sand, fine-grained, medium dense, moist, no odor.
2116-15-MW1	12	SP	925		15	Brown sand with subangular gravel, fine-grained, medium dense, moist, no odor.
2116-20-MW1	5	CL	935			Brown silty clay, medium stiff, moist, no odor, low plasticity.

L & W Environmental Services, Inc. 2111 Jennings Street San Francisco, California	Log of Boring Number: MW 1 Sheet 1 of 3 Beck Roofing 21123 Meekland Avenue Hayward, California	
Project Number: 2116	Date: November, 1991	Figure Number: 5

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
2116-25-MW1	13	CL	944		25	Same, with medium plasticity.
2116-30-MW1	9	CL/ SP	959		30	Same, but stiff.
						Brown sand, fine-grained, medium loose, moist, no odor.
2116-35-MW1	9	SP/ CL	1008		35	Brown silty clay, stiff, moist to wet near top of sample, no odor, medium plasticity.
2116-40-MW1	11	CL	1025		40	Same.

L & W Environmental Services, Inc. 2111 Jennings Street San Francisco, California	**Log of Boring Number: MW 1** **Sheet 2 of 3** Beck Roofing 21123 Meekland Avenue Hayward, California
Project Number: 2116	Date: November, 1991 | Figure Number: 5

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
		CL				
						Same.
2116-45-MWI	13	CL/SP	1035		45	Brown sand, fine-grained, medium dense, wet, no odor.

Boring terminated at 45.5 feet.
Groundwater encountered at 30.5 feet.
Boring drilled 10/30/91 with CME 75 rig.
Boring grouted from 45.5 to 39 feet and converted into Monitoring Well 1 on 10/30/91

L & W Environmental Services, Inc. 2111 Jennings Street San Francisco, California	Log of Boring Number: MW 1 Sheet 3 of 3 Beck Roofing 21123 Meekland Avenue Hayward, California	
Project Number: 2116	December, 1991	Figure Number: 5

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
					0	3" asphalt cover.
		GC				Brown gravel-sand-clay mixture, moist, no odor.
2116-5-MW2	18	SM	145		5	Brown silty sand, fine-grained, medium dense, moist, no odor.
2116-10-MW2	10	SM	150		10	Brown silty sand, fine-grained, loose to medium dense, moist, no odor.
2116-15-MW2	12	SP	200		15	Brown sand, fine-grained, medium dense, moist, no odor.
2116-20-MW2	6	SP			20	Same, but loose.

L & W Environmental Services, Inc. 2111 Jennings Street San Francisco, California	**Log of Boring Number: MW 2** **Sheet 1 of 2** Beck Roofing 21123 Meekland Avenue Hayward, California
Project Number: 2116	Date: December, 1991 — Figure Number: 6

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
2116-25-MW2	19	CL	235		25	Brown sandy silty clay, very stiff, moist, no odor, medium plasticity.
2116-30-MW2	18	CL	245		30	Same.
2116-35-MW2	12	SM	255		35	Brown sand, fine-grained, medium stiff, wet, no odor.

Boring terminated at 38 feet.
Groundwater encountered at 33 feet.
Boring drilled 10/30/91 with CME 75 rig
Boring converted into Monitoring Well 2 on 10/30/91

L & W Environmental Services, Inc. 2111 Jennings Street San Francisco, California	Log of Boring Number: MW 2 Sheet 2 of 2 Beck Roofing 21123 Meekland Avenue Hayward, California	
Project Number: 2116	Date. December, 1991	Figure Number: 6

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
					0	
						Brown silty clay with sand and gravel, moist, no odor.
2116-5-MW3	9	CL	115		5	Brown silty clay, stiff, moist, no odor medium plasticity.
2116-10-MW3	12	SM	125		10	Brown silty sand, fine-grained, medium dense, moist, no odor.
2116-15-MW3	12	SM	135		15	Same.
						Brown silty clay, stiff; moist, slight odor, medium plasticity.
2116-20-MW3	5	CL			20	Brown silty clay, medium stiff, moist, odor, medium plasticity.

L & W Environmental Services, Inc. 2111 Jennings Street San Francisco, California	**Log of Boring Number: MW 3** **Sheet 1 of 2** Beck Roofing 21123 Meekland Avenue Hayward, California
Project Number: 2116	Date: December, 1991 / Figure Number: 9

Sample Number	Blows per Foot	Soil Type	Time	Log	Depth in Feet	DESCRIPTION
2116-25-MW3	14	CL	207		25	Same.
2116-30-MW3	13	CL	225		30	Same.
2116-35-MW3	13	SM	230		35	Brown silty sand, fine-grained, medium dense, wet.

Boring terminated at 38 feet.
Groundwater encountered at 33 feet.
Boring drilled 10/31/91 with CME 75 rig.
Boring converted into Monitoring Well 3 on 10/31/91

L & W Environmental Services, Inc. 2111 Jennings Street San Francisco, California	**Log of Boring Number: MW 3** **Sheet 2 of 2** Beck Roofing 21123 Meekland Avenue Hayward, California

Project Number: 2116	Date. December, 1991	Figure Number: 9