RISK-BASED CORRECTIVE ACTION
TIER 1 AND TIER 2 ANALYSES

FORMER BEACON STATION #574
22315 REDWOOD ROAD
CASTRO VALLEY, CALIFORNIA

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1.0 INTRODUCTION

1.1 Purpose

El Dorado Environmental, Inc. (EDE) has been authorized by Ultramar to prepare this report which documents the findings of a Risk-Based Corrective Action (RBCA) assessment conducted on the property located at 22315 Redwood Road, Castro Valley, Alameda County, California (Figure 1), the former location of Beacon station #574. According to a information available to EDE, all underground storage tanks (USTs) were removed from the site on May 5, 1987. Subsequent detection of petroleum hydrocarbon constituents in soil beneath the former tanks prompted a soil and ground water investigation, which included advancing soil borings and installation of monitoring wells. Aquifer pumping and soil vapor extraction tests were also performed at the site. Quarterly ground water monitoring is currently being conducted at the site.

The purpose of this RBCA assessment is to evaluate the risk to human health and the environment from exposure to the contamination to soil and ground water left in place. This RBCA analysis was completed using ASTM ES 1739-95, "Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites and was facilitated by use of the "Tier 2 RBCA Guidance Manual for Risk-Based Corrective Action," (Conner, et al, 1995).

1.2 Overview of ASTM RBCA Process

Traditional assessment and remedial action uses a "forward calculation" approach to estimate the carcinogenic and non-carcinogenic health risks that may be posed from exposure to chemical concentrations in specific media at a site. The ASTM RBCA approach starts with accepted risk levels and "back calculates" allowable levels of chemicals in the impacted soil and groundwater. The calculation is done using accepted risk assessment and fate and transport protocols. Some commonly used terms in risk assessment and fate and transport discussions are provided in Appendix A of this report.

ASTM guidance recommends a three-tiered approach for conducting corrective action at petroleum release sites. The tiered approach is designed to address the variation in complexity of sites. For a given site, increasingly sophisticated levels of data collection and analyses are employed as the decision process moves to higher levels of complexity (i.e., moves from a lower to a higher tier).

Tier 1 of the RBCA process consists of the following main components: 1) initial site evaluation to identify potential human and ecological receptors, and potentially significant transport pathways;

2) classification of the site regarding the need for immediate response; and 3) comparison of media-specific chemical concentrations detected at the site against conservatively calculated Risk-Based Screening Levels (RBSLs). Should site maximum chemical concentrations exceed the Tier 1 RBSLs, then a Tier 2 evaluation is appropriate for only those constituents that exceed Tier 1 RBSLs.

A Tier 2 evaluation may calculate Site-Specific Target Levels (SSTLs) using site-specific data and/or recommend alternative compliance points. In calculating SSTLs, the fate and transport equations used for the Tier 1 evaluation or other accepted models may be used.

A Tier 3 evaluation may also be pursued, using site-specific data and more complex fate and transport models and/or Monte Carol statistical simulations. For this site, a Tier 3 analysis was not warranted.

2.0 SITE ASSESSMENT

2.1 Site Location and Description

The site is located at the intersection of Redwood Road and Grove Way in Castro Valley, 700 feet north of the southwestward-flowing San Lorenzo Creek. An unnamed creek (tributary to San Lorenzo Creek) is located approximately 500 feet north of the site. The elevation of the site is approximately 150 feet above sea level. Castro Valley is situated in the east San Francisco Bay Area, south of the San Leandro Hills and northwest of Walpert Ridge. Ground surface in the area of the site generally slopes toward the southwest. The site is bounded on the north by Grove Way and on the east by Redwood Road. The surrounding area is predominantly commercial properties with residences located west and southwest of the subject site (Figure 2).

A total of eight monitoring wells have been installed on or near the site by Delta Environmental Consultants, Inc. (Delta) and Acton-Mickelson-van Dam, Inc. (AMV) since 1991. Ultramar leased the site and petroleum product storage and piping equipment and operated a retail gasoline service station at this site from 1981 to 1987. Prior to 1981, the site had been leased and operated by Shell Oil Company (Shell). Information provided by Ultramar indicates that in 1987, when Ultramar ceased leasing the property, all USTs then in existence were removed. Available data indicate that at least one previous generation of USTs had been installed and used at the site by Shell. The first generation of tanks was removed prior to Ultramar's lease of the property in 1981. It is EDE's understanding that Ultramar is not aware of any specific incidents in which gasoline leaked from the former USTs or was spilled during filling of any of the USTs. The site is currently occupied by commercial businesses in separate suites within a single building (illustrated on Figure 2).

2.2 Regional Geologic and Hydrogeologic Setting

The site is located in Castro Valley, California, in the eastern San Francisco Bay Area. Ground water has been reported at depths of 15 to 25 feet below grade at the site. The surface of Castro Valley is covered with Quaternary, nonmarine alluvium (referred to as "older alluvium" and described as dissected terrace deposits), probably deposited by San Lorenzo Creek and its tributaries (Wagner, et al., 1991). Cretaceous marine sedimentary rocks, assigned to the Panoche Formation, underlie the alluvium in Castro Valley, and form the surrounding hills and ridges. The northwest-trending Hayward fault zone is present west of the site.

2.3 Local Water Supply

Potable water is supplied to the site and other users in the area by the East Bay Municipal Utilities District (EBMUD). EBMUD imports water derived from surface water sources from the Sierra Nevada foothills; no municipal water wells are located in the area.

Well permit records available through the California State Department of Water Resources indicate the existence of a private water well, reportedly used for "irrigation" purposes at 22447 Charlene Way, approximately 400 feet south-southeast (cross-gradient) of the site. The "Water Well Drillers Report" for this well indicates a total depth of 52 feet below grade with perforated plastic casing between 32 and 52 feet below grade. This well was installed in September 1977; neither the current status nor the current use of water produced by this well is known.

3.0 RESULTS OF HYDROGEOLOGIC INVESTIGATION

3.1 Underground Storage Tank Removal

A portion of the information incorporated in this section first appeared in the "Problem Assessment Report/Remedial Action Plan, Former Beacon Station #574," dated November 10, 1994, by AMV. According to a work plan prepared by Ultramar dated January 12 ,1993, all USTs were removed from the site on May 5, 1987. Underground fuel storage at the site had previously consisted of two 5,000-gallon diesel tanks, a 7,000-gallon gasoline tank, and one 8,000-gallon gasoline tank. In addition, a 500-gallon waste oil tank was present at the site. Records made available by Ultramar indicate that these tanks were originally installed and owned by Shell. These tanks replaced a set of three underground storage tanks that were removed by Shell sometime prior to 1981, when Ultramar assumed the lease on the property. The results of soil samples collected at the time of UST removal indicated the presence of petroleum hydrocarbon constituents in soil underlying the tanks. Over excavation of the tank basin to a depth of approximately 20 feet was performed on May 18, 1987. After over excavation, three of the seven soil samples collected at the limit of the excavation contained total volatile hydrocarbons at concentrations of 125.5, 208.7, and 1,989 parts per million (ppm); BTEX analyses were not performed.

Initial UST samples identified up to 3,264 ppm TVH + 89 ppm benzene → avg. % is 3.2 % of TVH is benzene. Therefore 1,989 × 3.2 % = ~63.7 ppm benzene in conf. sample @ 20' bgs

3.2 Soil Borings and Monitoring Well Installation

On March 26, 1991, three soil borings were advanced at the site to depths of approximately 30 feet below grade and completed as 4-inch-diameter monitoring wells MW-1, MW-2, and MW-3 (Figure 2). Ground water was encountered in the borings for these wells at approximately 22 feet below grade. Soil borings containing descriptions of soil encountered as the borings were advanced are contained in Appendix A. Soil samples collected as the borings for monitoring wells MW-1 and MW-2 were advanced consisted of gravelly sand to a depth of 6.5 feet below grade, underlain by sandy clay or clayey sand to approximately 22 feet, and sand and silty sand to the total boring depth of 30 feet below grade (Appendix A).

Soil samples collected from the soil borings were submitted for laboratory analysis of benzene, toluene, ethylbenzene, xylenes (BTEX), total petroleum hydrocarbons as gasoline (TPHg), and total petroleum hydrocarbons as diesel (TPHd). The results are compiled in Appendix B, Table 1. None of the soil samples contained detectable concentrations of TPHd. The soil samples collected from above the water table in the boring for monitoring well MW-2 (near the northwest corner of the first generation USTs operated by Shell) contained detectable concentrations of TPHg. The samples collected from 10 and 15 feet below grade form this boring contained 8.1 and 3,200 ppm TPHg, respectively.

The monitoring wells were installed as described in well construction diagrams contained in Appendix C. Water level measurements made in monitoring wells MW-1, MW-2, and MW-3 on March 26 and April 1, 1991 (Table 1), indicated a direction of ground water flow toward the southwest. The gradient of ground water flow was approximately 0.015 foot per foot. Ground water samples collected from monitoring wells MW-1, MW-2, and MW-3 on April 1, 1991, did not contain detectable concentrations of TPHd. BTEX and TPHg were detected in ground water samples collected from these wells. Benzene concentrations ranged from 41 micrograms per Liter (μg/L) in a sample from monitoring well MW-3 to 650 μg/L in the sample collected from monitoring well MW-2 (Table 2).

Based on the results of installation of monitoring wells MW-1, MW-2, and MW-3, Ultramar prepared a work plan for installation of additional monitoring wells ("Work Plan, Subsurface Environmental Investigation at Former Beacon No. 574, 22315 Redwood Road, Castro Valley, California," January 11, 1993). The work plan proposed installation of five additional ground water monitoring wells. After approval of Ultramar's work plan by the Alameda County Health Care Services Agency, Environmental Health Services division (Alameda County), the proposed work plan was executed by AMV on May 13 and 18, 1993. AMV advanced and sampled five soil borings which were then converted to 2-inch-diameter monitoring wells MW-4, MW-5, MW-6, MW-7, and MW-8 (Figure 2).

Soil encountered by AMV in the boring for monitoring well MW-6 included silty clay from the surface to 8.5 feet below grade, silty sand between 8.5 and 14 feet below grade, silty clay beneath the silty sand to a depth of 19.5 feet, sandy silt between 19.5 and 27 feet below grade, and gravelly sand between 27 and 30 feet (the total depth of the boring). Ground water was encountered at about 20 feet below grade in the borings for monitoring wells MW-4 through MW-8. Soil boring logs for monitoring wells MW-4 through MW-8 are contained in Appendix A.

AMV submitted a total of 23 soil samples for laboratory analysis of BTEX and TPHg. None of the soil samples collected from the borings for monitoring wells MW-4 through MW-8 contained detectable concentrations of petroleum constituents (Appendix B, Table 1).

AMV completed monitoring wells MW-4 through MW-8 as described on well construction diagrams contained in Appendix C. AMV measured depth to ground water in each existing monitoring well (MW-1 through MW-8) on May 18, 1993. Depth to ground water ranged from 15.72 to 22.66 feet below the top of the well casings (Table 1). AMV's water level measurements indicated a direction of ground water flow toward the southwest at a gradient of 0.01 foot per foot.

AMV collected ground water samples for analysis from monitoring wells MW-4 through MW-8 only on May 18, 1993 (monitoring wells MW-1 through MW-3 had been sampled on May 7, 1993) for laboratory analysis of BTEX and TPHg. BTEX constituents were not present at detectable concentrations in ground water samples collected from monitoring wells MW-4 through MW-8 (Table 2). The sample collected from monitoring well MW-6 did contain 170 μg/L TPHg.

The most recent quarterly monitoring event at the site was conducted on September 16, 1996, by Doulos Environmental and reported by EDE. Depth to ground water on this date ranged from 16.52 (MW-5) to 24.42 feet below grade (MW-1). The direction of ground water flow was generally toward the southwest (Figure 3) at a gradient of 0.01 foot per foot.

Analytical results of ground water samples collected on September 16, 1996, indicate that BTEX constituents were detected only in samples collected from monitoring wells MW-1, MW-2, and MW-3 (the sample collected from monitoring well MW-6 contained 170 μg/L TPHg). The inferred distribution of benzene in ground water on September 16, 1996, is illustrated on Figure 4.

3.3 Hydrogeologic Testing Results

On January 31 and February 1 and 2, 1994, AMV conducted an aquifer test, an air sparging test, and a vapor extraction test using monitoring wells at the site. Starting on January 31, 1994, a 24-hour continuous pumping test was conducted, using monitoring well MW-1 as the pumping well. The pumping rate throughout the test was maintained at approximately 0.25 gallon per minute (gpm). Water levels were recorded in the pumping well and monitoring well MW-2 using an automated data logger. Monitoring well MW-2 is located approximately 55 feet from MW-1. After 24 hours of pumping, a drawdown of approximately 4.2 feet was measured in the pumping well, and approximately 0.11 foot of drawdown was measured in monitoring well MW-2. AMV reported that aquifer test analytical methods indicated a calculated hydraulic conductivity (K) of approximately 0.005 ft/min. AMV inferred that the observed drawdown at monitoring well MW-2 (located northwest and cross gradient of the pumping well), indicated a down gradient capture zone extent of approximately 17 feet, and a cross gradient capture zone width of approximately 110 feet.

The soil vapor extraction test was performed over a 4 hour period using monitoring well MW-1 as the extraction well. Pumping of ground water from monitoring well MW-1 was continued during the soil vapor extraction test to maximize the open screened area in this well during the vapor extraction test. AMV reported that the airflow rate during the test was approximately 43.6 standard cubic feet per minute (scfm). Throughout the vapor extraction test, AMV measured a vacuum influence of about 0.35 inch of water column at monitoring well MW-2, indicating a zone of vacuum influence around monitoring well MW-1 with a radius of at least 55 feet. Air samples collected during the vapor extraction test by AMV contained 66 ppm benzene and 7,800 ppm TPHg at the start of the test and 42 ppm benzene and 4,500 ppm TPHg at the end of the test. Based on the analytical and flow rate data, AMV calculated an initial extraction rate for TPHg of 67.7 pounds per day (lbs/day). AMV's calculated initial extraction rate for benzene was 0.57 lbs/day.

AMV conducted an 8-hour sparge test by injecting air through a temporary sparge point installed approximately 15 feet from monitoring well MW-1. Air was injected at a rate ranging from 7.0 to 7.7 scfm. Dissolved oxygen, carbon dioxide (CO_2), and TPHg concentrations in water and air from monitoring well MW-2 were monitored in the field and with samples collected for laboratory analysis during the test. Dissolved oxygen content in water samples collected from monitoring well MW-1 increased from 2.6 percent (sample collected before sparging began) to 6.5 percent (sample collected at the end of the sparge test). AMV inferred that these measurements indicated that a sparge rate averaging approximately 7.4 scfm had an influence at least 15 feet away at monitoring well MW-1.

4.0 SUMMARY OF HYDROGEOLOGICAL ASSESSMENT

4.1 Distribution of Petroleum Constituents in Soil

Soil samples collected from the borings for monitoring wells MW-4, MW-5, MW-6, MW-7, and MW-8 did not contain detectable concentrations of petroleum constituents. Soil samples collected from the borings for monitoring wells MW-1 and MW-3 at 20 feet below grade contained detectable concentrations of petroleum constituents; however, these samples were collected within the zone of water table fluctuation and probably reflect the presence of these constituents in ground water rather than the presence of these constituents in the vadose zone above ground water. Only the samples collected from above the water table in the boring for monitoring well MW-2, located near or possibly adjacent to the tank basin of the first generation tanks operated by Shell, contained detectable concentrations of TPHg. Soil sample analytical results (Appendix B) and the results of a vapor extraction test performed on monitoring well MW-1 indicate that only soil in the vicinity of the former USTs contains petroleum constituents.

AMV constructed two soil cross-sections to illustrate the inferred distribution of petroleum constituents in soil underlying the site. The cross-sections and a location map are contained in Appendix D.

4.2 Distribution of Petroleum Constituents in Ground Water

The direction of ground water flow beneath the site has been consistently toward the southwest. The ground water gradient has typically been 0.01 foot per foot.

The distribution of petroleum constituents in ground water is defined up gradient, down gradient, and cross gradient of the site. Ground water samples collected from monitoring wells MW-8 (up gradient), MW-5 (down gradient), and MW-4 (cross gradient) have historically not contained detectable concentrations of petroleum constituents.

Ground water samples collected from monitoring wells MW-1, MW-2, and MW-3 have consistently contained detectable concentrations of petroleum constituents. Benzene concentrations have been, on average, highest in samples collected from monitoring well MW-2, ranging from 1,500 to 3,100 µg/L (the maximum benzene concentration in ground water (6,200 µg/L) was detected in a sample collected from monitoring well MW-1 in November 1993). The most recent benzene distribution map (Figure 4) indicates ground water containing dissolved petroleum constituents is limited to the area of the former USTs, with some dispersion towards the north (monitoring well MW-3). The nearest monitoring wells at off-site locations do not contain dissolved benzene.

5.0 RBCA EVALUATION

5.1 Site Classification and Initial Response Action

As site information is gathered and evaluated, ASTM RBCA guidance recommends classifying the site based on the urgency for response. The four possible site categories include: immediate, short-term, long-term, or no demonstrable threat to human health, safety, or sensitive environmental receptors. Once a site is classified, ASTM RBCA recommends appropriate initial response actions corresponding to each classification category.

As described in the preceding section, initial response at the site has been limited to removal of the USTs and excavation of impacted soils in the area of the former UST basin. Current site conditions indicate that the site does not pose an immediate or short-term threat to receptors. **Available records indicate** that the nearest water well in the vicinity of the site is located **approximately 400 feet south-**

southeast (cross-gradient) of the subject site. Since ground water beneath the site has been impacted, the site would be classified under the ASTM RBCA scheme as potentially representing a long-term threat. Therefore, the potential for long-term threat from the site is evaluated in this tiered approach and the appropriate response is recommended in Section 6.0 of this report.

5.2 Tier 1 Evaluation

This section of the report presents the results of a Tier 1 screening. The first subsection introduces the Tier 1 Look-Up Tables and discusses their components and their development. The second subsection presents the exposure assessment which helps identify appropriate populations and pathways for consideration in screening. The last subsection discusses the Tier 1 screening results.

5.2.1 Tier 1 Look-Up Tables

The RBSL Look-Up Tables, as developed by ASTM, were used for the initial screening. The Look-Up Tables are compilations of media-specific chemical concentrations based on potential exposure pathways and acceptable risk levels. The Look-Up Tables containing RBSLs for chemicals of concern in soil and ground water are contained in Appendix E. Appendix F contains information regarding the potential chemicals of concern included in the Look-Up Tables. The information in Appendix F includes physical, chemical, and toxicity information, and fate and transport characteristics that subsequently influence the likelihood of exposure pathways becoming complete. Exposure pathways are discussed in detail in Section 5.2.2.

RBSLs are determined by combining target risk levels with toxicity values and standard default values for specific exposure scenarios. As recommended by ASTM, the information used to develop RBSLs was verified as current with accepted USEPA methodology prior to using the published Tier 1 Look-Up Tables. Exposure frequency and duration variables used in the calculations are considered standard default values and represent the reasonable maximum exposure (RME) expected to occur under both current and future land-use conditions. RME values are considered plausible estimates of the individual exposure for persons at the upper, or high, end of an exposure distribution. The high end of the distribution means above the 90 percentile of the population distribution, but not higher than the individual in the population who has the highest exposure.

RBSLs for some of the exposure pathways were calculated using attenuation factors. Attenuation factors adjust for reduction in chemical concentrations with distance and time due to processes such as diffusion, dispersion, adsorption, degradation, and other natural processes. The attenuation factors used by ASTM to calculate RBSLs were developed using the Johnson and Ettinger (1991) fate and transport equation.

Tier 1 target risk levels are numeric values that are determined using conservative assumptions in order to be protective of human health. Target risk levels are established for both carcinogens and

Tier 1

Residential (10^{-6})
downgradient
→ Indoor resident — gw

Commercial (10^{-5})
on-site
→ Indoor worker — soil / gw
→ Construction worker — soil / gw
→ gw well on-site (hypothetical) — gw

non-carcinogens. For non-carcinogens, the target risk level is set at one (refer to Appendix F). For carcinogens, USEPA states that to be protective of human health, exposure should be limited so as to result in an individual upper bound excess lifetime carcinogenic risk level of 1 in 10,000 or less (USEPA, 1989). USEPA has set the target risk level range for carcinogens between 1 in 10,000 to 1 in 1,000,000. The mid-range, 1 in 100,000, is a commonly accepted remediation goal for a commercial or industrial setting. For the purposes of this evaluation, the risk level used in this Tier 1 evaluation for commercial exposure to carcinogens has been set at 1 in 100,000; for evaluating any potential residential exposure to carcinogens, the conservative target risk of 1 in 1,000,000 is used.

The following sections present the evaluation of exposure potential at the site and identify the potential exposure populations and pathways at the source. Section 5.2.3 presents the tables, compares the appropriate RBSLs to the maximum concentrations detected at the site, and evaluates the results.

5.2.2 Tier 1 Exposure Assessment

In the Tier 1 exposure assessment, potentially exposed populations near the source and potential exposure pathways are identified. The site physical description, hydrogeological conditions, and land zoning and water use in the surrounding area are all considered in determining potential exposure at the site. The site is not suitable habitat for wildlife, therefore, the following sections focus on potentially exposed human populations.

5.2.2.1 Potentially Exposed Populations

The site is located in a well-developed area of Castro Valley and is surrounded by commercial and residential properties. A discussion of land use in the area is contained in Section 2.1.

The site is currently used for commercial purposes, with several units in a single building, each with a separate commercial business. Potentially exposed populations at the site under current conditions are business workers who spend most of their time indoors. This receptor group is considered in the Tier 1 evaluation. Customers are not typically evaluated in Tier 1 RBCA assessments due to their sporadic, short-term exposure and because their potential exposures would be less than that estimated for a full-time worker.

There are no known construction or excavation activities ongoing at the site, although these activities could occur in the future. Future activities, such as building erection or underground utilities work, could feasibly bring a construction worker into contact with hydrocarbon-impacted soil at the site. Although exposure would be of short duration, hypothetical future construction workers are conservatively considered in the Tier 1 evaluation.

Future land use of the property and surrounding area is not expected to change due to the current development in the area and the property's current commercial zoning, therefore, future receptors at the site are not expected to change. Since the zoning of the property is not expected to change from commercial to residential, a future resident on site was not evaluated.

The nearest buildings to the site are the residences and apartments located to the west/southwest and the commercial building and restaurant located south of the site. The general direction of ground water flow has historically been toward the south/southwest. **The residents of the houses and apartments are considered as a potentially exposed off-site population.**

The property to the south is used commercially. It is expected to remain commercially zoned. The maximally potentially exposed population in the future for this property would be a full-time worker. However, exposure for this hypothetical receptor would be less than that for an on-site worker. Therefore, these potential off-site workers were not characterized in this assessment.

Other residences and commercial buildings are located further from the source than the buildings identified above. Because exposure concentrations decrease rapidly with distance, the risk to occupants in a building located further from the site will be lower that the risk to occupants in buildings identified above. Therefore, exposure and risk were not determined for occupants of buildings located at greater distances.

5.2.2.2 Potential Exposure Pathways

An exposure pathway is the course that a chemical takes from the hydrocarbon source to the exposed individual. An exposure pathway consists of the following four elements:

- A source of chemical released to the environment (such as impacted soil or ground water).
- An environmental transport medium (soil, ground water, or air).
- A point of potential human contact with the hydrocarbon-impacted medium (a Tier 1 evaluation considers the point of contact as near the source).
- An exposure route (ingestion, inhalation, or dermal contact).

Each exposure pathway describes a unique mechanism by which a population may be exposed to the hydrocarbons from the site. For an exposure pathway to be complete, all four elements listed above must be present. Pathways that are incomplete, such as when a hydrocarbon compound is released but there is no potential for contact with a receptor, are excluded from this evaluation.

Drinking water for the convenience store and local area is supplied by the EBMUD. **Although** ground water is impacted, there are no drinking water wells on site nor are there any known potable water well systems in the area. The California State Department of Water Resources records indicate the existence of an "industrial" water supply well within approximately 400 feet (cross-gradient) of the site. The Tier 1 evaluation is limited to on- or near-site receptors. To insure a conservative Tier 1 evaluation with respect to potential ground water consumption, it was assumed that ground water from a well on the property could be used in the future for commercial use. This assumption conservatively addresses the possibility of on- or near-site ground water withdrawal and consumption.

All hydrocarbon-impacted soils and ground water are located beneath the surface. Because of the asphalt and concrete surface coverings, current direct human exposure such as through ingestion or dermal contact to hydrocarbon-containing media is not likely. Although no future construction activities are planned for the property, should future construction or excavation take place, direct exposure to hydrocarbon-impacted soil and ground water may occur. This exposure is conservatively evaluated for a hypothetical construction worker in Tier 1.

Vapors from hydrocarbon-impacted soil and ground water beneath the site may migrate through the soil to the surface or into buildings. The likely receptor point on the site is inside the building, since potential workers at the commercial building are indoors full time.

Should hydrocarbon-impacted ground water migrate from the site to beneath a down gradient building, it is possible that vapor intrusion into an off-site residence may occur. Therefore, this pathway is conservatively assumed to be complete for the Tier 1 evaluation.

In summary, based on current site conditions and anticipated future conditions as described, potentially completed exposure pathways evaluated include:

- Direct contact with impacted ground water at the site.
- Vapor transport from hydrocarbon-impacted soil and ground water through the soil into the on-site commercial building.
- Vapor transport from hydrocarbon-impacted ground water through the soil and into an off-site down gradient residential building.
- Direct exposure by ingestion, inhalation, and dermal contact as a result of future on-site excavation into hydrocarbon-impacted soil or ground water (commercial exposure).

5.2.3 Evaluation of Tier 1 Screening Results

This section of the report compares representative constituents of concern concentrations detected in on-site soil and ground water samples to media specific RBSLs and evaluates the results. The Tier 1 analysis was facilitated using software provided by Conner, et. al., 1995. Representative chemical concentrations in hydrocarbon-impacted ground water samples were determined by selecting the maximum benzene, ethylbenzene, toluene, and xylenes (BETX) concentrations in detected in ground water samples collected from on-site monitoring wells MW-1, MW-2, MW-3, and MW-4 on September 16, 1996. Representative concentrations in soil were determined by averaging the results of soil samples which contained BETX concentrations above analytical detection limits collected from borings for on-site monitoring wells MW-1, MW-2, MW-3, and MW-4. ? What about source areas?

Appendix G contains tables which compare the representative concentrations of COCs detected at the site to relevant Tier 1 RBSLs based on potentially completed exposure pathways. For the protection of ground water underlying the site, the RBSL for benzene in subsurface soils was calculated to be 0.013 mg/Kg. This number must be corrected for California's more restrictive MCL by multiplying by the factor 0.29, which yields a California RBSL for benzene of 0.00377 mg/Kg, which is exceeded by the mean benzene concentration in subsurface soil of 0.73 mg/Kg. RBSLs for the constituents ethylbenzene, toluene, and xylenes were not exceeded.

Under the conservative assumption of (non-residential) ground water consumption at the site, the California RBSL for benzene in ground water beneath the site (1 μg/L) was exceeded by the maximum ground water concentrations of 3,200 μg/L. benzene was 7,000 ppb in 3/96

The Tier 1 analysis was not performed for surface soils because the shallowest detection of COCs in soil was a sample collected from 10 feet below grade.

Because RBSLs were exceeded, a decision was required whether to continue remediation until Site levels are below RBSLs or to upgrade to a Tier 2 evaluation. It was decided to proceed to a Tier 2 evaluation for the following reasons:

- The generic assumptions used to derive the Tier 1 RBSLs were not appropriate for the site. As an example, RBSLs for soil vapor intrusion into buildings were based on the assumption that the soil is sandy, resulting in a high vapor flux. However, the site vadose zone soils actually consist of clayey sand, silty sand, and sandy clay. In addition, the RBSLs for soil vapor intrusion were based on the assumption that the building was located directly over the impacted soil. At this site, the buildings are a known distance from the impacted soil. Both of these assumptions result in overly conservative RBSLs.

- The cost to move to the higher tier is significantly less than the cost of continuing corrective action to meet Tier 1 RBSLs.

- It is likely that by moving to a higher tier, the more site-specific corrective action goals will differ significantly from the Tier 1 RBSLs while maintaining the same levels of human and environmental protection.

5.3 Tier 2 Evaluation

This section of the report presents the Tier 2 evaluation for determining site-specific target levels (SSTLs) at the site. A Tier 2 evaluation may include a recommendation for alternative compliance points, use of site-specific data in the RBCA Tier 1 fate and transport algorithms, or use of site-specific data in other predictive models.

5.3.1 General Approach

Predictive models are used to account for chemical attenuation with time and distance from the source and are usually characterized by the following:

- The models are relatively simple and are often algebraic or semi-analytical expressions.

- Input to the model is limited to practicably attainable site-specific data, or easily estimated quantities, such as soil bulk density and total porosity.

- The models are based on descriptions of relevant physical/chemical phenomena. These simple models may neglect certain mechanisms; however, this generally results in lower, more conservative SSTLs (for example, assuming constant concentrations in the source area).

- The models involve some degree of uncertainty, but are based on assumptions that tend to over-estimate the predicted exposure risk and, therefore, are conservative and protective of human health and the environment.

The approach taken and the specific equations applied in this Tier 2 evaluation are described in Conner, et. al, 1995. The attenuation factors calculated for vapor and ground water transport by the model equations are applied in the SSTL calculations to account for dispersion, adsorption, and natural attenuation. The procedures used to develop attenuation factors are described in Section 5.3.2.4.

Tier 2

downgradient
(residential)
→ indoor resident — soil? / gw?
→ Drinking H_2O (400 ft)

On site
(commercial)
→ indoor worker — soil ✓ / gw ✓

5.3.2 Tier 2 Exposure Assessment

The Tier 2 exposure assessment reviews potentially exposed populations and potential exposure pathways both on and off site, as described in the Tier 1 exposure assessment.

5.3.2.1 Potentially Exposed Populations

The only on-site potentially exposed population evaluated in this Tier 2 is the full-time indoor, on-site office worker. As discussed in Section 5.2.2.1, customers are not considered in either a Tier 1 or Tier 2 evaluation because their potential for exposure is short-term and sporadic. (Also, since the Tier 1 evaluation of future construction workers did not indicate risk, even under conservative full-time exposure conditions, this group was excluded from this assessment.) Future on-site residential receptor populations are not evaluated in this Tier 2 analysis because the current commercial development of the site and its land use zoning make it unlikely that land use will revert to residential in the future.

As described in Section 5.2.2.1, the nearest potentially exposed receptors off the site are toward the west-southwest. Ground water flows toward the southwest beneath the site. **Both adult and child residents are considered as potentially exposed populations for the Tier 2 evaluation.** If this assessment demonstrates that there is no risk to the nearest receptors (on-site workers and off-site residents, including children, immediately adjacent to the site), then it is reasonable to assume that there would be no risk to occupants of more distant residential properties.

5.3.2.2 Potential Exposure Pathways

The potential exposure pathways for on-site indoor workers are the same as those described in Section 5.2.2.2 for the Tier 1 analysis, except that no ground water consumption is assumed for the site property; the nearest potentially exposed population is specified at 400 feet from the site for the Tier 2 analysis. This corresponds to the approximate location of a permitted water well, according to DWR records. Completed exposure pathways for on-site indoor workers are:

- Vapor transport from hydrocarbon-impacted soil to the interior of the commercial structure on site, followed by inhalation by a worker.

- Vapor transport from hydrocarbon-impacted ground water through the soil to the interior of the commercial offices and subsequent inhalation by a worker.

Potentially completed exposure pathways for the nearest off-site residential receptor populations (both child and adult) include the following:

- Vapor migration from hydrocarbon-impacted soil at the site to the nearest off-site residence, followed by intrusion into the home, and subsequent inhalation by its occupants.

- Impacted ground water migration from the site to the nearest off-site residence, followed by vapor partitioning under the building, upward migration through the soil, intrusion into the building, and vapor inhalation by residents.

Based on the availability, convenience, and cost of potable water supplied by EBMUD at this location, it is thought generally unlikely that homeowners would install private wells for potable water use in the future. Really? What if there is a drought?

- As noted, a permitted water well is located approximately 400 feet cross-gradient from the subject site, with a permitted use as an "irrigation" well. To insure ground water protection, water produced by this well was assumed to be used for human consumption. ok

5.3.2.3 Exposure Equations and Assumptions

Equations used to develop Tier 2 SSTLs for those pathways identified as potentially complete are contained in Appendix H. The first step in the Tier 2 evaluation is to calculate target values of COCs in air by using risk equations that include exposure variables, toxicity values, and target risk goals. Air target values are then divided by soil and ground water attenuation factors to determine target levels in soil and ground water. Definitions of the terms used in equations are also contained in Appendix H.

Full time indoor workers are assumed to breath 20 cubic meters of air per day (m^3/day) (USEPA, 1990) and weigh an average of 70 kilograms (Kg) (OSWER, 1991). Workers at the site are assumed to work 8 hours each day for 250 days each year (OSWER, 1991). Based on information provided in Conner, et al (1995), a mean exposure duration of 4 years is the Most Likely Exposure (MLE) for commercial workers.

Both adults and children are considered residential receptors. The average adult's weight is assumed to 70 Kg (OSWER, 1991). The child's weight averages 15 Kg until the age of 6 years, during which period of time he/she is most sensitive to exposure. Both adult and child receptors are assumed to breath 20 m^3/day outdoors and 15 m^3/day indoors. Adults and children are assumed to reside in the house 350 days each year for their respective exposure periods, 30 years for an adult and 6 years for a child.

Averaging time (AT) is the time period over which the dose is averaged. For carcinogens, the biological response is described in terms of lifetime probabilities, and the averaging time is a 70-year lifetime (LT) (OSWER, 1991). For chronic exposure to non-carcinogens, the AT is the time period over which the exposure occurs (equal to the exposure duration).

Chemical-specific information for BETX, such as toxicity values and accepted risk levels, are presented in Appendix F. Since it is not practical to evaluate every compound present in a petroleum product to assess risk from a release, indicator chemicals are usually selected to characterize risk. Selection is dependent on consideration of exposure routes, concentrations, mobilities, and toxicological properties. BETX constituents were selected for the Tier 2 analysis based on their mobility, volatility, and toxicity characteristics.

5.3.2.4 Calculation of Natural Attenuation Factors

Equations and assumptions used to calculate natural attenuation factors are documented in Appendix H. These formulas and associated assumptions are from Conner, et al, 1995. The effect of each assumption on the numerical clean up standard is also documented in Appendix H.

5.3.2.5 Tier 2 Assessment Assumptions

For the purposes of vapor transport modeling, the soil vapor concentration at the source is assumed to be in equilibrium with the impacted soil. Values used for site-specific soil properties (fraction organic carbon, total soil porosity, and bulk density) and chemical-specific properties are default values provided by Conner, et al, 1995. These data are documented in a summary of Tier 2 inputs contained in Appendix I.

Vapor transport into buildings is dependent upon the chemical flow into the building, the volume of the building, and the number of building air exchanges per day. **Building volume to area ratios assumed for model input are those default values provided by Conner, et al, 1995.** Site specific?

Ground water transport of COCs is determined by such factors as the conductivity (K) of the soil and rock media, the natural geochemistry of the ground water and aquifer, the physical/chemical properties of the COCs, the length of ground water pathways through saturated and unsaturated zones, the rate of ground water flow, and aquifer heterogeneity. The model used for ground water transport is described in Appendix H. Assumptions used to model ground water transport include:

- Dispersion is three-dimensional.

- The source concentration is constant over time (an infinite mass or continual leak). Since USTs have been removed from this site and the mass of impacted soil is finite, this assumption results in a conservatively low target COC level.

- Default estimates of the organic carbon coefficient, the ground water mixing rate, and the ground water infiltration rate, as provided in Conner, et al, were used. The

ok?, not site specific

default value for effective porosity (38%) provided by Conner, et al, was also used.

- Bio-attenuation is assumed to operate along the ground water transport path based on the general availability of dissolved oxygen in natural aquifers.

5.4 Tier 2 SSTLs and Screening Results

The calculated Tier 2 SSTLs for air, soil, and ground water are compiled in Appendix I. As indicated on the summary sheets in Appendix I, most of the SSTL values calculated exceed chemical saturation limits in soil or are greater than the water solubility of the pure substance in ground water. This indicates that the COCs would not pose risk at any concentrations under these exposure conditions.

The calculated SSTL for benzene in indoor air (as a result of volatilization from both subsurface soils and ground water) is the only SSTL value below saturation. These concentrations, 160 mg/Kg for soil and 750 mg/L for ground water, become 46.40 mg/Kg and 217.50 mg/L, respectively after adjusting for California benzene standards. These values are not exceeded by the mean soil benzene concentration (0.73 mg/Kg) or the maximum ground water benzene concentration (3.2 mg/L), thus indicating that there is no threat to human health under these exposure conditions.

The Tier 2 evaluation indicates that potential health risks from the most mobile of the petroleum hydrocarbon constituents, the BETX compounds, are not significant for the maximally exposed population on- and adjacent to the site. The potential risk through exposure at more distant locations or for less mobile petroleum hydrocarbon constituents are therefore also insignificant.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this Tier 2 evaluation, concentrations of petroleum constituents in soil and ground water beneath the site are not high enough to pose a significant long-term threat to human health or the environment. Therefore, no further assessment or remediation activities are recommended. The existing ground water monitoring results (Table 2) dating back to March of 1992 indicate that the extent of the dissolved petroleum constituent plume in ground water is stable (results dating to May of 1993 that document the lack of detectable BETX constituents in samples collected from monitoring wells MW-4 through MW-8). With some fluctuations, the magnitude of BETX detections in samples collected from monitoring wells MW-1 through MW-3 also appears to be reasonably constant or decreasing.

Since the extent of the dissolved plume is not increasing and concentrations of BETX are constant (or at least not generally increasing), it is recommended that no further action be performed at this site. Monitoring wells should be abandoned by removal (drilling out) or completely filling the monitoring well casings with a non-shrinking grout mixture. The monitoring well head will be removed and the ground surface materials will be replaced to match the surrounding materials. A brief report will be prepared to document monitoring well abandonment procedures.

7.0 REFERENCES

Conner, J.A., Nevin, J.P., Malander, M., Stanley, C., and DeVaull, G., Tier 2 Guidance Manual for Risk-Based Corrective Action, Groundwater Services, Inc. 1995.

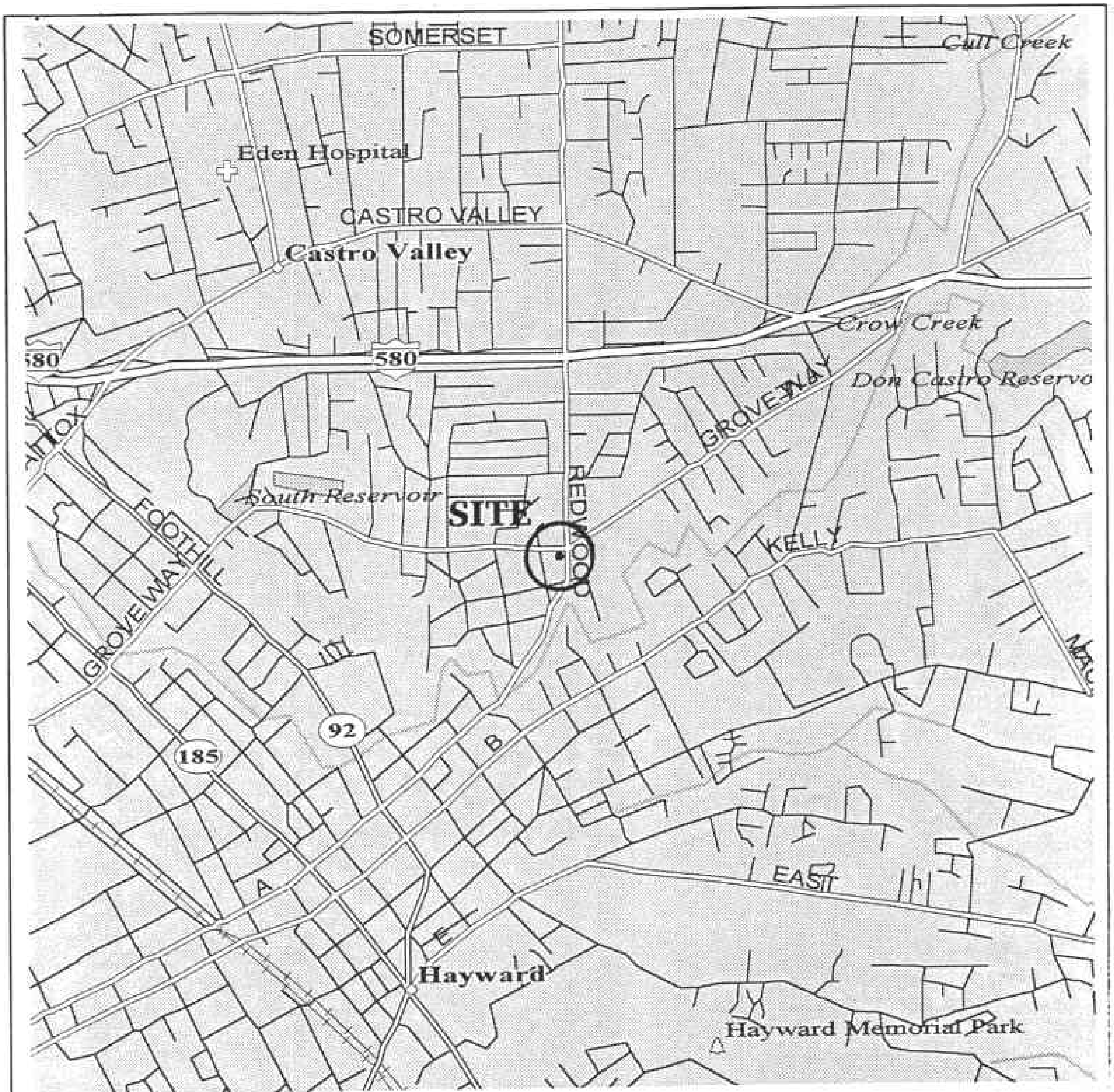
Johnson, P.C ., and Ettinger, R.A., "Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings," *Environmental Science and Technology*, Vol 25, No. 8, 1991, pp. 1445-1452.

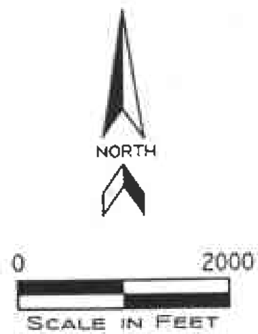
Maquire, S.R., June 1993, "Employer and Occupational Tenure: 1991 Update," Monthly Labor Review, 45-56.

Office of Solid Waste and Emergency Response (OSWER), 1991, Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors," Directive 9285.6-03.

USEPA, December 1989, Risk assessment Guidance for Superfund (Vol. 1) Human Health Evaluation Manual (Part A), EPA/540/1-89/002.

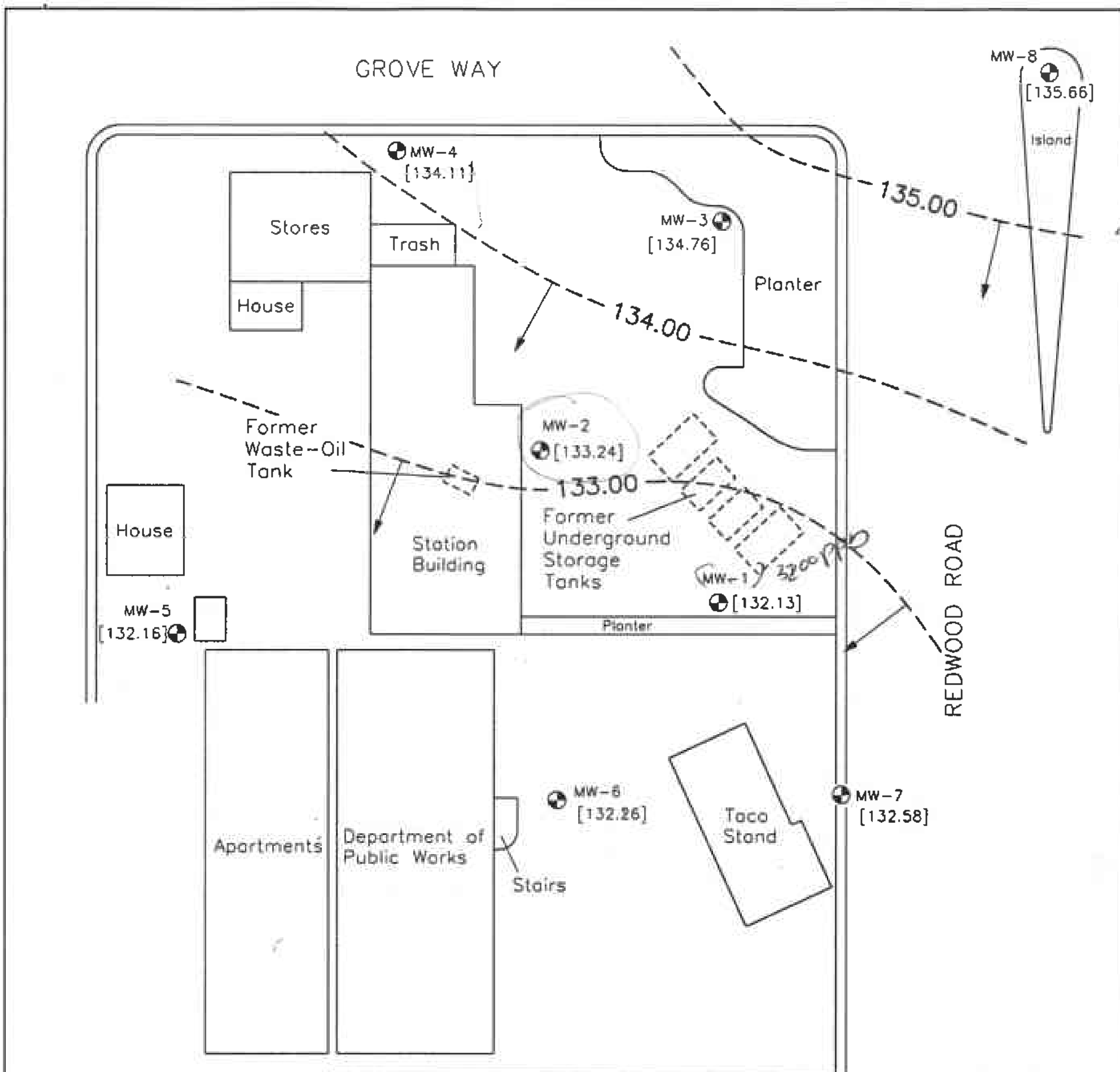
USEPA, March 1990, Exposure Factors Handbook, EPA/600/8-89/043.





SITE LOCATION MAP	FIGURE 1
BEACON STATION #574 22315 REDWOOD ROAD CASTRO VALLEY, CALIFORNIA	PROJECT NUMBER: U065.01 DRAWN BY: D.A.V.D.
EL DORADO ENVIRONMENTAL, INC.	CHECKED BY:

SOURCE: STREET ATLAS U.S.A., DELORME MAPPING, 1994



NORTH

0 50
SCALE IN FEET

EXPLANATION

MW-8 ⊕ Monitoring Well Location

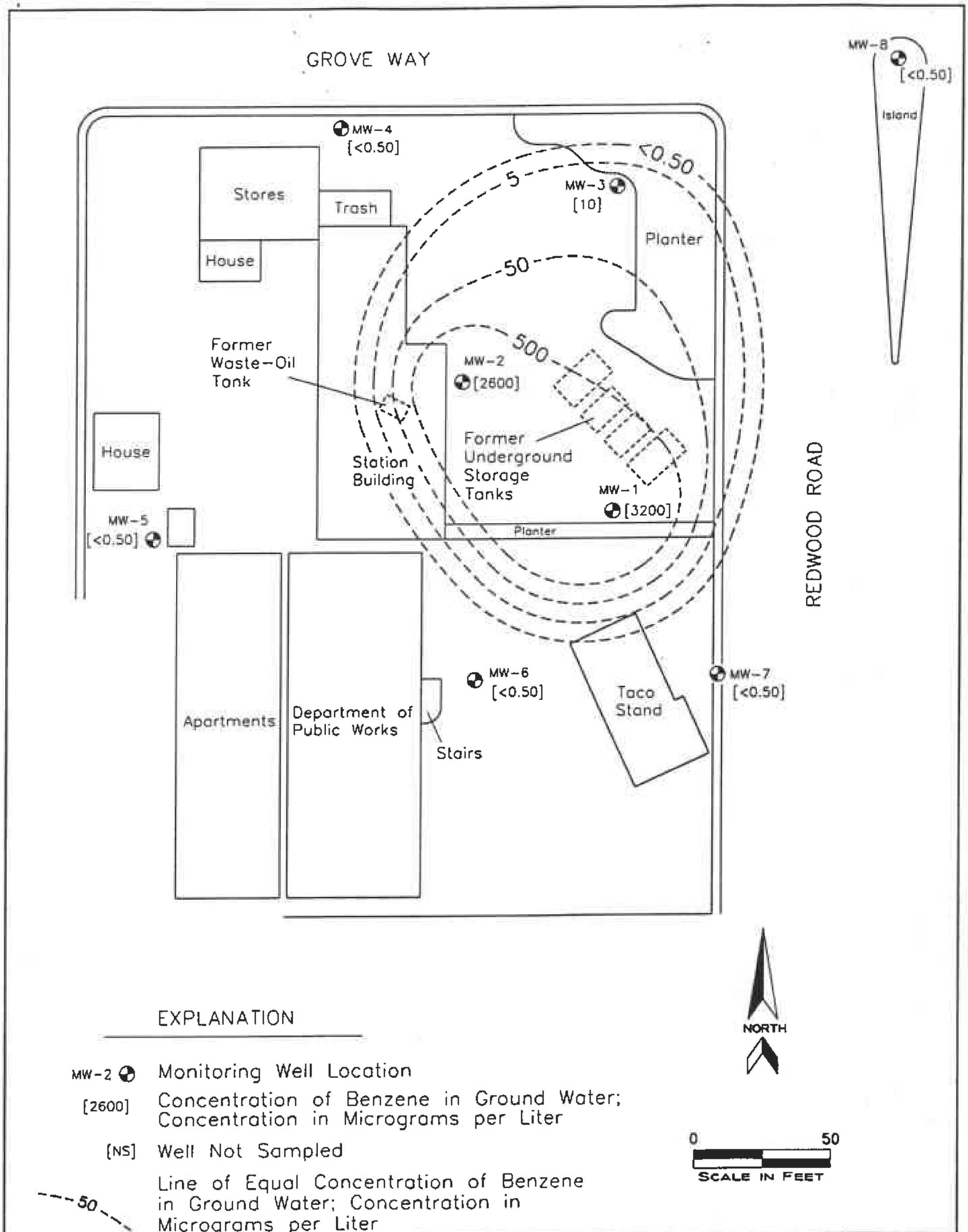
[135.66] Elevation of Ground Water Measured in Feet; Datum is Mean Sea Level

--- 134.00 --- Line of Equal Elevation of Ground Water Measured in Feet; Datum is Mean Sea Level

↙ Inferred Direction of Ground Water Flow

SOURCE: FIGURE MODIFIED FROM DRAWING PROVIDED BY FUGRO WEST, INC.

GROUND WATER CONTOUR MAP, SEPTEMBER 16, 1996	FIGURE 2
BEACON STATION #574 22315 REDWOOD ROAD CASTRO VALLEY, CALIFORNIA	PROJECT NUMBER: U065.01 DRAWN BY: D.A.
EL DORADO ENVIRONMENTAL, INC.	CHECKED BY: DJR



SOURCE: FIGURE MODIFIED FROM DRAWING PROVIDED BY FUGRO WEST, INC.

DISSOLVED BENZENE DISTRIBUTION MAP, SEPTEMBER 16, 1996	FIGURE 3
BEACON STATION #574 22315 REDWOOD ROAD CASTRO VALLEY, CALIFORNIA	PROJECT NUMBER: U065.01 DRAWN BY: D.A.
EL DORADO ENVIRONMENTAL, INC.	CHECKED BY: DVD

TABLE 1
GROUND WATER ELEVATION DATA
BEACON STATION #574
22315 REDWOOD ROAD, CASTRO VALLEY, CALIFORNIA
(Measurements in feet)

Monitoring Well	Date	Reference Elevation (top of casing)[1]	Depth to Ground Water[1]	Ground Water Elevation[2]	Well Depth	Comments
MW-1	03/27/92	156.55	22.43	134.12	---	
	06/04/92		23.40	133.15	---	
	09/23/92		24.07	132.48	---	
	11/12/92		24.16	132.39	29.33	
	02/02/93		21.87	134.68	29.80	
	05/07/93		22.58	133.97	29.84	
	05/18/93		22.66	133.89	---	
	08/11/93		23.41	133.14	29.81	
	11/05/93		24.09	132.46	29.81	
	03/01/94		22.76	133.79	29.85	
	06/02/94		23.24	133.31	29.85	
	09/09/94		23.93	132.62	29.86	
	12/20/94		22.94	133.61	29.85	
	03/08/95		22.20	134.35	29.71	
	06/14/95		22.65	133.90	29.70	
	09/26/95		23.44	133.11	29.71	
	12/27/95		23.04	133.51	29.72	
	03/26/96		21.39	135.16	29.71	
	06/05/96		22.43	134.12	29.73	
	09/16/96		24.42	132.13	29.74	
MW-2	03/27/92	155.17	20.82	134.35	---	
	06/04/92		21.81	133.36	---	
	09/23/92		22.45	132.72	---	
	11/12/92		22.60	132.57	29.71	
	02/02/93		20.28	134.89	29.73	
	05/07/93		20.97	134.20	29.73	
	05/18/93		21.06	134.11	---	
	08/11/93		21.85	133.32	29.70	
	11/05/93		22.32	132.85	29.70	
	03/01/94		21.19	133.98	29.68	
	06/02/94		21.59	133.58	29.69	
	09/09/94		22.33	132.84	29.66	
	12/20/94		21.37	133.80	29.65	
	03/08/95		20.60	134.57	29.52	
	06/14/95		21.04	134.13	29.54	
	09/26/95		21.84	133.33	29.53	
	12/27/95		21.44	133.73	29.56	
	03/26/96		19.81	135.36	29.56	
	06/05/96		20.83	134.34	29.59	
	09/16/96		21.93	133.24	29.58	

NOTES:
1 = Measurement and reference elevation taken from notch/mark on top north side of well casing.
2 = Elevation referenced to mean sea level
Well Depth = Measurement from top of casing to bottom of well.
--- = Not measured.

TABLE 1
GROUND WATER ELEVATION DATA
BEACON STATION #574
22315 REDWOOD ROAD, CASTRO VALLEY, CALIFORNIA
(Measurements in feet)

Monitoring Well	Date	Reference Elevation (top of casing)[1]	Depth to Ground Water[1]	Ground Water Elevation[2]	Well Depth	Comments
MW-3	03/27/92	157.13	21.46	135.67	---	
	06/04/92		22.34	134.79	---	
	09/23/92		22.84	134.29	---	
	11/12/92		23.04	134.09	29.55	
	02/02/93		21.03	136.10	29.45	
	05/07/93		21.59	135.54	29.53	
	05/18/93		21.73	135.40	---	
	08/11/93		22.31	134.82	29.41	
	11/05/93		22.85	134.28	29.41	
	03/01/94		21.97	135.16	29.55	
	06/02/94		22.29	134.84	29.56	
	09/09/94		22.91	134.22	29.56	
	12/20/94		22.11	135.02	29.54	
	03/08/95		21.40	135.73	29.38	
	06/14/95		21.80	135.33	29.36	
	09/26/95		22.38	134.75	29.37	
	12/27/95		22.07	135.06	29.37	
	03/26/96		20.73	136.40	29.38	
	06/05/96		21.54	135.59	29.40	
	09/16/96		22.37	134.76	29.43	
MW-4	05/18/93	151.96	17.55	134.41	---	
	08/11/93		17.50	134.46	28.43	
	11/05/93		15.84	136.12	28.43	
	03/01/94		17.35	134.61	28.11	
	06/02/94		17.68	134.28	28.12	
	09/09/94		18.19	133.77	28.13	
	12/20/94		17.52	134.44	28.10	
	03/08/95		16.82	135.14	27.97	
	06/14/95		17.22	134.74	27.97	
	09/26/95		17.79	134.17	27.91	
	12/27/95		17.47	134.49	27.89	
	03/26/96		16.32	135.64	27.89	
	06/05/96		17.10	134.86	27.88	
	09/16/96		17.85	134.11	27.89	
MW-5	05/18/93	148.68	15.72	132.96	---	
	08/11/93		16.42	132.26	25.43	
	11/05/93		16.92	131.76	25.43	
	03/01/94		15.54	133.14	25.00	
	06/02/94		16.19	132.49	25.00	
	09/09/94		16.87	131.81	25.00	
	12/20/94		15.84	132.84	25.01	
	03/08/95		15.11	133.57	24.85	
	06/14/95		15.69	132.99	24.86	
	09/26/95		16.46	132.22	24.81	
	12/27/95		15.91	132.77	24.80	
	03/26/96		14.31	134.37	24.81	
	06/05/96		15.43	133.25	24.75	
	09/16/96		16.52	132.16	24.74	

NOTES:
1 = Measurement and reference elevation taken from notch/mark on top north side of well casing.
2 = Elevation referenced to mean sea level.
Well Depth = Measurement from top of casing to bottom of well.
--- = Not measured.

TABLE 1
GROUND WATER ELEVATION DATA
BEACON STATION #574
22315 REDWOOD ROAD, CASTRO VALLEY, CALIFORNIA
(Measurements in feet)

Monitoring Well	Date	Reference Elevation (top of casing)[1]	Depth to Ground Water[1]	Ground Water Elevation[2]	Well Depth	Comments
MW-6	05/18/93	153.96	20.80	133.16	---	
	08/11/93		21.64	132.32	31.15	
	11/05/93		22.11	131.85	31.15	
	03/01/94		20.80	133.16	29.96	
	06/02/94		21.37	132.59	29.98	
	09/09/94		22.05	131.91	29.96	
	12/20/94		21.06	132.90	29.89	
	03/08/95		20.29	133.67	29.67	
	06/14/95		20.81	133.15	29.65	
	09/26/95		21.62	132.34	29.66	
	12/27/95		21.12	132.84	29.63	
	03/26/96		19.50	134.46	29.60	
	06/05/96		20.56	133.40	29.63	
	09/16/96		21.70	132.26	29.65	
MW-7	05/18/93	156.09	22.64	133.45	---	
	08/11/93		23.25	132.84	30.75	
	11/05/93		23.93	132.16	30.75	
	03/01/94		22.72	133.37	30.11	
	06/02/94		23.22	132.87	30.12	
	09/09/94		23.90	132.19	30.12	
	12/20/94		22.98	133.11	30.10	
	03/08/95		22.14	133.95	29.91	
	06/14/95		22.61	133.48	29.91	
	09/26/95		23.43	132.66	29.90	
	12/27/95		23.01	133.08	29.90	
	03/26/96		21.32	134.77	29.87	
	06/05/96		22.37	133.72	29.91	
	09/16/96		23.51	132.58	29.90	
MW-8	05/18/93	158.04	21.55	136.49	---	
	08/11/93		22.43	135.61	34.82	
	11/05/93		23.00	135.04	34.82	
	03/01/94		22.05	135.99	34.04	
	06/02/94		22.29	135.75	34.04	
	09/09/94		22.99	135.05	34.04	
	12/20/94		22.14	135.90	33.98	
	03/08/95		21.25	136.79	34.48	
	06/14/95		21.70	136.34	34.49	
	09/26/95		22.29	135.75	34.40	
	12/27/95		21.96	136.08	34.43	
	03/26/96		20.48	137.56	34.42	
	06/05/96		21.50	136.54	34.41	
	09/16/96		22.38	135.66	34.43	

NOTES:
1 = Measurement and reference elevation taken from notch/mark on top north side of well casing.
2 = Elevation referenced to mean sea level.
Well Depth = Measurement from top of casing to bottom of well.
--- = Not measured.

TABLE 2
GROUND WATER ANALYTICAL RESULTS
BEACON STATION #574
22315 REDWOOD ROAD, CASTRO VALLEY, CALIFORNIA
(All results in micrograms per Liter)

Monitoring Well	Date Collected	Total Petroleum Hydrocarbons			Aromatic Volatile Organics			
		Gasoline	Diesel	Motor Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes
MW-1	03/27/92	5,600	<50	<50	760	900	230	1,100
	06/04/92	2,600	<800	NA	270	57	230	440
	09/23/92	3,400	NA	NA	480	430	110	550
	11/12/92	2,700	NA	NA	5.8	<5.0	140	340
	02/02/93	8,500	NA	NA	760	770	250	1,200
	05/07/93	7,700	NA	NA	970	630	280	1,500
	08/11/93	11,000	NA	NA	1,400	1,000	260	1,600
	11/05/93	36,000	NA	NA	6,200	4,700	1,400	7,100
	03/01/94	3,800	NA	NA	580	490	110	620
	06/02/94	8,900	NA	NA	1,900	1,200	420	2,100
	09/09/94	4,300	NA	NA	740	290	200	630
	12/20/94	3,900	NA	NA	550	260	150	510
	03/08/95	8,100	NA	NA	1,100	540	250	1,100
	06/14/95	NS	NS	NS	NS	NS	NS	NS
	09/26/95	8,600	NA	NA	2,100	550	420	1,300
	12/27/95	NS	NS	NS	NS	NS	NS	NS
	03/26/96	21,000	NA	NA	7,000	2,700	590	7,000
	06/05/96	NS	NS	NS	NS	NS	NS	NS
	09/16/96	13,000	NA	NA	3,200	770	470	2,900
MW-2	03/27/92	18,000	<50	<50	2,400	2,300	870	3,300
	06/04/92	14,000	<5,000	NA	1,900	1,700	580	2,300
	09/23/92	22,000	NA	NA	2,100	1,500	760	2,900
	11/12/92	29,000	NA	NA	2,400	860	540	3,500
	02/02/93	24,000	NA	NA	2,700	1,900	590	2,600
	05/07/93	19,000	NA	NA	1,800	1,300	460	2,600
	08/11/93	23,000	NA	NA	2,300	1,500	550	2,300
	11/05/93	30,000	NA	NA	3,100	2,900	860	3,700
	03/01/94	13,000	NA	NA	1,500	490	350	1,000
	06/02/94	12,000	NA	NA	2,000	790	460	1,300
	09/09/94	13,000	NA	NA	1,800	660	440	1,000
	12/20/94	16,000	NA	NA	2,300	1,000	650	1,900
	03/08/95	16,000	NA	NA	2,200	1,000	550	2,100
	06/14/95	NS	NS	NS	NS	NS	NS	NS
	09/26/95	18,000	NA	NA	2,500	1,000	770	2,700
	12/27/95	NS	NS	NS	NS	NS	NS	NS
	03/26/96	33,000	NA	NA	4,200	2,600	1,000	5,000
	06/05/96	NS	NS	NS	NS	NS	NS	NS
	09/16/96	19,000	NA	NA	2,600	490	560	2,000

NOTES:
< = Below indicated detection limit.
NS = Not sampled.
NA = Not analyzed.
* = Product is not typical gasoline.

TABLE 2
GROUND WATER ANALYTICAL RESULTS
BEACON STATION #574
22315 REDWOOD ROAD, CASTRO VALLEY, CALIFORNIA
(All results in micrograms per Liter)

Monitoring Well	Date Collected	Total Petroleum Hydrocarbons			Aromatic Volatile Organics			
		Gasoline	Diesel	Motor Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes
MW-3	03/27/92	160	<50	<50	9.2	4.8	10	23
	06/04/92	120	<50	NA	7.5	2.7	0.5	15
	09/23/92	220	NA	NA	8.3	4.3	6.2	19
	11/12/92	230	NA	NA	12	5.5	7.7	19
	02/02/93	86	NA	NA	2.4	0.71	2.7	6.2
	05/07/93	140	NA	NA	2.6	1.2	3.9	8.4
	08/11/93	490	NA	NA	15	8.1	14	37
	11/05/93	820	NA	NA	45	24	34	93
	03/01/94	410	NA	NA	7.4	2.7	5.6	10
	06/02/94	440	NA	NA	13	4.9	14	31
	09/09/94	620	NA	NA	12	4.8	9.7	20
	12/20/94	770	NA	NA	24	11	16	36
	03/08/95	300	NA	NA	6.1	0.97	4.8	7.5
	06/14/95	NS	NS	NS	NS	NS	NS	NS
	09/26/95	130	NA	NA	4.8	1.6	4.8	9.4
	12/27/95	NS	NS	NS	NS	NS	NS	NS
	03/26/96	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
	06/05/96	NS	NS	NS	NS	NS	NS	NS
	09/16/96	170	NA	NA	10	2.9	4.4	15
MW-4	05/18/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	08/11/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	11/05/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	03/01/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	06/02/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	09/09/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	12/20/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	03/08/95	NS	NS	NS	NS	NS	NS	NS
	06/14/95	NS	NS	NS	NS	NS	NS	NS
	09/26/95	NS	NS	NS	NS	NS	NS	NS
	12/27/95	NS	NS	NS	NS	NS	NS	NS
	03/26/96	NS	NS	NS	NS	NS	NS	NS
	06/05/96	NS	NS	NS	NS	NS	NS	NS
	09/16/96	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
MW-5	05/18/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	08/11/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	11/05/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	03/01/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	06/02/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	09/09/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	12/20/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	03/08/95	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	06/14/95	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	09/26/95	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
	12/27/95	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
	03/26/96	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
	06/05/96	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
	09/16/96	<50	NA	NA	<0.50	<0.50	<0.50	<0.50

NOTES:
< = Below indicated detection limit.
NS = Not sampled.
NA = Not analyzed.
* = Product is not typical gasoline.

TABLE 2
GROUND WATER ANALYTICAL RESULTS
BEACON STATION #574
22315 REDWOOD ROAD, CASTRO VALLEY, CALIFORNIA
(All results in micrograms per Liter)

Monitoring Well	Date Collected	Total Petroleum Hydrocarbons			Aromatic Volatile Organics			
		Gasoline	Diesel	Motor Oil	Benzene	Toluene	Ethyl-benzene	Total Xylenes
MW-6	05/18/93	170	NA	NA	<0.5	<0.5	<0.5	<0.5
	08/11/93	78	NA	NA	<0.5	<0.5	<0.5	<0.5
	11/05/93	170	NA	NA	<0.5	<0.5	<0.5	0.65
	03/01/94	210	NA	NA	<0.5	<0.5	<0.5	<0.5
	06/02/94	190	NA	NA	<0.5	<0.5	<0.5	<0.5
	09/09/94	140	NA	NA	<0.5	<0.5	<0.5	<0.5
	12/20/94	210	NA	NA	<0.5	<0.5	<0.5	<0.5
	03/08/95	180*	NA	NA	<0.5	<0.5	<0.5	<0.5
	06/14/95	220*	NA	NA	<0.5	<0.5	<0.5	<0.5
	09/26/95	110*	NA	NA	<0.50	<0.50	<0.50	<0.50
	12/27/95	130*	NA	NA	<0.50	<0.50	<0.50	<0.50
	03/26/96	100*	NA	NA	<0.50	<0.50	<0.50	<0.50
	06/05/96	100*	NA	NA	<0.50	<0.50	<0.50	<0.50
	09/16/96	170	NA	NA	<0.50	<0.50	<0.50	<0.50
MW-7	05/18/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	08/11/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	11/05/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	03/01/94	60	NA	NA	<0.5	<0.5	<0.5	<0.5
	06/02/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	09/09/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	12/20/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	03/08/95	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	06/14/95	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	09/26/95	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
	12/27/95	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
	03/26/96	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
	06/05/96	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
	09/16/96	<50	NA	NA	<0.50	<0.50	<0.50	<0.50
MW-8	05/18/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	08/11/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	11/05/93	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	03/01/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	06/02/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	09/09/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	12/20/94	<50	NA	NA	<0.5	<0.5	<0.5	<0.5
	03/08/95	NS	NS	NS	NS	NS	NS	NS
	06/14/95	NS	NS	NS	NS	NS	NS	NS
	09/26/95	NS	NS	NS	NS	NS	NS	NS
	12/27/95	NS	NS	NS	NS	NS	NS	NS
	03/26/96	NS	NS	NS	NS	NS	NS	NS
	06/05/96	NS	NS	NS	NS	NS	NS	NS
	09/16/96	<50	NA	NA	<0.50	<0.50	<0.50	<0.50

NOTES:
< = Below indicated detection limit.
NS = Not sampled.
NA = Not analyzed.
* = Product is not typical gasoline.

PROJECT NAME / LOCATION	PROJECT NUMBER: 40-90-818	BORING NUMBER: MW-1	SHEET 1 OF 2
Former Beacon Station #574 22315 Redwood Road Castro Valley, CA	CONTRACTOR: West Hazmat Drilling		DRILLING METHOD: H.S.A.
	DRILLER: Gene Reinhart		DRILLING RIG: Acker
	START: 8:15/03-26-91		COMPLETED: 9:30/03-26-91
LAND OWNER: Paul Wilson	SURFACE ELEVATION: 156.55		LOGGED BY: Hal Hansen

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	SAMPLE INT (ft)	SAMPLE RECOV (in)	DEPTH SCALE 1"= 4'	DESCRIPTIONS OF MATERIALS AND CONDITIONS	CONTAMINANT OBSERVATION INSTRUMENT: hNu UNITS: ppm	GENERAL OBSERVATION NOTES
					0–1	ASPHALT AND ROADBASE		
					2–3	GRAVELLY SAND; olive, fine to coarse-grained, common plastic fines, moist (SP)		
CA	MW-1-1	15/30/50 for 5"	5.0-6.5	18"	5		0	
					7–9	SANDY CLAY; olive, moderately plastic, fine to coarse sand, some gravel, moist (CL)		
CA	MW-1-2	24/37/20	10.0-11.5	18"	10		0	
					14	CLAYEY SAND; olive-brown, fine to coarse sand, moist (SC)		
CA	MW-1-3	50 for 6"	15.0-16.5	7"	15		60	
CA	MW-1-4	30/50 for 5"	20.0-21.5	8"	20		180	
					22–23	SAND; olive-brown, fine-grained, saturated (SP)		

WATER LEVEL DATA			
DATE	03-26		
TIME	6:29		
GWL	22.43		
CASING DEPTH	30'		

GEOLOGIST

Hal Hansen (signature)

SIGNATURE

Hal Hansen

TYPED NAME

Screened ~10-30 ft

PROJECT NAME / LOCATION	PROJECT NUMBER: 40-90-818	BORING NUMBER: MW-1	SHEET 2 OF 2
Former Beacon Station #574 22315 Redwood Road Castro Valley, CA	CONTRACTOR: West Hazmat Drilling		DRILLING METHOD: H.S.A.
	DRILLER: Gene Reinhart		DRILLING RIG: Acker
	START: 8:15/03-26-91		COMPLETED: 9:30/03-26-91
LAND OWNER: Paul Wilson	SURFACE ELEVATION: 156.55		LOGGED BY: Hal Hansen

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	SAMPLE INT (ft)	SAMPLE RECOV (in)	DEPTH SCALE 1"= 4'	DESCRIPTIONS OF MATERIALS AND CONDITIONS	CONTAMINANT OBSERVATION INSTRUMENT: hNu UNITS: ppm	GENERAL OBSERVATION NOTES
CA	MW-1-5	8/23/25	25.0-26.5	8"	25	SILTY SAND; olive-brown, fine grained sand, saturated (SM)	8	
					26			
					27			
					28			
					29			
CA	MW-1-6	12/14/50 for 5"	30.0-31.5	7"	30		3	
					31			
					32	Total Depth 31.5 feet		
					33			
					34			
					35			
					36			
					37			
					38			
					39			
					40			
					41			
					42			
					43			
					44			
					45			
					46			
					47			

WATER LEVEL DATA			
DATE	03-26		
TIME	6:29		
GWL	22.43		
CASING DEPTH	30'		

GEOLOGIST

Hal Hansen

SIGNATURE

Hal Hansen

TYPED NAME

PROJECT NAME / LOCATION	PROJECT NUMBER: 40-90-818	BORING NUMBER: MW-2	SHEET 1 OF 2
Former Beacon Station #574 22315 Redwood Road Castro Valley, CA	CONTRACTOR: West Hazmat Drilling		DRILLING METHOD: H.S.A.
	DRILLER: Gene Reinhart		DRILLING RIG: Acker
	START: 10:30/03-26-91		COMPLETED: 11:45/03-26-91
LAND OWNER: Paul Wilson	SURFACE ELEVATION: 155.17		LOGGED BY: Hal Hansen

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	SAMPLE INT (ft)	SAMPLE RECOV (in)	DEPTH SCALE 1"= 4'	DESCRIPTIONS OF MATERIALS AND CONDITIONS	CONTAMINANT OBSERVATION INSTRUMENT: hNu UNITS: ppm	GENERAL OBSERVATION NOTES
					0	ASPHALT AND ROADBASE		
					1–5	GRAVELLY SAND; olive, fine to coarse-grained, common plastic fines, moist (SP)		
CA	MW-2-1	20/30/50 for 5"	5.0-6.5	7"	5		15	
					6–22	SANDY CLAY; olive, moderately plastic, fine to coarse sand some gravel, moist (CL)		
CA	MW-2-2	10/50 for 6"	10.0-11.5	12"	10		30	
CA	MW-2-3	30/50 for 5"	15.0-16.5	7"	15		90	
CA	MW-2-4	7/14/15	20.0-21.5	15"	20		90	
					22–23	SAND; olive-brown, fine-grained, saturated (SP)		

WATER LEVEL DATA			
DATE	03-26		
TIME	6:22		
GWL	20.91		
CASING DEPTH	30'		

GEOLOGIST

Hal Hansen (signature)

SIGNATURE

Hal Hansen

TYPED NAME

PROJECT NAME / LOCATION	PROJECT NUMBER: 40-90-818	BORING NUMBER: MW-2	SHEET 2 OF 2
Former Beacon Station #574 22315 Redwood Road Castro Valley, CA	CONTRACTOR: West Hazmat Drilling	DRILLING METHOD: H.S.A.	
	DRILLER: Gene Reinhart	DRILLING RIG: Acker	
	START: 10:30/03-26-91	COMPLETED: 11:45/03-26-91	
LAND OWNER: Paul Wilson	SURFACE ELEVATION: 155.17	LOGGED BY: Hal Hansen	

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	SAMPLE INT (ft)	SAMPLE RECOV (in)	DEPTH SCALE 1"= 4'	DESCRIPTIONS OF MATERIALS AND CONDITIONS	CONTAMINANT OBSERVATION INSTRUMENT: hNu UNITS: ppm	GENERAL OBSERVATION NOTES
CA	MW-2-5	15/16/18	25.0-26.5	16"	25	SILTY SAND; olive-brown, fine-grained sand, saturated (SM)	3	
					26			
					27			
					28			
					29			
CA	MW-2-6	14/22/43	30.0-31.5	14"	30		0	
					31			
					32	Total Depth 31.5 feet		
					33			
					34			
					35			
					36			
					37			
					38			
					39			
					40			
					41			
					42			
					43			
					44			
					45			
					46			
					47			

WATER LEVEL DATA			
DATE	03-26		
TIME	6:22		
GWL	20.91		
CASING DEPTH	30'		

GEOLOGIST

Hal Hansen

SIGNATURE

Hal Hansen

TYPED NAME

PROJECT NAME / LOCATION	PROJECT NUMBER: 40-90-818	BORING NUMBER: MW-3	SHEET 1 OF 2
Former Beacon Station #574 22315 Redwood Road Castro Valley, CA	CONTRACTOR: West Hazmat Drilling	DRILLING METHOD: H.S.A.	
	DRILLER: Gene Reinhart	DRILLING RIG: Acker	
	START: 1:40/03-26-91	COMPLETED: 3:00/03-26-91	
LAND OWNER: Paul Wilson	SURFACE ELEVATION: 157.13	LOGGED BY: Hal Hansen	

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	SAMPLE INT (ft)	SAMPLE RECOV (in)	DEPTH SCALE 1"= 4'	DESCRIPTIONS OF MATERIALS AND CONDITIONS	CONTAMINANT OBSERVATION INSTRUMENT: hNu UNITS: ppm	GENERAL OBSERVATION NOTES
						ASPHALT AND ROADBASE		
					1–2	SAND; brown, fine-grained, well sorted moist (SP)		
CA	MW-3-1	15/26/37	5.0-6.5	18"	5		0	
					7–8	CLAY; dark gray, lightly plastic, moist (CL)		
CA	MW-3-2	16/18/32	10.0-11.5	7"	10		0	
					12–14	SANDY CLAY; olive-brown, moderately plastic, moist (CL)		
CA	MW-3-3	23/50 for 5"	15.0-16.5	8"	15		1	
					19–20	SILTY CLAY; olive, moderately plastic, very moist (CL)		
CA	MW-3-4	50 for 6"	20.0-21.5	7"	20		8	
					22–23			

WATER LEVEL DATA			
DATE	03-26		
TIME	6:14		
GWL	21.62		
CASING DEPTH	30'		

GEOLOGIST

Hal Hansen (signature)

SIGNATURE

Hal Hansen

TYPED NAME

PROJECT NAME / LOCATION	PROJECT NUMBER: 40-90-818	BORING NUMBER: MW-3	SHEET 2 OF 2
Former Beacon Station #574 22315 Redwood Road Castro Valley, CA	CONTRACTOR: West Hazmat Drilling	DRILLING METHOD: H.S.A.	
	DRILLER: Gene Reinhart	DRILLING RIG: Acker	
	START: 1:40/03-26-91	COMPLETED: 3:00/03-26-91	
LAND OWNER: Paul Wilson	SURFACE ELEVATION: 157.13	LOGGED BY: Hal Hansen	

SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	SAMPLE INT (ft)	SAMPLE RECOV (in)	DEPTH SCALE 1"= 4'	DESCRIPTIONS OF MATERIALS AND CONDITIONS	CONTAMINANT OBSERVATION INSTRUMENT: hNu UNITS: ppm	GENERAL OBSERVATION NOTES
CA	MW-3-5	13/50 for 6"	25.0-26.5	8"	25	CLAYEY SAND; olive-brown, medium-grained sand, saturated (SC)	60	
					26			
					27			
					28			
					29			
CA	MW-3-6	14/50 for 6"	30.0-31.5	8"	30		0	
					31			
					32	Total Depth 31.5 feet		
					33			
					34			
					35			
					36			
					37			
					38			
					39			
					40			
					41			
					42			
					43			
					44			
					45			
					46			
					47			

WATER LEVEL DATA			
DATE	03-26		
TIME	6:14		
GWL	21.62		
CASING DEPTH	30'		

GEOLOGIST

Hal Hansen

SIGNATURE

Hal Hansen

TYPED NAME

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Consulting Scientists, Engineers, and Geologists

Log of Soil Boring MW-4

Casing Elevation: 151.96 ft

Completion Depth: 28 feet

Project No. 19021.01

Location: Former Beacon #574, 22315 Redwood Rd, Castro Valley, CA

Drilling Company: Woodward Drilling
Driller: Eric Forestrom
Drilling and Sampling Methods:
B-57 Mobile Drill Rig with Hollow Stem Auger
California modified split-spoon sampler fitted with 6" brass sample sleeves

Drilling	Date	Time
Start	05-13-93	11:40
Finish	05-13-93	12:00

Logged by: Hal E. Hansen

Checked by:

OVM/OVA: hNu PID with 10.2 eV Probe

Water Depth: 17.55 ft

Depth (feet)	DESCRIPTION	Graphic Log	Blows/6 in	Inches Driven	Inches Recov'd	Comments	Sample #	Field OVM/OVA Reading (ppm)
0	lawn							
0.5–4	SILTY CLAY, olive brown, moderately plastic, moist (CL)	CL						
4–15	GRAVELLY SAND, brown, fine- to coarse-grained, moist (SW)	SW	8, 9, 10	18	18		MW4-1	0
			50/6	6	3		MW4-2	0
15–18	SILTY CLAY, brown, moderately plastic, very moist (CL)	CL	10, 15, 20	18	18		MW4-3	0
18–23	SILTY SAND, brown, fine-grained, saturated (SM)	SM	27, 37, 40	18	18		MW4-4	0
23–	SAND, greenish gray, fine-grained saturated (SP)	SP	8, 12, 14	18	6		MW4-5	0

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Log of Soil Boring MW-4

Casing Elevation: 151.96 ft

Completion Depth: 28 feet

Project No.	19021.01
Location:	Former Beacon #574, 22315 Redwood Rd, Castro Valley, CA

Drilling Company: Woodward Drilling
Driller: Eric Forestrom
Drilling and Sampling Methods:
B-57 Mobile Drill Rig with Hollow Stem Auger
California modified split-spoon sampler
fitted with 6" brass sample sleeves

Drilling	Date	Time
Start	05-13-93	11:40
Finish	05-13-93	12:00

Logged by: Hal E. Hansen
Checked by:

OVM/OVA hNu PID with 10.2 eV Probe

Water Depth 17.55 ft

Depth (feet)	Sample Int.	DESCRIPTION	Graphic Log	Boring/Well Detail	Blows/6 In	Inches Driven	Inches Recov'd	Comments	Sample #	Field OVM/OVA Reading (ppm)
		continued from above								
25		SAND, greenish gray, fine-grained, saturated (SP)	SP		8 12 14	18	6		MW4-5	0
26										
27										
28		Terminated drilling at 28 feet.								
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										

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Log of Soil Boring MW-5

Project No. 19021.01

Location: Former Beacon #574, 22315 Redwood Rd, Castro Valley, CA

Drilling Company: Woodward Drilling
Driller: Eric Forestrom
Drilling and Sampling Methods: B-57 Mobile Drill Rig with Hollow Stem Auger, California modified split-spoon sampler fitted with 6" brass sample sleeves

Casing Elevation: 148.68 ft

Completion Depth: 25 feet

Drilling	Date	Time
Start	05-13-93	1:30
Finish	05-13-93	2:10

Logged by: Hal E. Hansen

Checked by:

OVM/OVA: hNu PID with 10.2 eV Probe

Water Depth: 15.72 ft

Depth (feet)	DESCRIPTION	Graphic Log	Blows/6 In	Inches Driven	Inches Recov'd	Comments	Sample #	Field OVM/OVA Reading (ppm)
0	asphalt							
0.5–6	CLAYEY SAND, brown, fine- to coarse-grained, moist (SC)	SC	11, 13, 18	18	15		MW5-1	0
6–11	SILTY SAND, brown, fine-grained, moist (SM)	SM	11, 12, 20	18	16		MW5-2	0
11–17.5	GRAVELLY SAND, brown, fine- to coarse-grained, common plastic fines, saturated (SW)	SW	14, 22, 50/3	15	15		MW5-3	0
17.5–25	SILTY SAND, greenish gray, fine-grained, saturated (SM)	SM	6, 10, 14	18	18		MW5-4	0
			6, 12, 14	18	5		MW5-5	0
25	Terminated drilling at 25 feet.							

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Log of Soil Boring MW-6

Project No.	Location:
19021.01	Former Beacon #574 22315 Redwood Rd, Castro Valley, CA

Casing Elevation: 153.96 ft

Completion Depth: 30 feet

Drilling Company: Woodward Drilling
Driller: Eric Forestrom
Drilling and Sampling Methods:
B-57 Mobile Drill Rig with Hollow Stem Auger
California modified split-spoon sampler
fitted with 6" brass sample sleeves

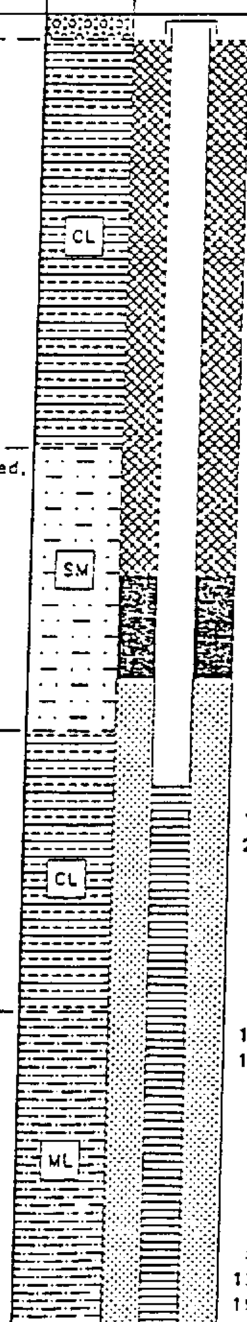
Drilling	Date	Time
Start	05-13-93	8:40
Finish	05-13-93	9:05

Logged by: Hal E. Hansen

Checked by:

OVM/OVA hNu PID with 10.2 eV Probe

Water Depth 20.80 ft



Depth (feet)	DESCRIPTION	Blows/6 In	Inches Driven	Inches Recov'd	Comments	Sample #	Field OVM/OVA Reading (ppm)
0	asphalt / roadbase						
1	SILTY CLAY, dark gray, moderately plastic, slightly moist (CL)						
5	color change to olive	5 8 18	18	18		MW6-1	0
9	SILTY SAND, yellowish brown, fine-grained, moist (SM)						
10		9 12 17	18	18		MW6-2	0
14	SILTY CLAY, olive, moderately plastic, very moist (CL)						
15		5 10 21	18	18		MW6-3	0
19.5	SANDY SILT, brown, non-plastic, fine-grained sand, saturated (ML)	7 14 16	18	18		MW6-4	0
25		5 12 19	18	15		MW6-5	1

File #19021004

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Log of Soil Boring MW-6

Casing Elevation: 153.96 ft

Completion Depth: 30 feet

Project No. 19021.01

Location: Former Beacon #574, 22315 Redwood Rd, Castro Valley, CA

Drilling Company: Woodward Drilling
Driller: Eric Forestrom
Drilling and Sampling Methods:
B-57 Mobile Drill Rig with Hollow Stem Auger
California modified split-spoon sampler
fitted with 6" brass sample sleeves

Drilling	Date	Time
Start	05-13-93	8:40
Finish	05-13-93	9:05

Logged by: Hal E. Hansen

Checked by:

OVM/OVA hNu PID with 10.2 eV Probe

Water Depth 20.80 ft

Depth (feet)	DESCRIPTION	Graphic Log	Blows/6 In	Inches Driven	Inches Recov'd	Comments	Sample #	Field OVM/OVA Reading (ppm)
	continued from above		5					
25	SANDY SILT, brown, non-plastic, fine-grained sand, saturated (ML)	ML	12 19	18	15		MW6-5	1
26								
27	GRAVELLY SAND, olive, fine- to coarse-grained, saturated (SW)							
28								
29		SW	5 14 23	18	17		MW6-6	1
30								

31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

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Log of Soil Boring MW-7

Casing Elevation: 156.09 ft

Completion Depth: 30 feet

Project No. 19021.01

Location: Former Beacon #574, 22315 Redwood Rd, Castro Valley, CA

Drilling Company: Woodward Drilling
Driller: Eric Forestrom
Drilling and Sampling Methods:
B-57 Mobile Drill Rig with Hollow Stem Auger
California modified split-spoon sampler
fitted with 6" brass sample sleeves

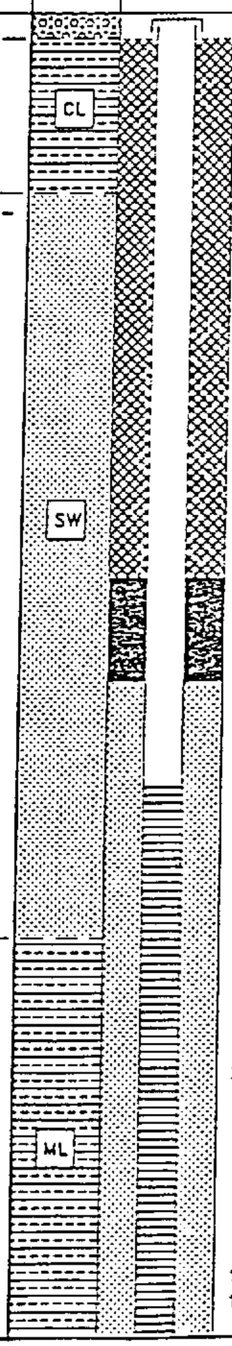
Drilling	Date	Time
Start	05-13-93	9:50
Finish	05-13-93	10:40

Logged by: Hal E. Hansen

Checked by:

OVM/OVA: hNu PID with 10.2 eV Probe

Water Depth 22.64 ft



Depth (feet)	DESCRIPTION	Blows/6 In	Inches Driven	Inches Recov'd	Comments	Sample #	Field OVM/OVA Reading (ppm)
0	asphalt						
0.5–3	SILTY CLAY, dark gray, moderately plastic, slightly moist (CL)						
3–18	GRAVELLY SAND, brown, fine- to coarse-grained, moist (SM)						
4.5–5		19, 21, 23	18	18		MW7-1	0
10–11		17, 25, 40	18	18		MW7-2	0
15–16		25, 50/6	12	12		MW7-3	0
18–25	CLAYEY SILT, brown, non-plastic, saturated (ML)						
20–21		7, 11, 23	18	18		MW7-4	0
24–25		8, 15, 16	18	18		MW7-5	2

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Log of Soil Boring MW-7

Project No.	19021.01
Location:	Former Beacon #574, 22315 Redwood Rd, Castro Valley, CA

Casing Elevation: 156.09 ft

Completion Depth: 30 feet

Drilling Company: Woodward Drilling
Driller: Eric Forestrom
Drilling and Sampling Methods:
B-57 Mobile Drill Rig with Hollow Stem Auger
California modified split-spoon sampler
fitted with 6" brass sample sleeves

Drilling	Date	Time
Start	05-13-93	9:50
Finish	05-13-93	10:40

Logged by: Hal E. Hansen

Checked by:

OVM/OVA hNu PID with 10.2 eV Probe

Water Depth 22.64 ft

Depth (feet)	DESCRIPTION	Graphic Log	Blows/6 In	Inches Driven	Inches Recov'd	Comments	Sample #	Field OVM/OVA Reading (ppm)
	continued from above		8					
25	CLAYEY SILT, brown, non-plastic saturated (ML)	ML	15					
			16	18	18		MW7-5	2
26								
27								
28	SILTY SAND, greenish blue, fine- to coarse-grained, saturated, common plastic fines (SM)	SM						
29			9					
			22					
30			23	18	12		MW7-6	0
	Terminated drilling at 30 feet.							
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
48								
49								
50								

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Log of Soil Boring MW-8

Project No.	19021.01
Location:	Former Beacon #574, 22315 Redwood Rd, Castro Valley, CA

Drilling Company: Woodward Drilling
Driller: Eric Forestrom
Drilling and Sampling Methods: B-57 Mobile Drill Rig with Hollow Stem Auger; California modified split-spoon sampler fitted with 6" brass sample sleeves

Casing Elevation: 158.04 ft

Completion Depth: 35 feet

Drilling	Date	Time
Start	05-13-93	3:00
Finish	05-13-93	3:40

Logged by: Hal E. Hansen
Checked by:

OVM/OVA: hNu PID with 10.2 eV Probe
Water Depth: 21.55 ft

Depth (feet)	DESCRIPTION	Blows/6 In	Inches Driven	Inches Recov'd	Comments	Sample #	Field OVM/OVA Reading (ppm)
0	concrete						
0.5–4	SILTY CLAY, brown, moderately plastic, moist (CL)						
4–8.5	GRAVELLY SAND, brown, fine- to coarse-grained, moist (SW)						
5		5, 8, 13	18	18		MW8-1	0
8.5–22	SAND, yellowish brown, fine-grained, moist (SP)						
10		7, 15, 19	18	18		MW8-2	0
15.5		11, 17, 20	18	18		MW8-3	0
20.5		12, 50/6	12	12		MW8-4	0
22–	SILTY CLAY, brown, moderately plastic, saturated (CL)						
25		9, 17, 22	18	18		MW8-5	0

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Log of Soil Boring MW-8

Casing Elevation: 158.04 ft

Completion Depth: 35 feet

Project No. 19021.01

Location: Former Beacon #574, 22315 Redwood Rd, Castro Valley, CA

Drilling Company: Woodward Drilling
Driller: Eric Forestrom
Drilling and Sampling Methods:
B-57 Mobile Drill Rig with Hollow Stem Auger
California modified split-spoon sampler fitted with 6" brass sample sleeves

Drilling	Date	Time
Start	05-13-93	3:00
Finish	05-13-93	3:40

Logged by: Hal E. Hansen

Checked by:

OVM/OVA hNu PID with 10.2 eV Probe

Water Depth 21.55 ft

Depth (feet)	DESCRIPTION	Graphic Log	Blows/6 In	Inches Driven	Inches Recov'd	Comments	Sample #	Field OVM/OVA Reading (ppm)
25	continued from above SILTY CLAY, brown, moderately plastic, saturated (CL)	CL	9 17 22	18	18		MWB-5	0
27	SILTY SAND, greenish gray, fine-grained, saturated (SM)	SM	8 13 14	18	18		MWB-6	0
32	SAND, greenish gray, medium-grained, saturated (SP)	SP	50 5	5	5		MWB-7	0
35	Terminated drilling at 35 feet.							

Depth scale: 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

APPENDIX B

SOIL SAMPLE ANALYTICAL RESULTS

TABLE 1

SOIL SAMPLE ANALYTICAL RESULTS
Former Beacon Station #574
22315 Redwood Road, Castro Valley, California
(concentrations in milligrams per kilogram)

Monitoring Well	Date Sampled	Depth Sampled (feet)	Benzene	Toluene	Ethylbenzene	Xylenes	TPHg[a]	TPHd[b]
MW-1	03-26-91	15	0.16	0.10	0.010	0.050	<1.0	<10
	03-26-91	20	13	110	33	300	3,200	<10
MW-2	03-26-91	10	0.013	0.26	0.11	0.68	8.1	<10
	03-26-91	15	19	120	42	240	3,200	<10
	03-26-91	20	0.39	0.22	0.11	0.41	14,000	<10
MW-3	03-26-91	15	<0.005	<0.005	<0.005	<0.005	<1.0	<10
	03-26-91	20	<0.005	0.18	0.44	5.9	230	<10
MW-4	05/14/93	5	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	15	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	20	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
MW-5	05/14/93	5	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	10	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	15	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	20	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
MW-6	05/14/93	5	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	10	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	15	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	20	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
MW-7	05/14/93	5	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	10	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	15	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	20	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
MW-8	05/14/93	5	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	10	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	15	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA
	05/14/93	20	<0.0050	<0.0050	<0.0050	<0.0050	<0.50	NA

[a]TPHg = Total petroleum hydrocarbons as gasoline.
[b]TPHd = Total petroleum hydrocarbons as diesel.

APPENDIX C

MONITORING WELL CONSTRUCTION SPECIFICATION DIAGRAMS

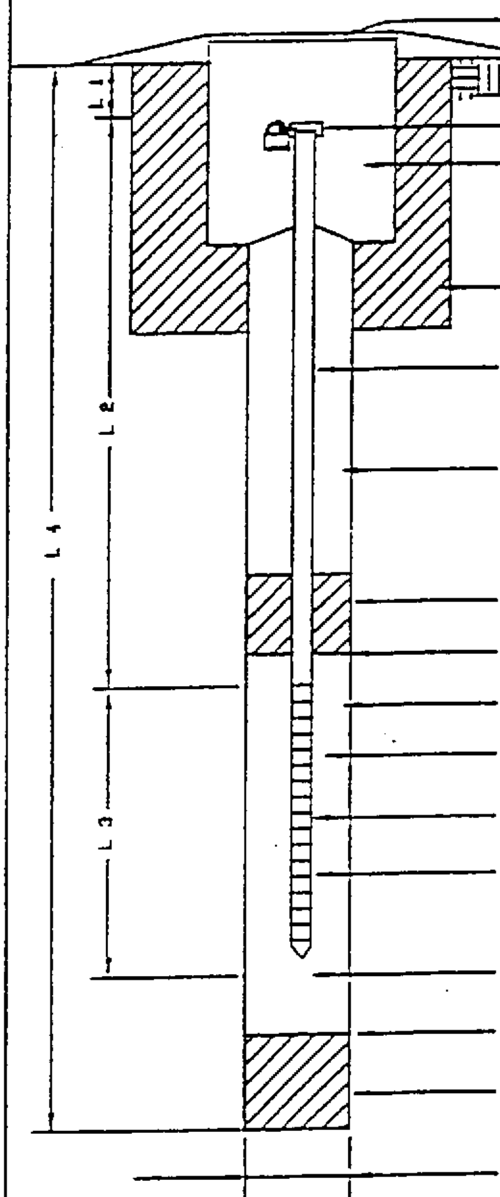
INSTALLATION OF FLUSH GRADE MONITORING WELL

PROJECT: Former Beacon Station #574
22315 Redwood Road, Castro Valley, CA

DELTA NO. 40-90-818

MONITORING WELL NO. MW-1

ELEVATIONS: TOP OF RISER 156.55
GROUND LEVEL ______



PROTECTIVE CASING

LOCKING WATER TIGHT CAP

FLUSH GRADE WELL CONSTRUCTION
DIAMETER AND MATERIAL: 12-inch steel
TOTAL LENGTH: 12 inches
LENGTH ABOVE GROUND: ½ inch
THICKNESS AND TYPE OF SEAL: 2-feet concrete

DIAMETER, MATERIAL AND JOINT TYPE OF RISER PIPE: 4-inch Sch 40 PVC Flush Thread

TYPE OF BACKFILL AROUND RISER: Neat cement containing 5% bentonite

THICKNESS AND TYPE OF SEAL: 2-feet bentonite pellets

DISTANCE OF FILTER SAND ABOVE TOP OF SCREEN: 2 feet

TYPE OF FILTER AROUND SCREEN: #3 lonestar

MONITORING WELL MATERIAL: Sch 40 PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT SIZE): 0.01 inch

DIAMETER AND LENGTH OF SCREEN: 4 inch x 20 feet

DEPTH TO THE BOTTOM OF MONITORING WELL: 30 feet

DEPTH TO THE BOTTOM OF FILTER SAND: 30 feet

THICKNESS AND TYPE OF SEAL: N/A

DIAMETER OF BOREHOLE: 10 inches

L 1 = 0.25 FT.
L 2 = 9.75 FT.
L 3 = 20 FT.
L 4 = 30 FT.

INSTALLATION COMPLETED:
DATE: 3/26/91
TIME: 10:30

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL *
3-26-91	6:29	22.43

* MEASURE POINT: Top of casing

Delta Environmental Consultants, Inc.

1022 B/3-89

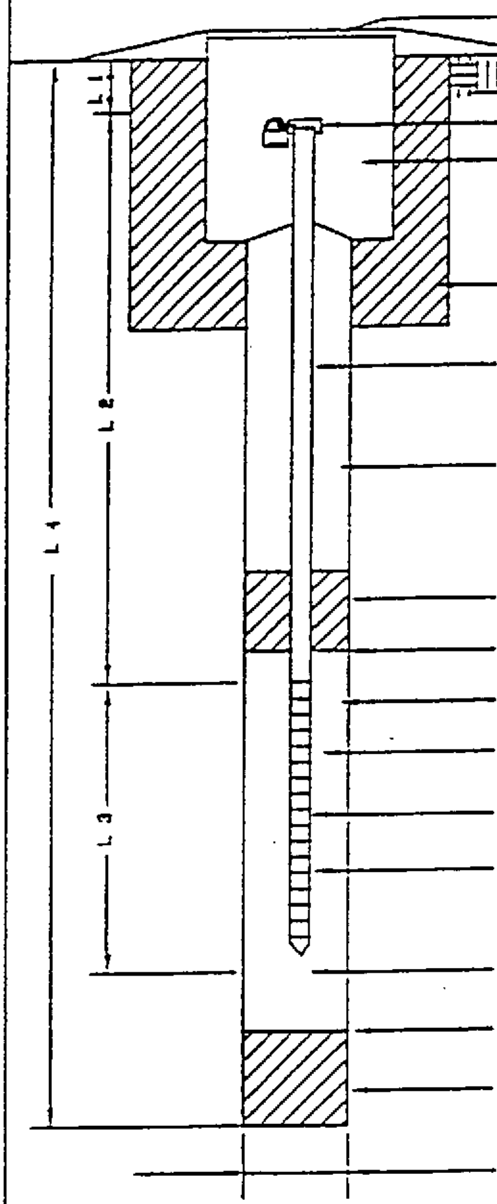
INSTALLATION OF FLUSH GRADE MONITORING WELL

PROJECT: Former Beacon Station #574
22315 Redwood Road, Castro Valley, CA

DELTA NO.: 40-90-818

MONITORING WELL NO.: MW-2

ELEVATIONS: TOP OF RISER: 155.17
GROUND LEVEL:



LOCKING WATER TIGHT CAP	
FLUSH GRADE WELL CONSTRUCTION DIAMETER AND MATERIAL	12-inch steel
TOTAL LENGTH	12 inches
LENGTH ABOVE GROUND	½ inch
THICKNESS AND TYPE OF SEAL	2-feet concrete
DIAMETER, MATERIAL AND JOINT TYPE OF RISER PIPE	4-inch Sch 40 PVC Flush Thread
TYPE OF BACKFILL AROUND RISER	Neat cement containing 5% bentonite
THICKNESS AND TYPE OF SEAL	2-feet bentonite pellets
DISTANCE OF FILTER SAND ABOVE TOP OF SCREEN	2 feet
TYPE OF FILTER AROUND SCREEN	#3 lonestar
MONITORING WELL MATERIAL	Sch 40 PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT SIZE)	0.01 inch
DIAMETER AND LENGTH OF SCREEN	4 inch x 20 feet
DEPTH TO THE BOTTOM OF MONITORING WELL	30 feet
DEPTH TO THE BOTTOM OF FILTER SAND	30 feet
THICKNESS AND TYPE OF SEAL	N/A
DIAMETER OF BOREHOLE	10 inches

L 1 = 0.25 FT.
L 2 = 9.75 FT.
L 3 = 20 FT.
L 4 = 30 FT.

INSTALLATION COMPLETED:
DATE: 3/26/91
TIME: 12:45

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL *
3-26-91	6:22	20.91

* MEASURE POINT: Top of casing

Delta Environmental Consultants, Inc.

1022 B/3-89

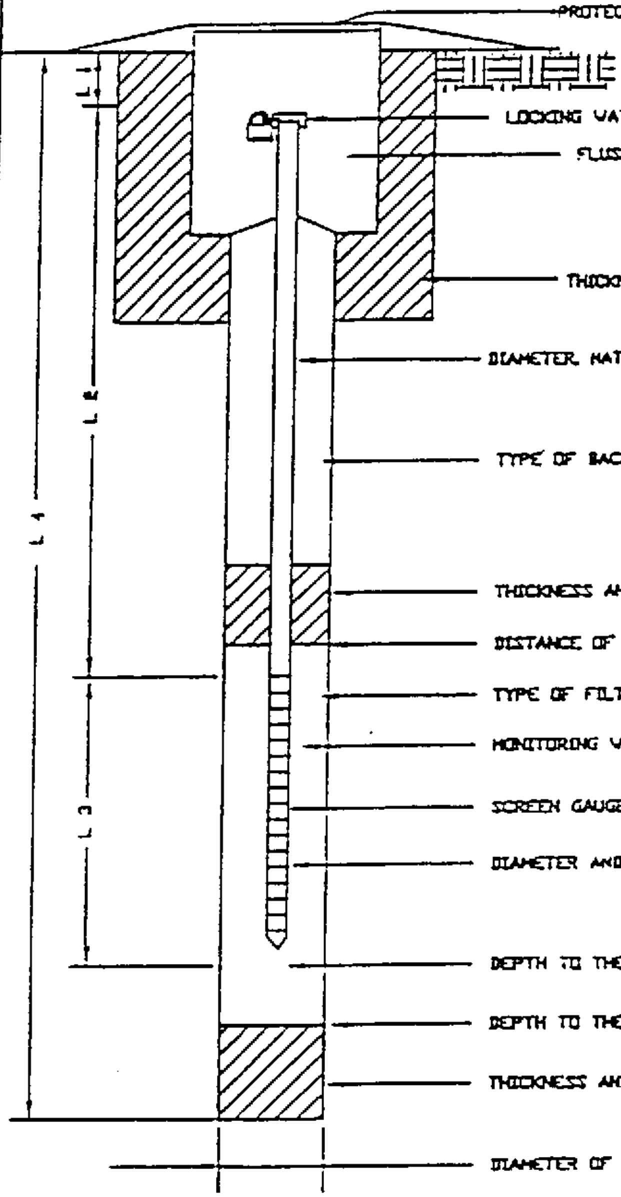
INSTALLATION OF FLUSH GRADE MONITORING WELL

PROJECT: Former Beacon Station #574
22315 Redwood Road, Castro Valley, CA

DELTA NO. 40-90-818

MONITORING WELL NO. MW-3

ELEVATIONS: TOP OF RISER 157.13
GROUND LEVEL ______



FLUSH GRADE WELL CONSTRUCTION
DIAMETER AND MATERIAL: 12-inch steel
TOTAL LENGTH: 12 inches
LENGTH ABOVE GROUND: ¼ inch
THICKNESS AND TYPE OF SEAL: 2-feet concrete

DIAMETER, MATERIAL AND JOINT TYPE OF RISER PIPE: 4-inch Sch 40 PVC Flush Thread

TYPE OF BACKFILL AROUND RISER: Neat cement containing 5% bentonite

THICKNESS AND TYPE OF SEAL: 2 feet bentonite pellets

DISTANCE OF FILTER SAND ABOVE TOP OF SCREEN: 2 feet

TYPE OF FILTER AROUND SCREEN: #3 lonestar

MONITORING WELL MATERIAL: Sch 40 PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT SIZE): 0.01 inch

DIAMETER AND LENGTH OF SCREEN: 4 inch x 20 feet

DEPTH TO THE BOTTOM OF MONITORING WELL: 30 feet

DEPTH TO THE BOTTOM OF FILTER SAND: 30 feet

THICKNESS AND TYPE OF SEAL: N/A

DIAMETER OF BOREHOLE: 10 inches

L 1 = 0.25 FT.
L 2 = 9.75 FT.
L 3 = 20 FT.
L 4 = 30 FT.

INSTALLATION COMPLETED:
DATE: 3/26/91
TIME: 4:30

MONITORING WELL WATER LEVEL MEASUREMENTS		
DATE	TIME	WATER LEVEL *
3-26-91	6:14	21.62

* MEASURE POINT: Top of casing

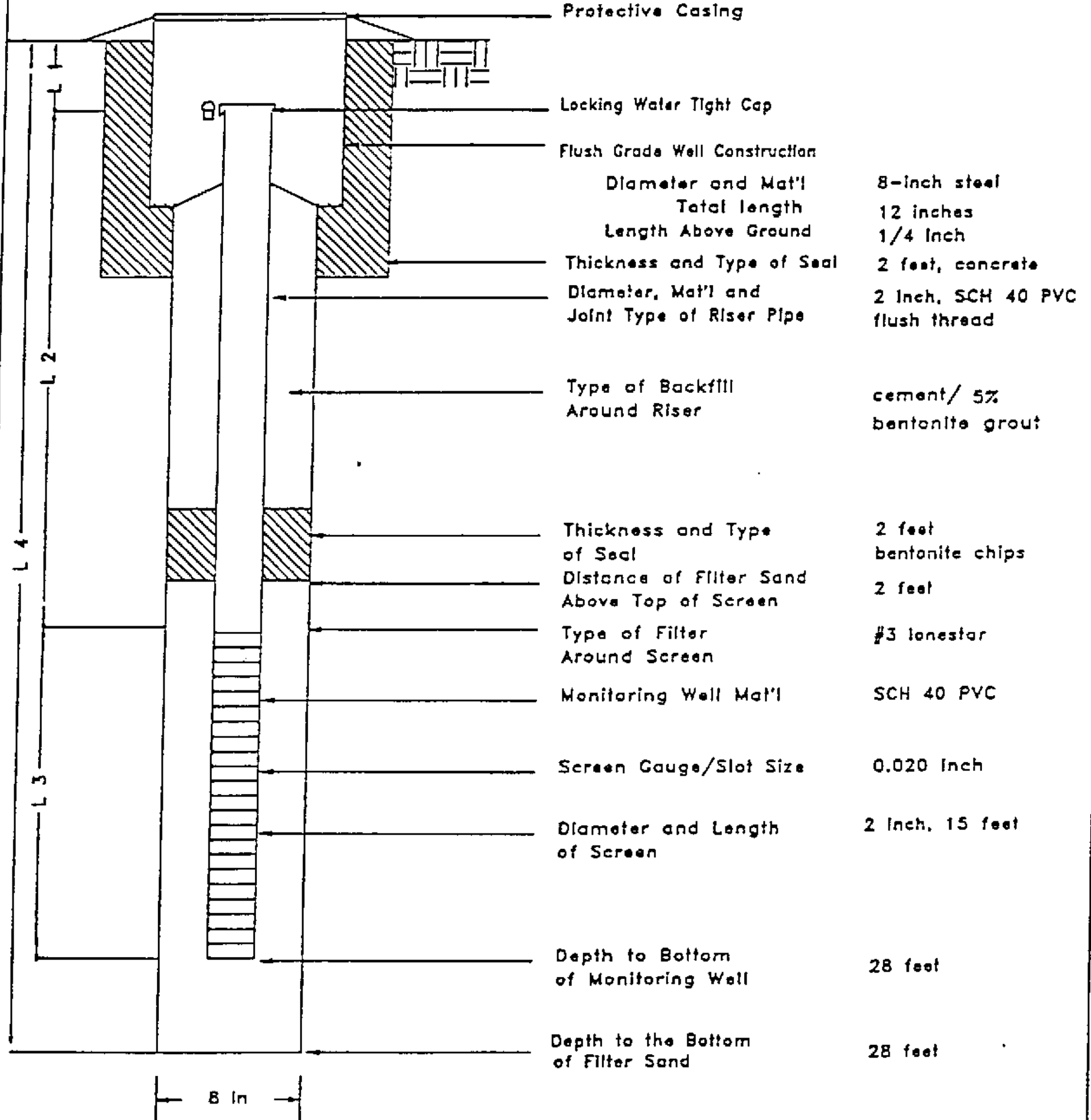
Delta Environmental Consultants, Inc.

1022 B/3-89

MONITORING WELL CONSTRUCTION DETAILS

PROJECT: Former Beacon #574
22315 Redwood Rd.
Castro Valley, CA

MONITORING WELL NO.: MW-4
ELEVATION: 151.96 ft



L1 = 0.25 ft
L2 = 12.75 ft
L3 = 15 ft
L4 = 28 ft

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL*
05-18-93	8:22	17.55 ft

*Measuring Point Top of casing

Completion Date and Time
05-13-93 12:25

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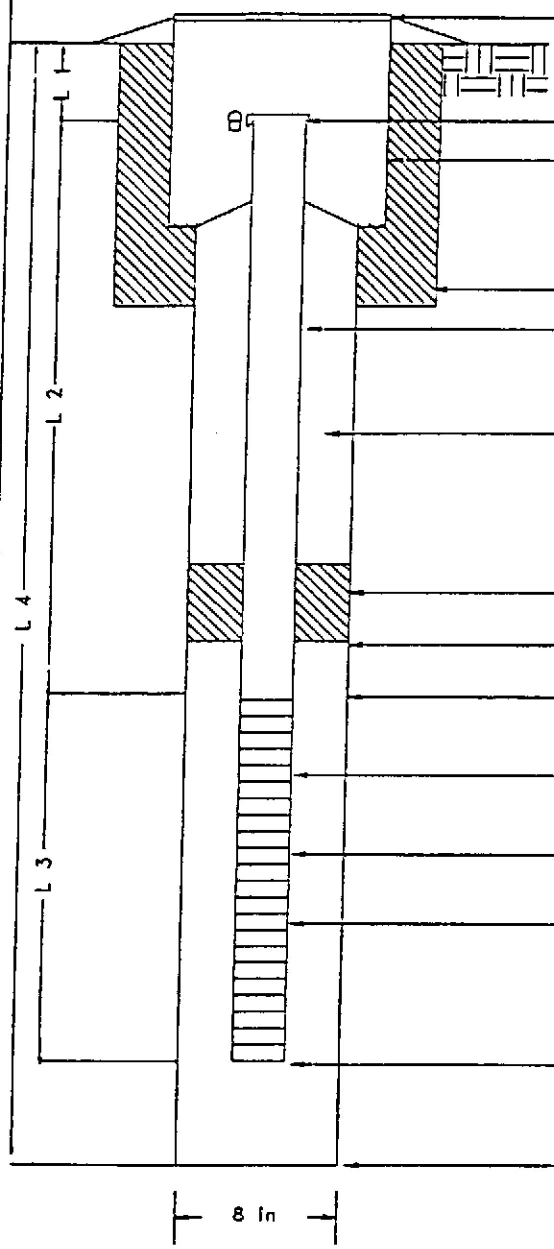
File #19021010

MONITORING WELL CONSTRUCTION DETAILS

PROJECT: Former Beacon #574
22315 Redwood Rd
Castro Valley, CA

MONITORING WELL NO.: MW-5
ELEVATION: 148.68 ft



Protective Casing	
Locking Water Tight Cap	
Flush Grade Well Construction	
Diameter and Mat'l	8-inch steel
Total length	12 inches
Length Above Ground	1/4 inch
Thickness and Type of Seal	2 feet, concrete
Diameter, Mat'l and Joint Type of Riser Pipe	2 inch, SCH 40 PVC flush thread
Type of Backfill Around Riser	cement/ 5% bentonite grout
Thickness and Type of Seal	2 feet bentonite chips
Distance of Filter Sand Above Top of Screen	2 feet
Type of Filter Around Screen	#3 lonestar
Monitoring Well Mat'l	SCH 40 PVC
Screen Gauge/Slot Size	0.020 inch
Diameter and Length of Screen	2 inch, 15 feet
Depth to Bottom of Monitoring Well	25 feet
Depth to the Bottom of Filter Sand	25 feet

L1 = 0.25 ft
L2 = 9.75 ft
L3 = 15 ft
L4 = 25 ft

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL*
05-18-93	8:27	15.72 ft

*Measuring Point Top of casing

Completion Date and Time

05-13-93 2:30

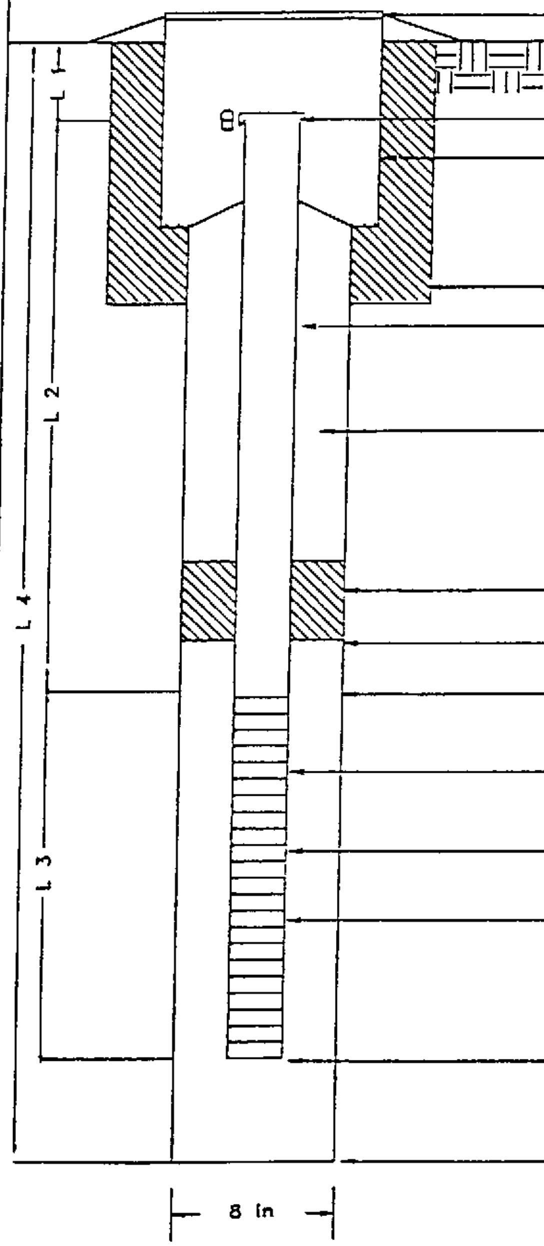
ACTON • MICKELSON • VAN DAM, INC.

File #19021011

MONITORING WELL CONSTRUCTION DETAILS

PROJECT: Former Beacon #574
22315 Redwood Rd.
Castro Valley, CA

MONITORING WELL NO.: MW-6
ELEVATION: 153.96 ft



Protective Casing	
Locking Water Tight Cap	
Flush Grade Well Construction	
Diameter and Mat'l	8-inch steel
Total length	12 inches
Length Above Ground	1/4 inch
Thickness and Type of Seal	2 feet, concrete
Diameter, Mat'l and Joint Type of Riser Pipe	2 inch, SCH 40 PVC flush thread
Type of Backfill Around Riser	cement/ 5% bentonite grout
Thickness and Type of Seal	2 feet bentonite chips
Distance of Filter Sand Above Top of Screen	2 feet
Type of Filter Around Screen	#3 lonestar
Monitoring Well Mat'l	SCH 40 PVC
Screen Gauge/Slot Size	0.020 inch
Diameter and Length of Screen	2 inch, 15 feet
Depth to Bottom of Monitoring Well	30 feet
Depth to the Bottom of Filter Sand	30 feet

L1 = 0.25 ft
L2 = 14.75 ft
L3 = 15 ft
L4 = 30 ft

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL*
05-18-93	8:07	20.80 ft

*Measuring Point Top of casing

Completion Date and Time
05-13-93 9:30

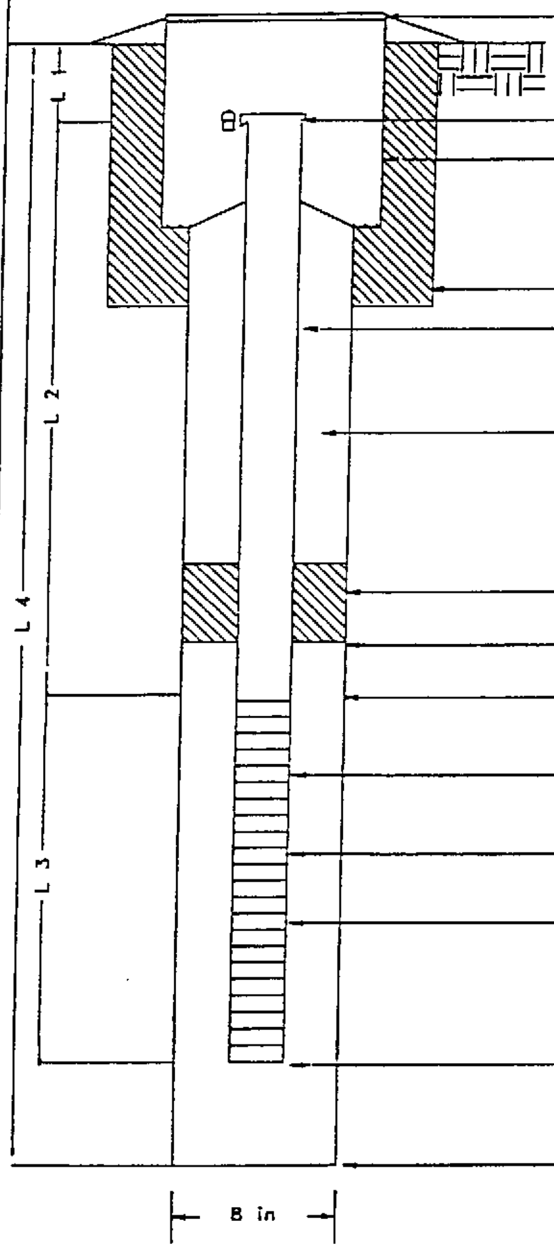
ACTON • MICKELSON • VAN DAM, INC.

File #19021012

MONITORING WELL CONSTRUCTION DETAILS

PROJECT: Former Beacon #574
22315 Redwood Rd
Castro Valley, CA

MONITORING WELL NO.: MW-7
ELEVATION: 156.09 ft



Protective Casing	
Locking Water Tight Cap	
Flush Grade Well Construction	
Diameter and Mat'l	8-inch steel
Total length	12 inches
Length Above Ground	1/4 inch
Thickness and Type of Seal	2 feet, concrete
Diameter, Mat'l and Joint Type of Riser Pipe	2 inch, SCH 40 PVC flush thread
Type of Backfill Around Riser	cement/ 5% bentonite grout
Thickness and Type of Seal	2 feet bentonite chips
Distance of Filter Sand Above Top of Screen	2 feet
Type of Filter Around Screen	#3 lonestar
Monitoring Well Mat'l	SCH 40 PVC
Screen Gauge/Slot Size	0.020 inch
Diameter and Length of Screen	2 inch, 15 feet
Depth to Bottom of Monitoring Well	30 feet
Depth to the Bottom of Filter Sand	30 feet

L1 = 0.25 ft
L2 = 14.75 ft
L3 = 15 ft
L4 = 30 ft

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL*
05-18-93	8:13	22.64 ft

*Measuring Point Top of casing

Completion Date and Time

05-13-93 10:55

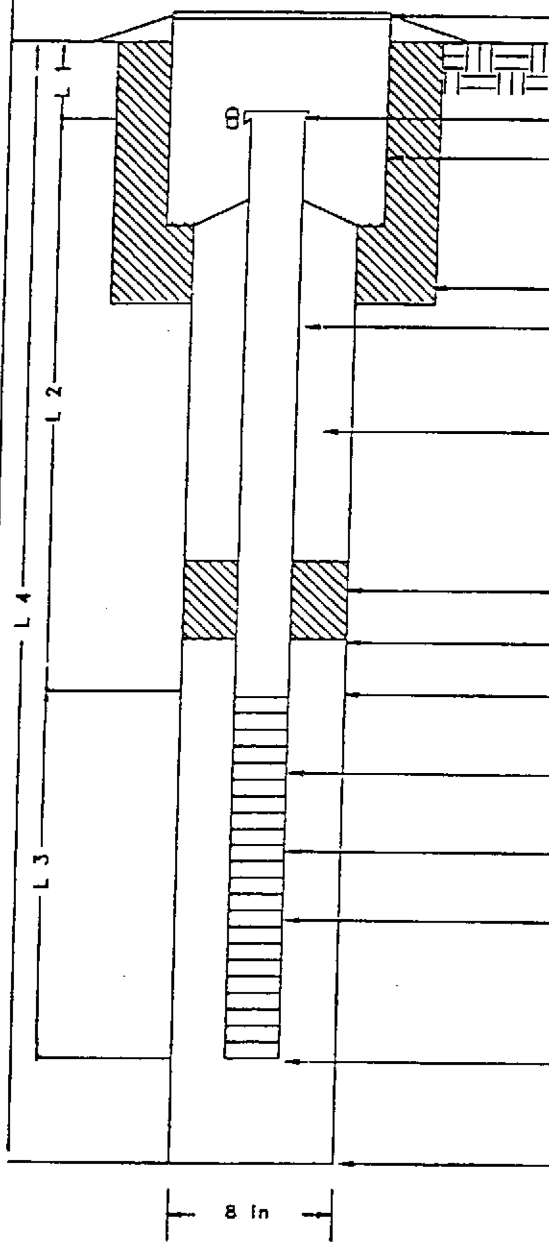
ACTON • MICKELSON • VAN DAM, INC.

File #19021013

MONITORING WELL CONSTRUCTION DETAILS

PROJECT: Former Beacon #574
22315 Redwood Rd
Castro Valley, CA

MONITORING WELL NO.: MW-8
ELEVATION: 158.04 ft



Protective Casing	
Locking Water Tight Cap	
Flush Grade Well Construction	
Diameter and Mat'l	8-inch steel
Total length	12 inches
Length Above Ground	1/4 inch
Thickness and Type of Seal	2 feet, concrete
Diameter, Mat'l and Joint Type of Riser Pipe	2 inch, SCH 40 PVC flush thread
Type of Backfill Around Riser	cement/ 5% bentonite grout
Thickness and Type of Seal	2 feet bentonite chips
Distance of Filter Sand Above Top of Screen	2 feet
Type of Filter Around Screen	#3 lonestar
Monitoring Well Mat'l	SCH 40 PVC
Screen Gauge/Slot Size	0.020 inch
Diameter and Length of Screen	2 inch, 15 feet
Depth to Bottom of Monitoring Well	33 feet
Depth to the Bottom of Filter Sand	33 feet

L1 = 0.25 ft
L2 = 17.75 ft
L3 = 15 ft
L4 = 33 ft

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL*
05-18-93	8:16	21.55 ft

*Measuring Point Top of casing

Completion Date and Time

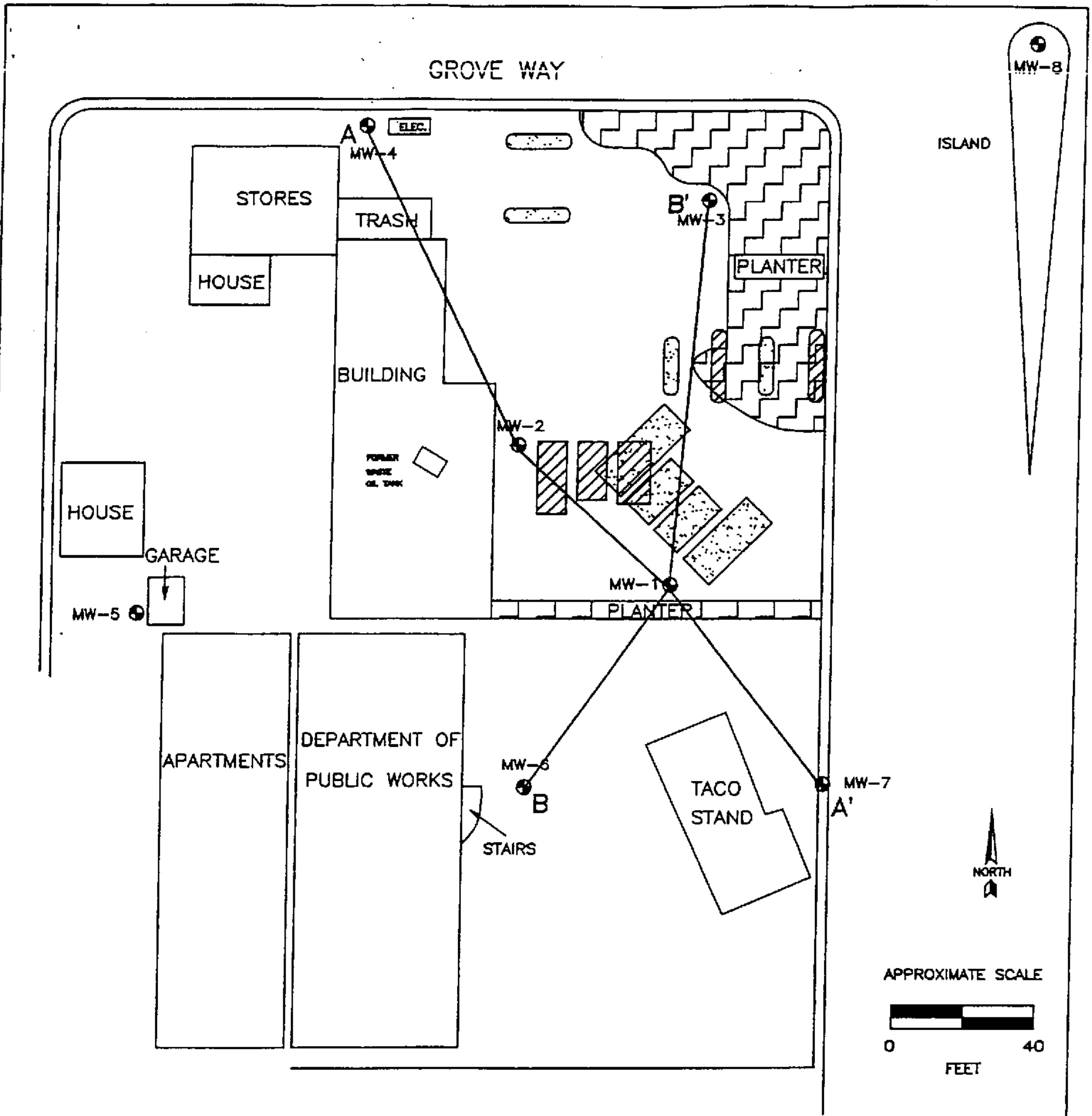
05-13-93 5:00

ACTON • MICKELSON • VAN DAM, INC.

File #19021014

APPENDIX D

GEOLOGIC CROSS-SECTIONS



LEGEND

MW-6 — GROUND WATER MONITORING WELL AND NUMBER

FIRST LOCATION OF TANKS AND PUMP ISLANDS

SECOND LOCATION OF TANKS AND PUMP ISLANDS

FIGURE 5

GEOLOGIC CROSS-SECTION LOCATION MAP

FORMER BEACON STATION #574
22315 REDWOOD ROAD
CASTRO VALLEY, CA

Project No. 19021.02	Drawn CCB	Acton • Mickelson • van Dam, Inc. Consulting Scientists, Engineers, and Geologists
File No. PA05FD	Prepared DVD	4511 Golden Foothill Parkway, #1 El Dorado Hills, California 95762 (916) 939-7550
Revision	Reviewed	

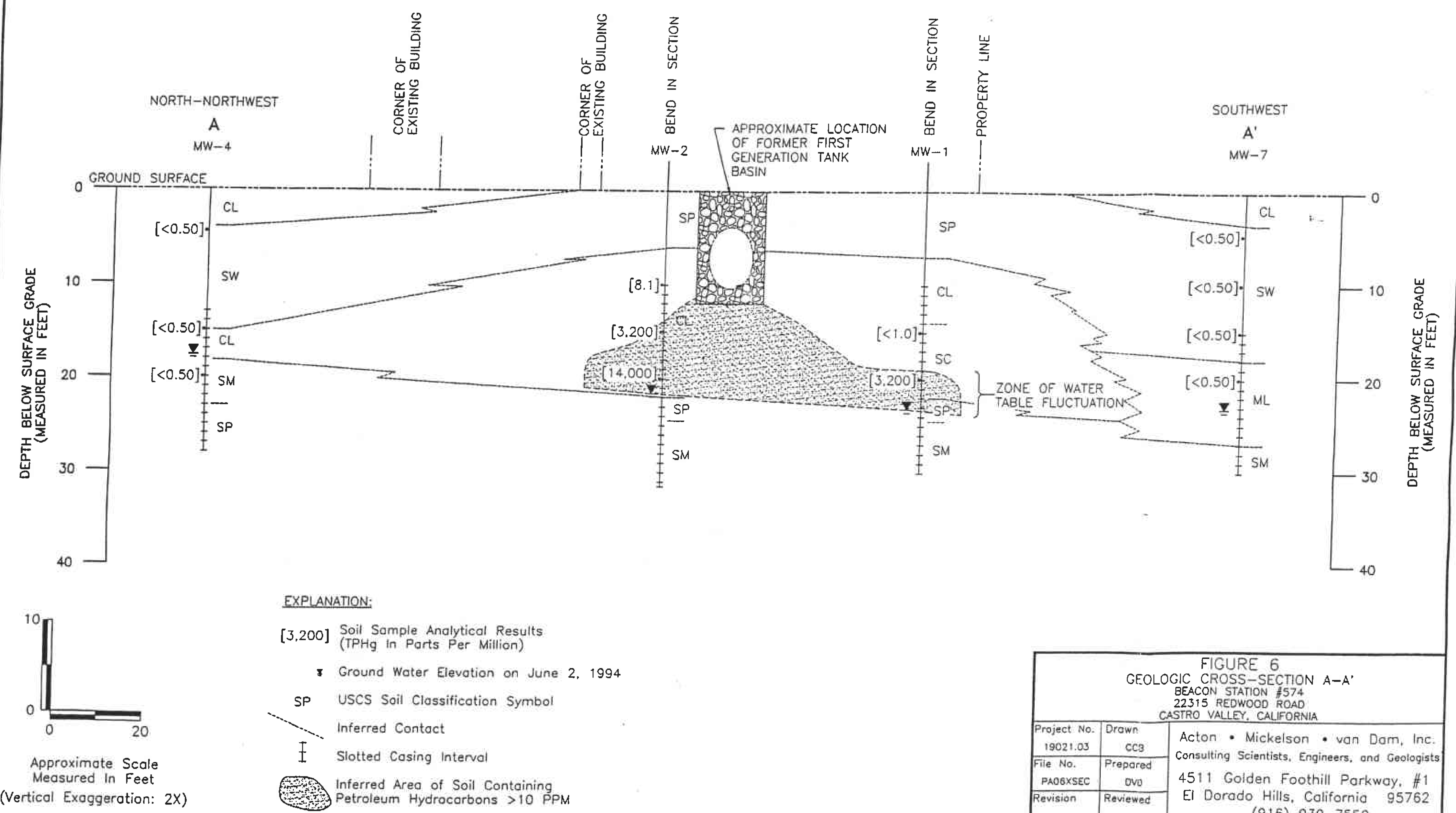
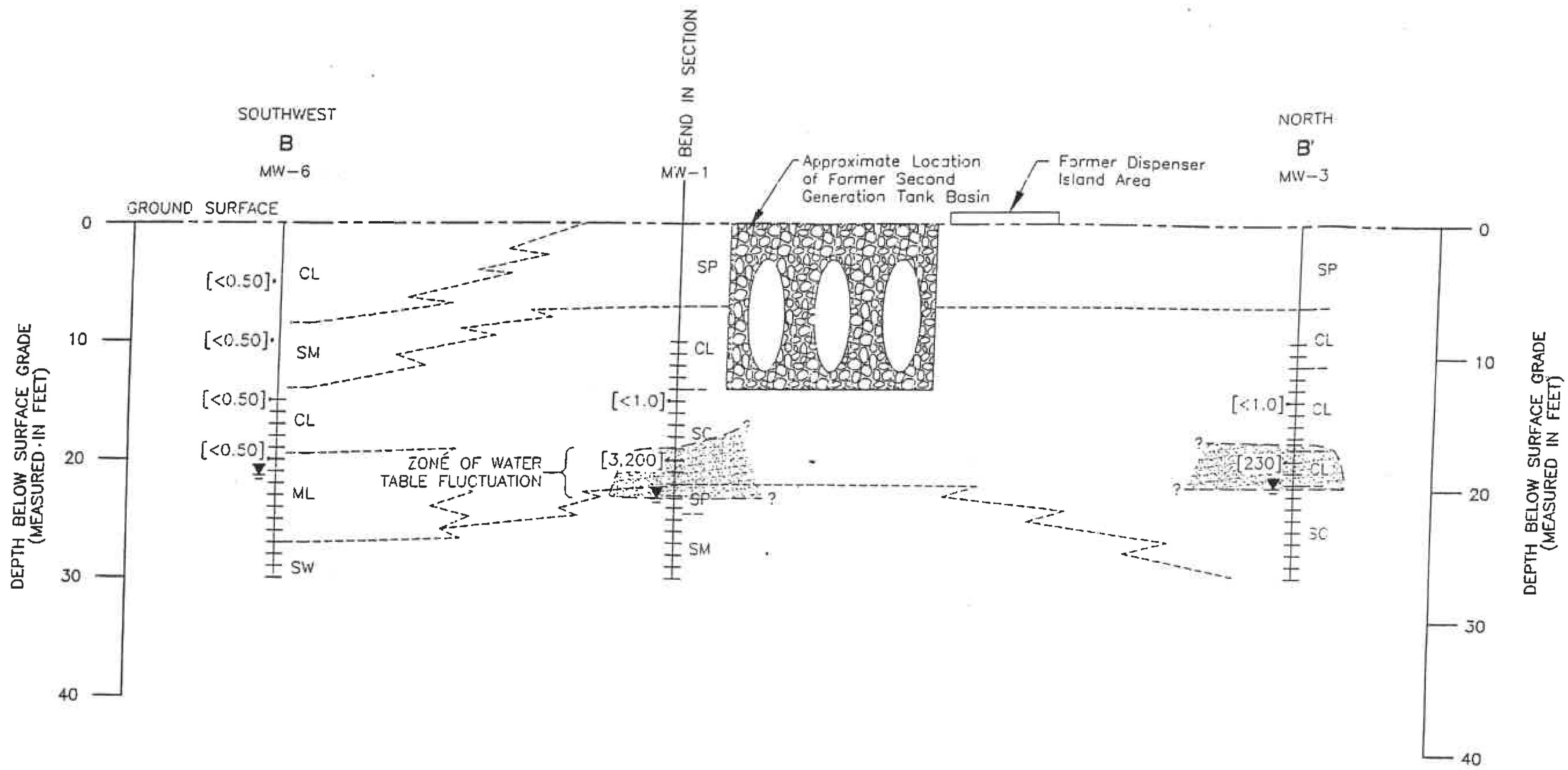
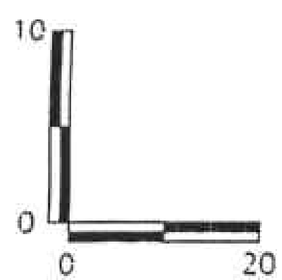


FIGURE 6
GEOLOGIC CROSS–SECTION A–A'
BEACON STATION #574
22315 REDWOOD ROAD
CASTRO VALLEY, CALIFORNIA

Project No. 19021.03	Drawn CC3
File No. PA06XSEC	Prepared DV0
Revision	Reviewed

Acton • Mickelson • van Dam, Inc.
Consulting Scientists, Engineers, and Geologists
4511 Golden Foothill Parkway, #1
El Dorado Hills, California 95762
(916) 939–7550





Approximate Scale Measured In Feet
(Vertical Exaggeration: 2X)

EXPLANATION:

[3,200] Soil Sample Analytical Results (TPHg In Parts Per Million)

Ground Water Elevation on June 2, 1994

SP USCS Soil Classification Symbol

Inferred Contact

Slotted Casing Interval

Inferred Area of Soil Containing Petroleum Hydrocarbons >10 PPM

FIGURE 7
GEOLOGIC CROSS SECTION B-B'
BEACON STATION #574
22315 REDWOOD ROAD
CASTRO VALLEY, CALIFORNIA

Project No.	Drawn
19021.03	CCB
File No.	Prepared
PA07XSEC	DVD
Revision	Reviewed

Acton • Mickelson • van Dam, Inc.
Consulting Scientists, Engineers, and Geologists
4511 Golden Foothill Parkway, #1
El Dorado Hills, California 95762
(916) 939-7550

APPENDIX E

ASTM LOOK-UP TABLES FOR SOIL AND GROUND WATER

Table 5
Tier 1 Risk-Based Screening Level (RBSL)
Look-up Table - Soil

Exposure Pathway	Receptor Scenario	Target Level	Benzene *	Ethylbenzene	Toluene	Xylene (Mixed)	Naphthalene	Benzo(a)pyrene
Soil Volatilization to Outdoor Air (mg/kg)	Residential	Carcinogenic Risk = 1×10^{-6}	2.72×10^{-1}					RES
		Chronic HQ = 1		RES	RES	RES	RES	
	Commercial/ Industrial	Carcinogenic Risk = 1×10^{-5}	4.57					RES
		Chronic HQ = 1		RES	RES	RES	RES	
Soil - Vapor Intrusion from Soil to Buildings (mg/kg)	Residential	Carcinogenic Risk = 1×10^{-6}	5.37×10^{-3}					RES
		Chronic HQ = 1		4.27×10^{2}	2.06×10^{1}	RES	4.07×10^{1}	
	Commercial/ Industrial	Carcinogenic Risk = 1×10^{-5}	1.09×10^{-1}					RES
		Chronic HQ = 1		1.10×10^{3}	5.45×10^{1}	RES	1.07×10^{2}	
Surficial Soil (0 to 3 feet) Ingestion/Dermal/ Inhalation (mg/kg)	Residential	Carcinogenic Risk = 1×10^{-6}	5.82 1.7					1.30×10^{-1}
		Chronic HQ = 1	?	7.83×10^{3}	1.33×10^{4}	1.45×10^{5}	9.77×10^{2}	
	Commercial/ Industrial	Carcinogenic Risk = 1×10^{-5}	1.00×10^{2}					3.04×10^{-1}
		Chronic HQ = 1		1.15×10^{4}	1.87×10^{4}	2.08×10^{5}	1.90×10^{3}	
Soil - Leachate to Protect Groundwater Ingestion Target Level (mg/kg)	MCLs		2.93×10^{-2}	1.10×10^{2}	1.77	3.05×10^{2}	NA	9.42
	Residential	Carcinogenic Risk = 1×10^{6}	1.72×10^{-2}					5.90×10^{-1}
		Chronic HQ = 1		5.75×10^{2}	1.29×10^{2}	RES	2.29×10^{1}	
	Commercial/ Industrial	Carcinogenic Risk - 1×10^{-5}	5.78×10^{-1}					1.85
		Chronic HQ = 1		1.61×10^{3}	3.61×10^{2}	RES	6.42×10^{1}	

RES = Selected risk level is not exceeded for pure compound present at any concentration

* Missing California's toxicity factor; however, it was used/considered in the evaluation (see text).

Table 4
Tier 1 Risk-Based Screening Level (RBSL) Look-up Table - Groundwater

Exposure Pathway	Receptor Scenario	Target Level	Benzene	Ethylbenzene	Toluene	Xylene (Mixed)	Naphthalene	Benzo(a)pyrene
Groundwater Volatilization to Outdoor Air (mg/L)	Residential	Carcinogenic Risk = 1 x 10^{-6}	1.10					> S
		Chronic HQ = 1		> S	> S	> S	> S	
	Commercial	Carcinogenic Risk = 1 x 10^{-5}	1.84					> S
		Chronic HQ = 1		> S	> S	> S	> S	
Groundwater Ingestion (mg/L)	MCLs		5.00 x 10^{-3}	7.00 x 10^{-1}	1.00	1.00 x 10^{1}	NA	2.00 x 10^{-4}
	Residential	Carcinogenic Risk = 1 x 10^{6}	2.94 x 10^{-3}					1.17 x 10^{-5}
		Chronic HQ = 1		3.65	7.30	7.30 x 10^{1}	1.46 x 10^{-1}	
	Commercial/ Industrial	Carcinogenic Risk - 1 x 10^{-5}	9.87 x 10^{-2}					3.92 x 10^{-6}
		Chronic HQ = 1		1.02 x 10^{1}	2.04 x 10^{1}	> S	4.09 x 10^{-1}	
Groundwater - Vapor Intrusion from Groundwater to Buildings (mg/L)	Residential	Carcinogenic Risk = 1 x 10^{-6}	2.38 x 10^{-2}					-> S
		Chronic HQ = 1		7.75 x 10^{1}	3.28 x 10^{1}	> S	4.74	
	Commercial/ Industrial	Carcinogenic Risk = 1 x 10^{-5}	7.39 x 10^{-1}					> S
		Chronic HQ = 1		> S	8.50 x 10^{1}	> S	1.23 x 10^{1}	

> S = Selected risk level is not exceeded for all possible dissolved levels (< = pure component solubility)

APPENDIX F

PHYSICAL/CHEMICAL/TOXICITY PROPERTIES FOR CONSTITUENTS OF CONCERN

RBCA CHEMICAL DATABASE

Physical Property Data

CAS Number	Constituent	type	Molecular Weight (g/mole) MW	ref	Diffusion Coefficients in air (cm2/s) Dair	re	Diffusion Coefficients in water (cm2/s) Dwat	re	log (Koc) or log(Kd) (@ 20 - 25 C) (l/kg) Koc	ref	Henry's Law Constant (@ 20 - 25 C) (atm-m3) mol	Henry's Law Constant (@ 20 - 25 C) (unitless)	re	Vapor Pressure (@ 20 - 25 C) (mm Hg) Pure Component	ref	Solubility (@ 20 - 25 C) (mg/l) Pure Component	ref	acid pKa	base pKb	ref
71-43-2	Benzene	A	78.1	5	9.30E-02	A	1.10E-05	A	1.58	A	5.29E-03	2.20E-01	A	9.52E+01	4	1.75E+03	A			
100-41-4	Ethylbenzene	A	106.2	5	7.60E-02	A	8.50E-06	A	1.98	A	7.69E-03	3.20E-01	A	1.00E+01	4	1.52E+02	5			
108-88-3	Toluene	A	92.4	5	8.50E-02	A	9.40E-06	A	2.13	A	6.25E-03	2.60E-01	A	3.00E+01	4	5.15E+02	29			
1330-20-7	Xylene (mixed isomers)	A	106.2	5	7.20E-02	A	8.50E-06	A	2.38	A	6.97E-03	2.90E-01	A	7.00E+00	4	1.98E+02	5			

Site Name: Fmr Beacon #574 Site Location: Castro Valley, CA Completed By: D. van Dam Date Completed: 12/3/1996

Software version: v 1.0

RBCA CHEMICAL DATABASE

Toxicity Data

		Reference Dose (mg/kg/day)				Slope Factors 1/(mg/kg/day)					
CAS Number	Constituent	Oral RfD_oral	ref	Inhalation RfD_inhal	re	Oral SF_oral	ref	Inhalation SF_inhal	ref	EPA Weight of Evidence	Is Constituent Carcinogenic ?
71-43-2	Benzene	-	R	1.70E-03	R	2.90E-02	A	2.90E-02	A	A	TRUE
100-41-4	Ethylbenzene	1.00E-01	A	2.86E-01	A	-	R	-	R	D	FALSE
108-88-3	Toluene	2.00E-01	A,R	1.14E-01	,	-	R	-	R	D	FALSE
1330-20-7	Xylene (mixed isomers)	2.00E+00	A,R	2.00E+00	A	-	R	-	R	D	FALSE

Site Name: Fmr Beacon # Site Location: Castro Valley, CA Completed By: D. van Dam Date Completed: 12/3/1996

Software version: v 1.0

RBCA CHEMICAL DATABASE

Miscellaneous Chemical Data

CAS		Maximum Contaminant Level		Permissible Exposure Limit PEL/TLV		Relative Absorption Factors		Detection Limits Groundwater (mg/L)		Detection Limits Soil (mg/kg)		Half Life (First-Order Decay) (days)		
Number	Constituent	MCL (mg/L)	reference	(mg/m3)	ref	Oral	Dermal		ref		re	Saturated	Unsaturated	ref
71-43-2	Benzene	5.00E-03	52 FR 25690	3.20E+00	OSHA	1	0.5	0.002	C	0.005	S	720	720	H
100-41-4	Ethylbenzene	7.00E-01	6 FR 3526 (30 Jan 91	4.34E+02	ACGIH	1	0.5	0.002	C	0.005	S	228	228	H
108-88-3	Toluene	1.00E+00	6 FR 3526 (30 Jan 91	1.47E+02	ACGIH	1	0.5	0.002	C	0.005	S	28	28	H
1330-20-7	Xylene (mixed isomers)	1.00E+01	6 FR 3526 (30 Jan 91	4.34E+02	ACGIH	1	0.5	0.005	C	0.005	S	360	360	H

Site Name: Fmr Beacon # Site Location: Castro Valley, CA Completed By: D. van Dam Date Completed: 12/3/1996

Software version: v 1.0

RBCA SITE ASSESSMENT | **Tier 2 Worksheet 5.5**

Site Name: Fmr Beacon #574
Site Location: Castro Valley, CA

Completed By: D. van Dam
Date Completed: 11/11/1996

TIER 2 SUBSURFACE SOIL CONCENTRATION DATA SUMMA (e.g., >3 FT BGS)

CONSTITUENTS DETECTED		Analytical Method			Detected Concentrations		
CAS No.	Name	Typical Detection Limit (mg/kg)	No. of Samples	No. of Detects	Maximum Conc. (mg/kg)	Mean Conc. (mg/kg)	UCL on Mean Conc. (mg/kg)
71-43-2	Benzene		5	5	1.9E+01	7.3E-01	6.0E+00
100-41-4	Ethylbenzene		6	6	4.2E+01	6.5E-01	4.9E+00
108-88-3	Toluene		6	6	1.2E+02	1.5E+00	1.2E+01
1330-20-7	Xylene (mixed isomers)		6	6	3.0E+02	6.4E+00	5.1E+01

→ Used soil samples collected from monitoring wells, none of which were installed in the source area. However, there currently are no building structures near the soil/source area.

Site Name: Fmr Beacon #574
Site Location: Castro Valley, CA

Completed By: D. van Dam
Date Completed: 11/11/1996

TIER 2 GROUNDWATER CONCENTRATION DATA SUMMARY

CONSTITUENTS DETECTED		Analytical Method			Detected Concentrations		
CAS No.	Name	Typical Detection Limit (mg/L)	No. of Samples	No. of Detects	Maximum Conc. (mg/L)	Mean Conc. (mg/L)	UCL on Mean Conc. (mg/L)
71-43-2	Benzene	5.0E-03	3	3	3.2E+00	1.9E+00	4.8E+00
100-41-4	Ethylbenzene	[illegible]	3	3	5.6E-01	3.6E-01	8.2E-01
108-88-3	Toluene	[illegible]	3	3	7.7E-01	4.3E-01	1.1E+00
1330-20-7	Xylene (mixed isomers)	[illegible]	3	3	2.9E+00	1.7E+00	4.0E+00

Serial: G-349-KIX-808

Software: GSI RBCA Spreadshe
Version: v 1.0

APPENDIX G

TIER 1 EVALUATION INPUTS SUMMARY AND RESULTS TABLES

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Fmr Beacon #574
Site Location: Castro Valley, CA
Job Identification: U065.02
Date Completed: 12/3/96
Completed By: D. van Dam
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)	***<u>FALSE</u>***				
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	FALSE	TRUE	
GW.v	Volatilization to Outdoor Air	FALSE	TRUE	
GW.b	Vapor Intrusion to Buildings	FALSE	TRUE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	FALSE	TRUE	
SS.v	Volatiles and Particulate Inhalation	FALSE	FALSE	TRUE
SS.d	Direct Ingestion and Dermal Contact	FALSE	FALSE	TRUE
S.l	Leaching to Groundwater from all Soils	FALSE	TRUE	
S.b	Intrusion to Buildings - Subsurface Soils	FALSE	TRUE	

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)		TRUE		TRUE
S	Inhalation receptor (cm)		TRUE		TRUE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	1.0E-06	
TRc	Target Risk (class C carcinogens)	1.0E-05	
THQ	Target Hazard Quotient	1.0E+00	
Opt	Calculation Option (1, 2, or 3)	1	
Tier	RBCA Tier	1	

Surface Parameters	Definition (Units)	Residential	Commercial/Industrial Chronic	Commercial/Industrial Construction
t	Exposure duration (yr)	30	25	1
A	Contaminated soil area (cm^2)	***<u>3.5E+06</u>***		***<u>1.6E+06</u>***
W	Length of affected soil parallel to wind (cm)	***<u>1.5E+03</u>***		***<u>1.0E+03</u>***
W.gw	Length of affected soil parallel to groundwater (c	***<u>1.5E+03</u>***		
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)	***<u>9.6E+02</u>***
Ugw.tr	Groundwater Transport velocity (cm/yr)	***<u>2.5E+03</u>***
Ks	Saturated Hydraulic Conductivity(cm/s)	2.5E-03
grad	Groundwater Gradient (cm/cm)	1.2E-02
Sw	Width of groundwater source zone (cm)	
Sd	Depth of groundwater source zone (cm)	
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	TRUE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	1.0E-03

Soil	Definition (Units)	Value
hc	Capillary zone thickness (cm)	***<u>1.0E+01</u>***
hv	Vadose zone thickness (cm)	***<u>6.0E+02</u>***
rho	Soil density (g/cm^3)	1.7
foc	Fraction of organic carbon in vadose zone	0.01
phi	Soil porosity in vadose zone	0.38
Lgw	Depth to groundwater (cm)	***<u>6.1E+02</u>***
Ls	Depth to top of affected soil (cm)	***<u>3.0E+02</u>***
Lsubs	Thickness of affected subsurface soils (cm)	***<u>3.0E+02</u>***
pH	Soil/groundwater pH	6.5

not site-specific

		capillary	vadose	foundation
phi.w	Volumetric water content	0.342	0.12	0.12
phi.a	Volumetric air content	0.038	0.26	0.26

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (s^-1)	1.4E-04	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	0.01	

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		
ay	Transverse dispersion coefficient (cm)		
az	Vertical dispersion coefficient (cm)		
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

Site Name: Fmr Beacon #574
Site Location: Castro Valley, CA

Completed By: D. van Dam
Date Completed: 12/3/1996

TIER 1 BASELINE RISK SUMMARY TABLE

	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk Limit(s) Exceeded?	Hazard Quotient		Hazard Index		Toxicity Limit(s) Exceeded?
EXPOSURE PATHWAY	Maximum Value	Target Risk	Total Value	Target Risk		Maximum Value	Applicable Limit	Total Value	Applicable Limit	
AIR EXPOSURE PATHWAYS										
Complete:	3.3E-8	1.0E-6	3.3E-8	N/A	☐	1.9E-3	1.0E+0	1.9E-3	N/A	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	3.2E-4	1.0E-6	3.2E-4	N/A	■	5.5E-2	1.0E+0	1.1E-1	N/A	☐
SOIL EXPOSURE PATHWAYS										
Complete:	0.0E+0	1.0E-6	0.0E+0	N/A	☐	0.0E+0	1.0E+0	0.0E+0	N/A	☐

CRITICAL EXPOSURE PATHWAY (Select Maximum Values From Complete Pathways)										
	3.2E-4	1.0E-6	3.2E-4	N/A	■	5.5E-2	1.0E+0	1.1E-1	N/A	☐

RBCA SITE ASSESSMENT

Tier 1 Worksheet 6.2

Site Name: Fmr Beacon #574
Completed By: D. van Dam
Site Location: Castro Valley, CA
Date Completed: 12/3/1996

SUBSURFACE SOIL RBSL VALUES (> 3 FT BGS)

Target Risk (Class A & B) 1.0E-6
Target Risk (Class C) 1.0E-5
Target Hazard Quotient 1.0E+0

■ MCL exposure limit?
■ PEL exposure limit?

Calculation Option: 1

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

CONSTITUENTS OF CONCERN		Representative Concentration	X Soil Leaching to Groundwater			X Soil Volatilization to Indoor Air		X Soil Volatilization to Outdoor Air		Applicable RBSL	RBSL Exceeded ?	Required CRF
CAS No.	Name	(mg/kg)	Residential: (on-site)	Commercial: (on-site)	Regulatory(MCL): (on-site)	Residential: (on-site)	Commercial: (on-site) (PEL)	Residential: (on-site)	Commercial: (PEL) (on-site)	(mg/kg)	"■" If yes	Only if "yes" left
71-43-2	Benzene	7.3E-1	NA	2.5E-2	1.3E-2	NA	3.4E+2	NA	>Res	1.3E-2	■	5.8E+01
100-41-4	Ethylbenzene	6.5E-1	NA	5.7E+1	3.9E+0	NA	>Res	NA	>Res	3.9E+0	☐	<1
108-88-3	Toluene	1.5E+0	NA	1.6E+2	7.6E+0	NA	>Res	NA	>Res	7.6E+0	☐	<1
1330-20-7	Xylene (mixed isomers)	6.4E+0	NA	>Res	1.3E+2	NA	>Res	NA	>Res	1.3E+2	☐	<1

Software: GSI RBCA Spreadsheet
Version: v 1.0
Serial: G-349-KIX-808

RBCA SITE ASSESSMENT | **Tier 1 Worksheet 6.3**

Site Name: Fmr Beacon #574 | Completed By: D. van Dam

Site Location: Castro Valley, CA | Date Completed: 11/11/1996

GROUNDWATER RBSL VALUES

Target Risk (Class A & B) 1.0E-6 | ■ MCL exposure limit? | **Calculation Option: 1**

Target Risk (Class C) 1.0E-5 | ■ PEL exposure limit?

Target Hazard Quotient 1.0E+0

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

CONSTITUENTS OF CONCERN		Representative Concentration	X Groundwater Ingestion			X Groundwater Volatilization to Indoor Air		X Groundwater Volatilization to Outdoor Air		Applicable RBSL	RBSL Exceeded ?	Required CRF
CAS No.	Name	(mg/L)	Residential: (on-site)	Commercial: (on-site)	Regulatory(MCL): (on-site)	Residential: (on-site)	Commercial: (on-site) (PEL)	Residential (on-site)	Commercial: (on-site) (PEL)	(mg/L	"■" if yes	Only if "yes" left
71-43-2	Benzene	3.2E+0	NA	9.9E-3	5.0E-3	NA	7.5E+2	NA	>Sol	5.0E-3	■	6.4E+02
100-41-4	Ethylbenzene	5.6E-1	NA	1.0E+1	7.0E-1	NA	>Sol	NA	>Sol	7.0E-1	☐	<1
108-88-3	Toluene	7.7E-1	NA	2.0E+1	1.0E+0	NA	>Sol	NA	>Sol	1.0E+0	☐	<1
1330-20-7	Xylene (mixed isomers)	2.9E+0	NA	>Sol	1.0E+1	NA	>Sol	NA	>Sol	1.0E+1	☐	<1

Software: GSI RBCA Spreadsheet | Serial: G-349-KIX-808

Version: v 1.0

APPENDIX H

EQUATIONS AND ASSUMPTIONS USED TO DESCRIBE TRANSPORT AND ATTENUATION OF CONSTITUENTS OF CONCERN

- ***Baseline Risk Results***: For each complete exposure pathway, baseline intake rates and risk levels associated with current site conditions are tabulated for both individual and cumulative constituent exposure. To identify critical exposure pathways, a graphical plot is provided comparing cumulative risks for air, water, and soil exposure pathways.
- ***Media Cleanup Values***: Site-Specific Target Levels (SSTLs) for each complete exposure pathway are provided both for individual constituent and cumulative constituent risk limits (if applicable). The software automatically identifies the critical SSTL value for each constituent and calculates the constituent reduction factor (CRF) required to meet the cleanup goal.

EXIT TO EXCEL WORKBOOK

If desired, the user can bypass the software interface and directly access the Excel workbook structure. This feature allows the user to inspect the detailed calculation steps conducted in the various worksheets or review the modeling equations. This option is recommended only for users experienced with direct operation of Excel. Further discussion of the worksheet environment is provided in Section A.4 of this Appendix.

A.3 Fate and Transport Modeling Methods

The RBCA Spreadsheet System contains a series of fate and transport models for predicting COC concentrations at the point of exposure (POE) for indirect exposure pathways, such as air and groundwater. Under Tier 2, relatively simple analytical models are to be employed for this calculation, representing a minor incremental effort relative to Tier 1. The spreadsheet modeling system is consistent with Appendix X.2 of ASTM E-1739, although selected algorithms and default parameters have been updated to reflect advances in evaluation methods.

The idealized schematic shown on Figure A.2 illustrates the steps included in the RBCA software for predicting transport of contaminants from the source zone to the POE for air and groundwater exposure pathways. (Please note that POE attenuation factors and surface water exposure pathways are not included in the software at this time. See Volume 1, Figure 10.) Each element in Figure A.2 represents a step-specific attenuation factor, corresponding to either a cross-media transfer factor (CM) or a lateral transport factor (LT). The effective NAF value for each COC on each pathway is then calculated as the arithmetic product of the various attenuation factors occurring along the flow path from source to receptor. These steady-state NAF values are then used for calculation of baseline risks and back-calculation of Site-Specific Target Levels (SSTLs), as discussed in Section A.2 above. Please note that fate and transport modeling is *not* required for direct exposure pathways, such as soil ingestion or dermal contact, where the source and exposure concentrations are equal (i.e., NAF = 1). Analytical models used for conservative estimation of each transport factor are described below.

CROSS-MEDIA TRANSFER FACTORS

Exposure pathways involving transport of COCs from one medium to another (e.g., soil-to-air, soil-to-groundwater) require estimation of the corresponding cross-media transfer factor. Various analytical expressions are available for estimating soil-to-air *volatilization factors* as a function of site soil characteristics and the physical/chemical properties of volatile organic COCs. *Leaching factors* for organic and inorganic constituent releases from soil to groundwater can similarly be estimated as a function of COC characteristics, soil conditions, and annual rainfall infiltration. Cross-media transfer equations incorporated in the RBCA Spreadsheet System are presented in Figure A.3 beginning on Page A-11. Detailed discussion of each of these cross-media factors is provided below.

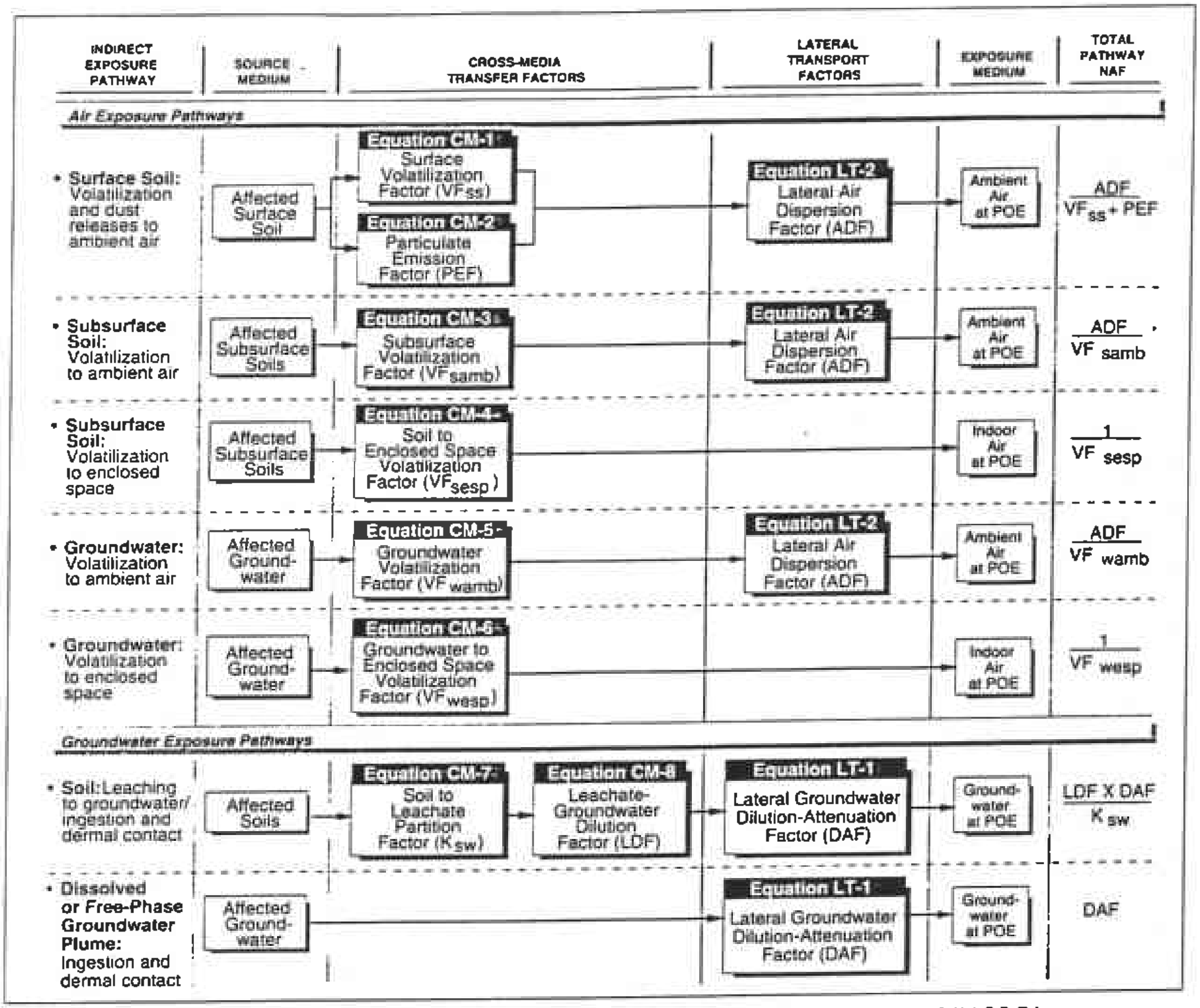


FIGURE A.2. NAF CALCULATION SCHEMATIC FOR INDIRECT EXPOSURE PATHWAYS IN RBCA SPREADSHEET SYSTEM

- ***VF_{ss}: Surface Soil Volatilization Factor (Equation CM-1)***
  The surface volatilization factor is the steady-state ratio of the concentration of an organic constituent in the ambient air breathing zone to the source concentration in the surface soil. The surface volatilization factor incorporates two cross-media transfer elements: i) organic vapor flux from the surface soil mass to ground surface and ii) mixing of soil vapors in the ambient air breathing zone directly over the affected surface soil. For each site, the applicable VF_{SS} value corresponds to the lesser result of two calculation methods (termed CM-1a and CM-1b on Figure A.3, page A-11). Equation CM-1a typically controls for low-volatility organics, as it assumes there is an infinite source of organics in the surface soils and uses a volatilization rate based primarily on chemical properties. Equation CM-1b, which typically controls for volatile organics, is based on a mass balance approach. In this equation, a finite amount of organics is assumed to be present in the surface soil (based on the representative COC concentration), volatilizing at a constant rate over the duration of the exposure period (e.g., 25-30 years). Both expressions account for the dilution of organics in ambient air above the source zone due to mixing with ambient air moving across the site. A simple box model is used for this dilution calculation, based on the following adjustable default assumptions: 2-meter mixing zone height and 225 cm/sec (5 mph) lateral wind speed. The length of the mixing zone is set equal to the lateral dimension of the exposed affected surface soil area parallel to the assumed wind direction.

Key assumptions used in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: VF_{ss}	EFFECT ON CLEANUP STANDARD
• **Uniform COC Concentrations**: Constituent levels uniformly distributed in soil and constant over exposure period.	-----
• **No COC Decay**: No biodegradation or other loss mechanism in soil or vapor phase.	⇩
• **Finite Source Term**: Source term mass adjusted for constant volatilization over exposure period.	-----

- ***PEF: Soil Particulate Emission Factor (Equation CM-2)***
The Particulate Emission Factor (PEF) is the steady-state ratio of the concentration of organics in particulates in the ambient air breathing zone to the source concentration of organics in the surface soil. The factor incorporates two cross-media transfer elements: i) the release rate of soil particulates (dust) from ground surface and ii) mixing of these particulates in the ambient air breathing zone directly over the affected surface soil. The particulate release rate is commonly matched to a conservative default value of 6.9×10^{-14} g/cm^2-sec (approximately 0.2 lbs/acre-year), unless a more appropriate site-specific estimate is available. (If the site is paved, the particulate release rate and resultant PEF value for the covered soil area will be zero.) Particulates are assumed to be diluted by lateral air flow directly over the source zone. For this purpose, a simple box model is employed, based on the following adjustable default assumptions: 2-meter mixing zone height and 225 cm/sec (5 mph) lateral wind speed. The length of the mixing zone is matched to the lateral dimension of the exposed affected surface soil area parallel to the assumed wind direction.

Key assumptions incorporated in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: PEF	EFFECT ON CLEANUP STANDARD
• **Uniform COC Concentrations**: Constituent levels uniformly distributed in soil and constant over exposure period.	-----
• **No COC Decay**: No biodegradation or other loss mechanism in soil or vapor phase.	⇩
• **Default Emission Rate**: Conservative particulate emission rate.	⇩

- ***VF_{samb}: Subsurface Soil Volatilization Factor (Equation CM-3)***
The subsurface soil volatilization factor is comparable to the surface volatilization equation, except that the algorithm has been adjusted to account for vapor flux from greater soil depths. The volatilization factor accounts for two cross-media transfer elements: i) organic vapor flux from the subsurface affected soil mass to ground surface and ii) mixing of soil vapors in the ambient air breathing zone directly over the affected soil zone. As with the surface soil volatilization factor, VF_{SS}, the applicable subsurface soil volatilization factor, VF_{samb}, corresponds to the lesser result of two calculation methods (termed CM-3a and CM-3b on Figure A.3, page A-12). Equation CM-3a, which corresponds to the expression given in Appendix X.2 of ASTM E-1739, assumes a constant source mass in the subsurface and can severely overpredict the soil vapor flux rate. To correct for this problem, Equation CM-3b, which accounts for a mass balance of the volatilized source mass over the exposure period (similar to Equation CM-1b) has been incorporated in the RBCA Spreadsheet. With either equation (CM-3a or CM 3-b), dilution of soil vapors in the ambient air breathing zone is estimated using the same box model described for Equation CM-1.

Key assumptions incorporated in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: VF_{samb}	EFFECT ON CLEANUP STANDARD
• **Uniform COC Concentrations**: Constituent levels uniformly distributed in soil and constant over exposure period.	——
• **No COC Decay**: No biodegradation or other loss mechanism in soil or vapor phase.	⇩
• **Finite Source Term**: Source term mass adjusted for constant volatilization over exposure period.	——

- ***VF_{sesp}: Subsurface Soil-to-Enclosed-Space Volatilization Factor (Equation CM-4)***

  This factor is the steady-state ratio of the source concentration of an organic constituent in indoor air due to the concentration in underlying subsurface soils. Again, two expressions are evaluated: i) Equation CM-4a, which assumes an infinite source mass and is of the same form as Equation CM-3a with a term added to represent diffusion through cracks in the foundation of the building, and ii) Equation CM-4b which accounts for a finite source mass volatilizing at a constant rate over the exposure period. The applicable VF_{sesp} value corresponds to the lesser of these two expressions. The soil-to-enclosed-space volatilization factor incorporates two cross-media transfer elements: i) organic vapor flux from the underlying soil mass through the building floor and ii) mixing of soil vapors with indoor air. Tier 1 default assumptions in the software include: i) a 1% open crack space in the foundation allowing vapors to diffuse into the building and ii) a building air exchange rate of one exchange every 20 days. When used with these default values, the expression yields very conservative results and can represent the controlling pathway for SSTL calculations for many sites. In such case, users are advised to conduct direct air or soil vapor measurements prior to proceeding with remedial measures for this pathway.

  Key assumptions used in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: VF_{sesp}	EFFECT ON CLEANUP STANDARD
• **Uniform COC Concentrations**: Constituent levels uniformly distributed in soil and constant over exposure period.	——
• **No COC Decay**: No biodegradation or other loss mechanism in soil or vapor phase.	⇩
• **Finite Source Term**: Source term mass adjusted for constant volatilization over exposure period.	——
• **Default Building Parameters**: Conservative default values for foundation crack area and air exchange rate.	⇩

- ***VF_{wamb}: Groundwater Volatilization Factor (Equation CM-5)***

  The groundwater volatilization factor is the steady-state ratio of the concentration of an organic constituent in ambient air to the source concentration in underlying affected groundwater. Vapor flux rates from groundwater to soil vapor and thence from soil vapor to ground surface are generally lower than those associated with direct volatilization from affected soils. Consequently, this groundwater-to-ambient-air volatilization factor is typically not significant in comparison to soil volatilization factors (i.e., Equations CM-1 or CM-3). This factor accounts for i) steady-state partitioning of dissolved organic constituents from groundwater to the soil vapor phase, ii) soil vapor flux rates to ground surface, and iii) mixing of soil vapors in the ambient air breathing zone directly over the plume. Dilution of organic vapors in the breathing zone is estimated using a box model, as described for Equation CM-1 above.

Key assumptions incorporated in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: VF_{wamb}	EFFECT ON CLEANUP STANDARD
• **Vapor Equilibrium:** Soil vapor concentrations reach immediate equilibrium with groundwater source.	⇩
• **No COC Decay:** No biodegradation or other loss mechanism in groundwater or vapor phase.	⇩
• **Infinite Source:** COC mass in source term constant over time.	⇩

- ***VF_{wesp}: Groundwater to Enclosed Space Volatilization Factor (Equation CM-6)***
  This factor is the steady-state ratio of the concentration of an organic constituent in indoor air to the source concentration in the underlying affected groundwater. The algorithm is equivalent to Equation CM-5, modified to address vapor diffusion through a building floor and enclosed space accumulation. Tier 1 default values are the same as those specified for Equation CM-4 and, as noted previously, can provide a relatively conservative (upper-range) estimate of indoor vapor concentrations. If this pathway produces the controlling (minimum) RBSL or SSTL value for a given site, the user is advised to conduct direct air or soil vapor measurements to evaluate the actual need for remedial measures.

  Key assumptions used in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: VF_{wesp}	EFFECT ON CLEANUP STANDARD
• **Vapor Equilibrium:** Soil vapor concentrations reach immediate equilibrium with groundwater source.	⇩
• **No COC Decay:** No biodegradation or other loss mechanism in groundwater or vapor phase.	⇩
• **Infinite Source:** COC mass in source term constant over time.	⇩
• **Default Building Factors:** Conservative default values for foundation crack area and air exchange rate.	⇩

- ***K_{sw}: Soil Leachate Partition Factor (Equation CM-7)***
  The soil leachate partition factor is the steady-state ratio between the concentration of an organic constituent in soil pore water and the source concentration on the affected soil mass. This factor is used to represent the release of soil constituents to leachate percolating through the affected soil zone.

  Key assumptions used in this equation and their effect on the SSTL calculation are as follows:

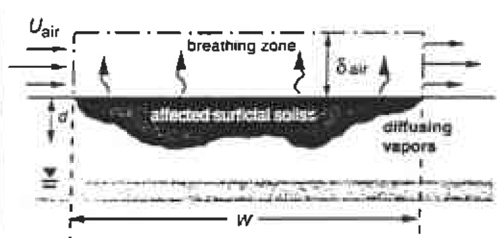
KEY ASSUMPTIONS: K_{sw}	EFFECT ON CLEANUP STANDARD
• **Leachate Equilibrium:** Leachate concentrations reach immediate equilibrium with affected soil source.	⇩
• **No COC Decay:** No biodegradation or other loss mechanism in soil or leachate.	⇩
• **Infinite Source:** COC mass in soil constant over time.	⇩

- ***LDF: Leachate-Groundwater Dilution Factor (Equation CM-8)***
  The LDF factor accounts for dilution of organics as leachate from the overlying affected soil zone mixes with groundwater in the underlying water-bearing unit. As indicated on Figure A.2, the leachate dilution factor (LDF) divided by the soil-leachate partition factor (K_{sw}) represents the steady-state ratio between the concentration of an organic constituent in the groundwater zone and the source concentration on the overlying affected soil. To estimate the leachate dilution factor, a simple box model is used to estimate mass dilution within a mixing zone in the water-bearing unit directly beneath the affected soil mass (see Equation CM-8, Figure A.3 on page A-13). The leachate volume entering the water-bearing unit is represented by the deep infiltration term, I, which typically falls in the range of 0.5% - 5% of annual site precipitation. For the Tier 1 RBSL calculation, a conservative default infiltration value of 30 cm/year is used, consistent with the example provided in ASTM E-1739, Appendix X.2. For many sites, this default value (equivalent to an annual rainfall rate of over 200 in/year) may significantly overestimate actual leachate rates.

  Key assumptions used in this equation and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: LDF	EFFECT ON CLEANUP STANDARD
• **Rainfall Infiltration:** Deep percolation through affected soil assumed to reach water-bearing unit regardless of soil thickness or permeability.	⇩
• **No COC Decay**: No biodegradation or other loss in mechanism groundwater zone.	⇩
• **Default Dilution Parameters:** Conservative default value for infiltration rate.	⇩

Equation CM-1: Surface Soil Volatilization Factor (VFss)



CM-1a:

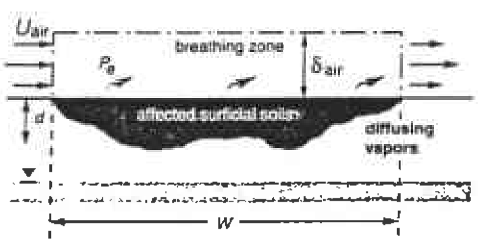
$$VF_{ss}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{2W\rho_s}{U_{air}\delta_{air}}\sqrt{\frac{D_s^{eff}H}{\pi\tau(\theta_{ws}+k_s\rho_s+H\theta_{as})}}\times10^3$$

or CM-1b:

$$VF_{ss}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{W\rho_s d}{U_{air}\delta_{air}\tau}\times10^3$$

whichever is less

Equation CM-2: Soil Particulate Emission Factor (PEF)

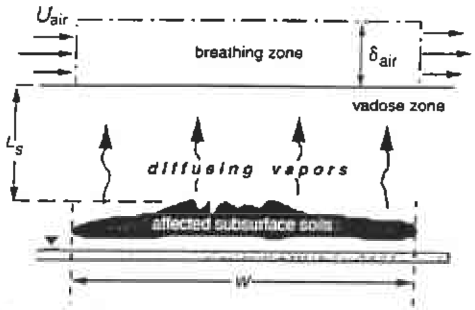


$$PEF\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{P_e W}{U_{air}\delta_{air}}\times10^3$$

FIGURE A.3 CROSS-MEDIA PARTITIONING EQUATIONS IN THE RBCA SPREADSHEET SYSTEM *Continued*

Continued

Equation CM-3: Subsurface Soil Volatilization Factor (VFsamb)



CM-3a:

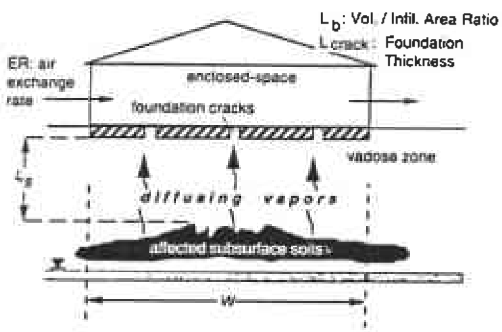
$$VF_{samb}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{H\rho_s}{\left[\theta_{ws}+k_s\rho_s+H\theta_{as}\right]\left[1+\frac{U_{air}\delta_{air}L_s}{D_s^{eff}W}\right]}\times10^3$$

or CM-3b:

$$VF_{samb}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{W\rho_s d_s}{U_{air}\delta_{air}\tau}\times10^3$$

whichever is less

Equation CM-4: Subsurface Soil to Enclosed Space Volatilization Factor (VFsesp)



CM-4a:

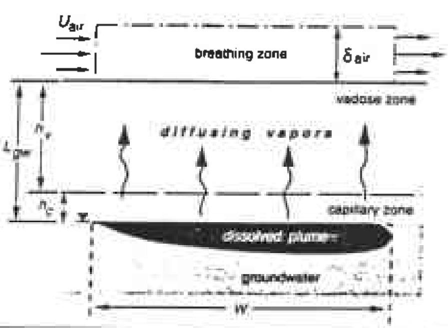
$$VF_{sesp}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{\frac{H\rho_s}{\left[\theta_{ws}+k_s\rho_s+H\theta_{as}\right]}\left[\frac{D_s^{eff}/L_s}{ER\ L_B}\right]}{1+\left[\frac{D_s^{eff}/L_s}{ER\ L_B}\right]+\left[\frac{D_s^{eff}/L_s}{\left(D_{crack}^{eff}/L_{crack}\right)\eta}\right]}\times10^3$$

or CM-4b:

$$VF_{sesp}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{\rho_s d_s}{L_B ER\tau}\times10^3$$

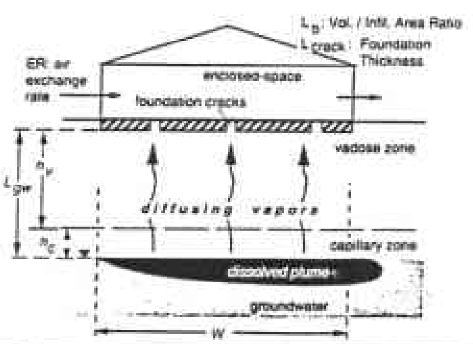
whichever is less

Equation CM-5: Groundwater Volatilization Factor (VFwamb)



$$VF_{wamb}\left[\frac{(mg/m^3-air)}{(mg/L-H_2O)}\right]=\frac{H}{1+\left[\frac{U_{air}\delta_{air}L_{GW}}{WD_{ws}^{eff}}\right]}\times10^3$$

Equation CM-6: Groundwater to Enclosed Space Volatilization Factor (VFwesp)



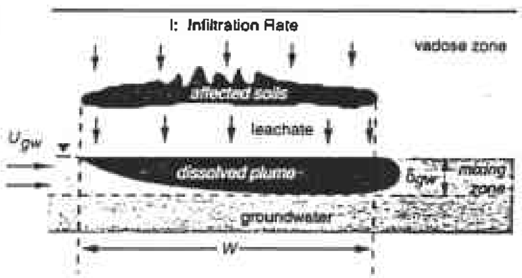
$$VF_{wesp}\left[\frac{(mg/m^3-air)}{(mg/L-H_2O)}\right]=\frac{H\left[\frac{D_{ws}^{eff}/L_{GW}}{ER\ L_B}\right]}{1+\left[\frac{D_{ws}^{eff}/L_{GW}}{ER\ L_B}\right]+\left[\frac{D_{ws}^{eff}/L_{GW}}{\left(D_{crack}^{eff}/L_{crack}\right)\eta}\right]}\times10^3$$

FIGURE A.3 CROSS-MEDIA PARTITIONING EQUATIONS IN THE RBCA SPREADSHEET SYSTEM *Continued*

Continued

Equation CM-7: Soil Leachate Partition Factor(Ksw)

Equation CM-8: Leachate-Groundwater Dilution Factor (LDF)



$$K_{sw}\left[\frac{(mg/L-H_2O)}{(mg/kg-soil)}\right]=\frac{\rho_s}{\theta_{ws}+k_s\rho_s+H\theta_{as}}$$

$$LDF[dimensionless]=1+\frac{V_{gw}\delta_{gw}}{IW}$$

Definitions for Cross-Media Transfer Equations

D_s^{eff} Effective diffusivity in vadose zone soils:

$$D_s^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{as}^{3.33}}{\theta_T^2}+\left[\frac{D^{wat}}{H}\right]\left[\frac{\theta_{ws}^{3.33}}{\theta_T^2}\right]$$

D_{ws}^{eff} Effective diffusivity above the water table:

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right]=\left(h_{cap}+h_v\right)\left[\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right]^{-1}$$

D_{crack}^{eff} Effective diffusivity through foundation cracks:

$$D_{crack}^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{acrack}^{3.33}}{\theta_T^2}+\left[\frac{D^{wat}}{H}\right]\left[\frac{\theta_{wcrack}^{3.33}}{\theta_T^2}\right]$$

D_{cap}^{eff} Effective diffusivity in the capillary zone:

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{acap}^{3.33}}{\theta_T^2}+\left[\frac{D^{wat}}{H}\right]\left[\frac{\theta_{wcap}^{3.33}}{\theta_T^2}\right]$$

d	Lower depth of surficial soil zone (cm)
d_s	Thickness of affected subsurface soils
D^{air}	Diffusion coefficient in air (cm^2/s)
D^{wat}	Diffusion coefficient in water (cm^2/s)
ER	Enclosed-space air exchange rate (L/s)
f_{oc}	Fraction of organic carbon in soil (g-C/g-soil)
H	Henry's law constant (cm^3-H_2O)/(cm^3-air)
h_{cap}	Thickness of capillary fringe (cm)
h_v	Thickness of vadose zone (cm)
I	Infiltration rate of water through soil (cm/year)
k_{oc}	Carbon-water sorption coefficient (g-H_2O/g-C)
k_s	Soil-water sorption coefficient (g-H_2O/g-soil)
L_B	Enclosed space volume/infiltration area ratio (cm)
L_{crack}	Enclosed space foundation or wall thickness (cm)
L_{GW}	Depth to groundwater = $h_{cap}+h_v$ (cm)
L_s	Depth to subsurface soil sources (cm)
P_e	Particulate emission rate (g/cm^2-s)
U_{air}	Wind speed above ground surface in ambient mixing zone (cm/s)
V_{gw}	Groundwater Darcy velocity (cm/s)
W	Width of source area parallel to wind, or groundwater flow direction (cm)
δ_{air}	Ambient air mixing zone height (cm)
δ_{gw}	Groundwater mixing zone thickness (cm)
η	Areal fraction of cracks in foundations/walls (cm^2-cracks/cm^2-total area)
θ_{acap}	Volumetric air content in capillary fringe soils (cm^2-air/cm^3-soil)
θ_{acrack}	Volumetric air content in foundation/wall cracks (cm^3-air/cm^3 total volume)
θ_{as}	Volumetric air content in vadose zone soils (cm^3-air/cm^3-soil)
θ_T	Total soil porosity (cm^3-pore-space/ cm^3-soil)
θ_{wcap}	Volumetric water content in capillary fringe soils (cm^3-H_2O/cm^3-soil)
θ_{wcrack}	Volumetric water content in foundation/wall cracks (cm^3-H_2O)/cm^3 total volume)
θ_{ws}	Volumetric water content in vadose zone soils (cm^3-H_2O/cm^3-soil)
ρ_s	Soil bulk density (g-soil/cm^3-soil)
τ	Averaging time for vapor flux (s)

FIGURE A.3 CROSS-MEDIA PARTITIONING EQUATIONS IN THE RBCA SPREADSHEET SYSTEM

LATERAL TRANSPORT FACTORS

During lateral transport within air or groundwater, COC concentrations in the flow stream will be diminished due to mixing and attenuation effects (see Figure A.2). Site-specific attenuation factors

LATERAL TRANSPORT FACTORS

During lateral transport within air or groundwater, COC concentrations in the flow stream will be diminished due to mixing and attenuation effects (see Figure A.2). Site-specific attenuation factors characterizing COC mass dilution or loss during lateral transport can be estimated using the air dispersion and groundwater transport models provided in the RBCA Spreadsheet System. Equations for the steady-state analytical transport models incorporated in the RBCA spreadsheet are shown on Figure A.4. The user must provide information regarding COC properties and transport parameters (flow velocities, dispersion coefficients, retardation factors, decay factors, etc.), as required for the selected contaminant transport model. Calculation procedures for lateral air dispersion and groundwater dilution-attenuation factors are described below.

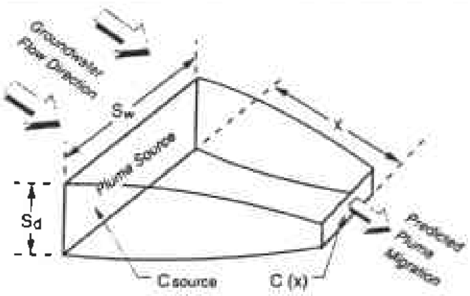
- ***DAF: Lateral Groundwater Dilution Attenuation Factor (Equation LT-1)***

  To account for attenuation of affected groundwater concentrations between the source and POE, the Domenico analytical solute transport model has been incorporated into the RBCA software. This model uses a partially or completely penetrating vertical plane source, perpendicular to groundwater flow, to simulate the release of organics from the mixing zone to the moving groundwater (see Figure A.4). Within the groundwater flow regime, the model accounts for the effects of advection, dispersion, sorption, and biodegradation. Given a representative source zone concentration for each COC, the model can predict steady-state plume concentrations at any point (x, y, z) in the downgradient flow system. In the RBCA Spreadsheet System, the model is set to predict centerline plume concentrations at any downgradient distance x, based on 1-D advective flow and 3-D dispersion. The receptor well is assumed to be located on the plume centerline, directly downgradient of the source zone at a location specified by the user. Source concentrations and critical flow parameters must be provided by the user. Guidelines for selection of key input parameters are outlined below.

i) **Groundwater Source Term.** The Domenico model represents the groundwater source term as a vertical plane source, perpendicular to groundwater flow, releasing dissolved constituents into groundwater passing through the plane. In the RBCA Spreadsheet System, the source plane dimensions are matched to the source width and thickness specified by the user. The user should provide source dimensions equivalent to the measured thickness and transverse width of the groundwater plume at the source point (area of maximum plume concentration). The source is assumed to be infinite and constant, with source zone concentrations set equal to the representative COC concentrations supplied by the user. Representative source concentrations must be provided for each COC. As indicated on Table 6 in Volume 1, Section 3.0, of this manual, these values should correspond to the maximum COC concentrations measured at the plume "hot spot" unless sufficient data are available to facilitate use of other statistical estimates. If non-aqueous phase liquids (NAPLs) are present, maximum COC solubility limits in groundwater can be corrected for mixture effects by using Raoult's Law (see References 18 and 24, Section 5.0, Volume 1). For this purpose, the user must provide data regarding the mole fractions of principal NAPL constituents.

ii) **Flow and Mixing Parameters.** The degree of contaminant mixing predicted by the model will be a function of the dispersion coefficients, hydraulic conductivity, hydraulic flow gradient, and effective soil porosity specified by the user. Hydraulic conductivity and flow gradient should be matched directly to site measurements. In many cases, the effective soil porosity of the water-bearing unit can be reasonably estimated based on soil type using published references. Typical default values are provided in the software.

Equation LT-1: Lateral Groundwater Dilution Attenuation Factor



LT-1a: Solute Transport with First-Order Decay:

$$\frac{C(x)_i}{Csi} = \exp\left(\frac{x}{2\alpha_x}\left[1-\sqrt{1+\frac{4\lambda_i\alpha_x R_i}{v}}\right]\right) erf\left(\frac{S_w}{4\sqrt{\alpha_y x}}\right) erf\left(\frac{S_d}{4\sqrt{\alpha_z x}}\right)$$

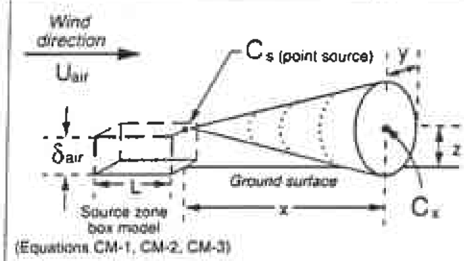
where: $v = \dfrac{K \cdot i}{\theta_e}$

LT-1b: Solute Transport with Biodegradation by Electron-Acceptor Superposition Method:

$$C(x)_i = \left[(C_{si} + BC_i) erf\left(\frac{S_w}{4\sqrt{\alpha_y x}}\right) erf\left(\frac{S_d}{4\sqrt{\alpha_z x}}\right)\right] - BC_i$$

where: $BC_i = BC_T \times \dfrac{C_{si}}{\sum C_{si}}$ *and* $BC_T = \Sigma \dfrac{C(ea)_n}{UF_n}$

Equation LT-2: Lateral Air Dispersion Factor



$$\frac{C(x)_i}{C_{si}} = \frac{Q}{2\pi U_{air}\sigma_y\sigma_z} \times \exp\left(-\frac{y^2}{2\sigma_y^2}\right)\left(\exp\left(-\frac{(z-\delta_{air})^2}{2\sigma_z^2}\right) + \exp\left(-\frac{(z+\delta_{air})^2}{2\sigma_z^2}\right)\right)$$

where: $Q = \dfrac{U_{air}(\delta_{air})(A)}{L}$

Definitions for Lateral Transport Equations

$C(x)_i$	Concentration of constituent *i* at distance x downstream of source (mg/L) or (mg/m^3)
C_{si}	Concentration of constituent *i* in Source Zone (mg/L) or (mg/m^3)
BC_i	Biodegradation capacity available for constituent *i*
BC_T	Total biodegradation capacity of all electron acceptors in groundwater
$C(ea)_n$	Concentration of electron acceptor *n* in groundwater
UF_n	Utilization factor for electron acceptor *n* (i.e., mass ratio of electron acceptor to hydrocarbon consumed in biodegradation reaction)
x	Distance downgradient of source (cm)
α_x	Longitudinal groundwater dispersivity (cm)
α_y	Transverse groundwater dispersivity (cm)
α_z	Vertical groundwater dispersivity (cm)
θ_e	Effective Soil Porosity
λ_i	First-Order Degradation Rate (day^{-1}) for constituent *i*
υ	Groundwater Seepage Velocity (cm/day)
K	Hydraulic Conductivity (cm/day)
R_i	Constituent retardation factor
i	Hydraulic Gradient (cm/cm)
S_w	Source Width (cm)
S_d	Source Depth (cm)
δ_{air}	Ambient air mixing zone height (cm)
Q	Air volumetric flow rate through mixing zone (cm^3/s)
U_{air}	Wind Speed (cm/sec)
σ_y	Transverse air dispersion coefficient (cm)
σ_z	Vertical air dispersion coefficient (cm)
y	Lateral Distance From source zone (cm)
z	Height of Breathing Zone (assumed equal to δ_{air}) (cm)
A	Cross Sectional Area of Air Emissions Source (cm^2)
L	Length of Air Emissions source (cm) parallel to wind direction

FIGURE A.4 LATERAL TRANSPORT EQUATIONS IN THE RBCA SPREADSHEET SYSTEM

Selection of dispersion coefficients can prove problematic, given the impracticability of direct site measurements. Conservative practice calls for setting the longitudinal dispersivity, α_x (units of length), equal to 0.1 times the advective plume length from source to receptor; the transverse dispersivity, α_y equal to 0.33 times α_x; and the vertical dispersivity, α_z, equal to 0.05 times α_x (see References 17 and 28, Section 5.0, Volume 1). This fixed relationship is incorporated in the RBCA spreadsheet, allowing the user to calculate dispersion coefficients based on the distance from the source to the receptor.

iii) **Retardation Factors.** The rate of plume migration can be reduced due to constituent sorption to the solid matrix of the water-bearing unit. The user is referred to standard hydrogeologic texts regarding calculation of retardation factors for both inorganic and organic plume constituents (see Reference 18 and 24, Section 5.0, Volume 1). The RBCA software calculates a retardation factor for each COC using information on the organic-carbon partition coefficient (K_{oc}) of the constituent and the fraction organic carbon (foc) of the soil matrix. Sorption can significantly affect the NAF calculation if first-order decay conditions are assumed to apply. However, the retardation factor will not affect model results under constant source, steady-state conditions in the absence of first-order decay.

iv) **First-Order Decay Parameters.** Under steady-state conditions, hydrolysis and biodegradation represent the principal mechanisms of organic contaminant mass reduction during groundwater plume transport within the subsurface. Many groundwater transport models account for these attenuation phenomena by means of a first-order decay function within the advection-dispersion equation. In the RBCA Spreadsheet System, the user may elect to use a version of the Domenico solute transport model incorporating first-order decay (see Equation LT-1a on Figure A.4 and Screen 9 of software). Considerable care must be exercised in the selection of a first-order decay coefficient for each COC, however, in order to avoid significantly over-predicting or under-predicting actual decay rates. Optional methods for selection of appropriate decay coefficients are as follows:

Literature Values: Various published references are available regarding decay half-life values for hydrolysis and biodegradation (see References 36 and 37, Section 5.0, Volume 1). The chemical / toxicological database incorporated in the RBCA Spreadsheet System includes minimum published decay rate coefficients (representing maximum decay half-lives) for each chemical, and the user may select to load these or other input values on Screens 9 and 9.1 of the software. Use of these first-order decay coefficients will generally provide a conservative result (i.e., predict worst-case exposure concentrations and more stringent cleanup standards).

Calibrate to Existing Plume Data with RBCA Software: If the plume is in a steady-state or diminishing condition, the Domenico model can be used to determine first-order decay coefficients that best match the observed site concentrations. The user may adopt a trial-and-error procedure with the RBCA Spreadsheet using the *Alternate POC Action Level* worksheet (see Screen 11 of software) to derive a best-fit decay coefficient value for each COC. For this purpose, with all other input parameters fixed, the decay-rate value for each COC should be individually adjusted until the ratio of i) the calculated action level concentration to ii) the actual COC measurement at each alternate point of compliance (APOC) location is relatively uniform among all APOCs (i.e., same ratio at each APOC). SSTL values calculated for these plume-matched decay values can then be used in the Tier 2 evaluation. Please note that, for expanding plumes, this steady-state calibration method may over-estimate actual decay-rate coefficients and contribute to an under-estimation of predicted POE concentration levels and baseline risks. Further guidelines for model calibration to existing data are provided in Reference 28, Section 5.0, Volume 1.

Calibrate to Existing Plume Data with Alternate Model: If desired, a more complex groundwater model may be used to characterize decay-rate coefficients under either steady-state, diminishing, or expanding plume conditions, and the resultant decay-rate values used indicates an expanding plume condition (or is insufficient to confirm a steady-state or diminishing condition), a transient flow model accounting for the time since the release occurred can be employed to more accurately estimate first-order decay terms, based on a best-fit match to site data. These estimated decay-rate coefficients can then be entered in the steady-state RBCA Spreadsheet model (Equation LT-1a) to predict chronic exposure and risk levels at the POE.

At low constituent concentrations and in low flowrate groundwater systems, groundwater transport models are particularly sensitive to first-order decay parameters. Consequently, care should be taken in selection of these values to ensure reliable modeling results. Because many biodegradation processes within the subsurface groundwater system are rate-limited based on the availability of electron acceptors (e.g., dissolved oxygen), first-order decay rate factors should not be transferred from the laboratory to the field, or from one field site to another, without consideration of key site conditions (e.g., background electron acceptor concentration in groundwater, COC source concentration, groundwater seepage velocity, etc.). In addition, for some organics (primarily chlorinated solvents), the user must consider the breakdown products (or *progeny*) of the hydrolysis or biodegradation process and select a decay rate coefficient that is representative of the full decay chain (i.e., from COC to non-hazardous progeny).

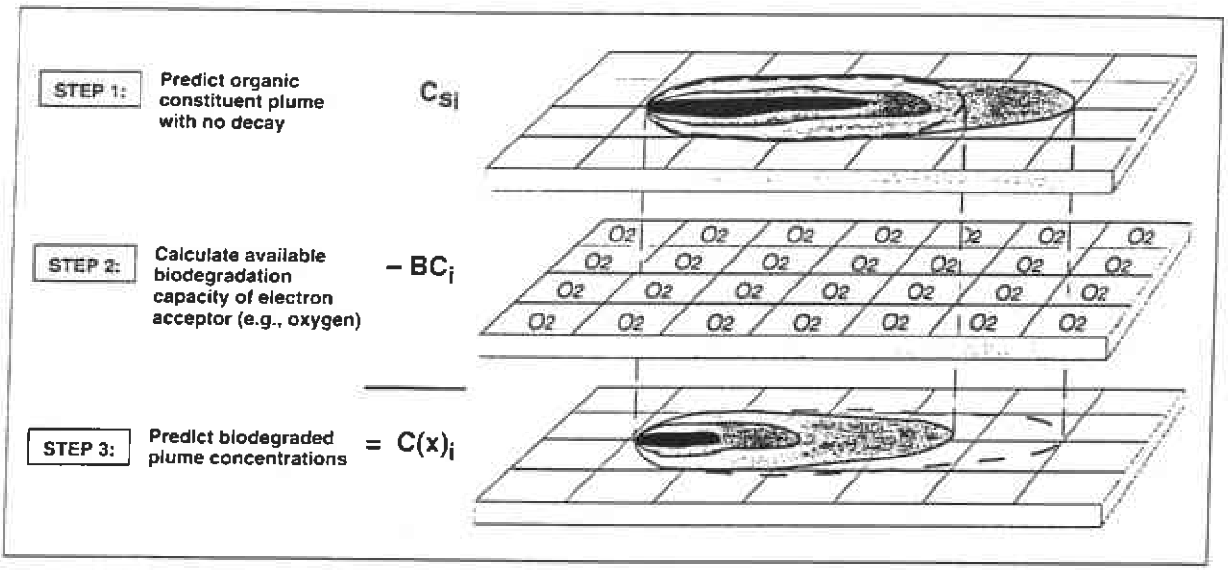


FIGURE A.5. ELECTRON ACCEPTOR SUPERPOSITION METHOD FOR SIMULATION OF GROUNDWATER CONTAMINANT BIODEGRADATION

v) **Electron-Limited Biodegradation Rates.** As an alternative to a first-order decay function, the user may select a groundwater contaminant transport model incorporating a direct simulation of in-situ biodegradation processes. To account for stoichiometric constraints, such models commonly employ particle transport of both organic and electron acceptors with an instantaneous reaction assumption. Given proper characterization of background concentrations of key electron acceptors, source zone COC concentrations, and groundwater flow parameters, these models can generally be relied upon to provide a conservative estimate of biodegradation effects on organic plume concentrations at the POE, without the difficulty associated with selection of a site-specific, first-order decay rate.

For this purpose, the RBCA Spreadsheet System includes a version of the Domenico solute transport model incorporating an electron acceptor superposition algorithm (see Equation LT-1b on Figure A.4 and Screen 9 of the software). Based on the biodegradation capacity of electron acceptors present in the groundwater system, this algorithm will correct the non-decayed groundwater plume concentrations predicted by the Domenico model for the effects of organic constituent biodegradation. This calculation procedure is illustrated on Figure A.5 and discussed in further detail below.

Based on the stoichiometric equation for the biodegradation reaction, a *utilization factor*, representing the ratio of electron acceptor mass to hydrocarbon mass consumed during biodegradation, can be defined for each electron acceptor. Utilization factors for the principal electron acceptors present in shallow groundwater systems, as reported in the research literature (see Reference 29b, Volume 1, Section 5.0), are summarized on Table A.1.

TABLE A.1 UTILIZATION FACTORS FOR SELECTED ELECTRON ACCEPTORS

ELECTRON ACCEPTOR	UTILIZATION FACTOR (gm/gm)
Oxygen	3.14
Nitrate	4.9
Ferrous Iron (for Ferric Iron)	21.8
Sulfate	4.6
Methane (for Carbon Dioxide)	0.78

Note: "Electron Acceptor" refers to actual electron acceptor or surrogate by-products. Utilization Factor represents the mass ratio of electron acceptor to hydrocarbon quantity consumed (gm/gm) in biodegradation reaction within groundwater.

Given these values, the potential contaminant mass removal or biodegradation capacity (BC_n) of a given electron acceptor *n* can then be estimated as the concentration of that electron acceptor ($C(ea)_n$) in the groundwater divided by its utilization factor (UF_n). The total biodegradation capacity of the groundwater mass mixing with the contaminant plume is the sum of the individual capacities for each of the principal electron acceptors (i.e., $BC_T = \sum BC_n$ for n = oxygen, nitrate, iron, sulfate, etc.). Note that, in this process, *electron acceptors* are defined as three easily measured electron acceptors (dissolved oxygen, nitrate, and sulfate) and surrogate by-products for two other difficult-to-quantify electron acceptors (ferrous iron instead of ferric iron and methane instead of carbon dioxide). The concentrations of the actual electron acceptors are measured in background wells, while the concentration of the by-products are measured in the source zone. For this calculation, using the background concentration of each electron acceptor (oxygen, nitrate, sulfate) from outside the plume will provide an upperbound estimate of BC_T. For a lowerbound estimate, the calculation may be based upon the difference in the electron acceptor concentrations (oxygen, nitrate, sulfate) measured inside and outside the plume area (i.e., $C(ea)_n$*-outside* minus $C(ea)_n$*-inside*), thereby accounting for non-utilization of a portion of the electron acceptor mass.

The total biodegradation capacity of the groundwater mass must be distributed among the various organic constituents present in the dissolved contaminant plume. Compared to the rate of plume transport, biodegradation reactions occur relatively instantaneously upon mixing of a readily degradable organic plume (e.g., monoaromatic hydrocarbons) with the background electron acceptor mass. Given the relatively uniform rate of biodecay of the organic compounds typically present in petroleum hydrocarbon products, the portion of the total biodegradation capacity available for removal of each constituent *i* (BC_i) can be estimated based on the mass percentage of each constituent in the plume (i.e., $BC_i = BC_T \cdot Cs_i / \sum Cs_i$, where Cs_i = source concentration of constituent *i*). This assumption will prove reasonable for mixtures of all-readily degradable compounds, due to the relatively uniform biokinetic rates within these groups. However, within mixed degradable and non-degradable constituent plumes (e.g., benzene with dichloroethane), the readily degradable compounds will actually consume a disproportionate share of the biodegradation capacity.

If the user elects to use the electron acceptor superposition option, the RBCA Spreadsheet System will i) estimate the total biodegradation capacity (BC_T) of the groundwater mass based on the electron acceptor concentrations provided by the user (see Screen 9.1), ii) allocate an available biodegradation capacity (BC_i) to each of the various dissolved organic constituents based on the concentration data provided by the user (see Screen 7), and iii) correct the steady-state plume concentrations predicted by the Domenico solute transport model for the effects of biodegradation using Equation LT-1b (see Figure A.4). Further information regarding the electron acceptor biodegradation algorithm is provided in References 19 and 29 (see Section 5.0, Volume 1).

Key assumptions used in the groundwater solute transport model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: LATERAL GROUNDWATER DAF	EFFECT ON CLEANUP STANDARD
• **Infinite Source**: Groundwater source term constant over time with no depletion.	⇩
• **Dispersion Coefficient**: Fixed proportions assumed among longitudinal, transverse, and vertical dispersion coefficients.	-----
• **Receptor Location**: Downgradient receptor well assumed to be on plume centerline.	⇩
• **Biodegradation Rate**: High or low first-order of decay rate may be specified by user per site data.	variable

- ***ADF: Lateral Air Dispersion Factor (Equation LT-2)***
  The RBCA software includes a 3-dimensional gaussian dispersion model to account for transport of air-borne contaminants from the source area to a downwind POE (see Equation LT-2 on Figure A.4). The model incorporates two conservative assumptions: i) a source zone height equivalent to the breathing zone and ii) a receptor located directly downwind of the source at all times. As indicated on Figure A.2, an effective pathway NAF value is calculated as the steady-state ratio between the ambient organic vapor or particulate concentration at the downwind POE and the source concentration in the on-site affected soil zone. The model requires input data for the affected soil zone dimensions and concentrations, wind speed, and horizontal and vertical air dispersion coefficients to compute the resulting COC concentrations in ambient air at the POE. Guidelines for estimating key input parameters are provided below:

  i) **Air Source Term:** In the RBCA Spreadsheet, the source term for the air dispersion model is matched to the ambient air vapor concentrations determined in accordance with the soil-to-air cross-media transfer equations CM-1, CM-2, and CM-3 shown on Figure A.3. Specifically, the source concentration for off-site vapor transport is equivalent to the vapor concentration exiting the box model for the surface soil and subsurface soil volatilization algorithms (see Figure A.3). The model assumes the source zone to be a point source (located in the center of the affected soil area) with the same mass flux as the entire affected soil zone. The off-site receptor is assumed to be located directly downwind of the source point for the full duration of the exposure period. To define the source term, the user must provide the same soil information as required for the volatilization factors (i.e., affected soil zone concentrations, dimensions, etc.).

  Please note that for receptors located directly over or adjacent to the affected soil zone (i.e., inside the "mixing zone" for Equations CM-1, CM-2, or CM-3), the gaussian dispersion model is not needed and can be shut off by entering a value of zero for the distance from the source to the off-site receptor on Screen 3.2 of the RBCA Spreadsheet.

ii) **Wind Speed:** Wind speed should be matched to the average annual wind speed through the mixing zone. The model assumes the wind direction to be in a straight line from the source to the specified POE at all times for the full duration of the exposure period. In the RBCA software, a default wind speed value of 225 cm/sec (~ 5 mph) is assumed unless the user enters a site-specific value.

iii) **Air Dispersion Coefficients:** Estimating dispersion coefficients requires knowledge of the atmospheric stability class and the distance between the source and POE. Stability is an indicator of atmospheric turbulence and, at any one time, depends upon i) static stability (the change of temperature with height), ii) thermal turbulence (caused by ground heating), and iii) mechanical turbulence (a function of wind speed and roughness). The Pasquill-Gifford system for stability classification is summarized on Figure A.6. Corresponding horizontal and vertical dispersion coefficients for each class are provided on Figure A.7. Stability Class A, which represents extremely unstable air with a high potential for mixing, occurs under low wind conditions and high levels of incoming solar radiation. At the other extreme, Stability Classes E and F represent stable atmospheric conditions, with a lower potential for mixing, and occur with higher wind speeds and greater cloud cover (see Reference 21 in Volume 1, Section 5.0).

The stability class for a given site can vary with rapidly changing weather conditions. Long-term weather patterns can be characterized on the basis of STAR summaries, comprised of joint frequency distributions of stability class, wind direction, and wind speed, which are available from the National Climatic Data Center in Asheville, North Carolina. Comprehensive atmospheric dispersion models, such as the Industrial Source Complex Long-Term (ISCLT) model, can directly incorporate STAR data to predict constituent dispersion in any direction from the source area. However, due to the complexity and expense of this modeling effort, use of models such as the ISCLT would normally correspond to a Tier 3 evaluation under the RBCA process.

To facilitate a Tier 2 evaluation of downwind receptor impacts, the RBCA Spreadsheet employs a simple gaussian dispersion model to predict maximum exposure concentrations at the POE under steady-state conditions, incorporating the conservative receptor assumptions noted above. A reasonable estimate of downwind COC concentrations can be obtained by assuming a wind turbulence consistent with Stability Class C for the full exposure period. For most locations, Stability Class C (slightly unstable) is representative of average annual conditions over time and can be used to estimate typical dispersion coefficients. For convenience, the RBCA Spreadsheet will directly calculate dispersion coefficients corresponding to Stability Class C for use in the air transport model, based on data provided by the user (see Screen 8.3.1 of software). Note that, even when these average dispersion coefficients are employed, the exposure concentrations predicted by the RBCA Spreadsheet model are likely to be conservative, given that the POE is assumed to be located directly downwind of the source zone at all times during the exposure period.

Key assumptions incorporated in this model and their affect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: LATERAL AIR DISPERSION FACTOR	EFFECT ON CLEANUP STANDARD
• **Source Term**: Vapor source concentration based on steady-state, soil-to-air cross-media equations.	⇩
• **Default Stability Class**: Default dispersion coefficients matched to Class C stability classification (slightly unstable).	-----
• **Receptor Location**: Receptor assumed to be located directly downwind of source zone at all times during exposure period.	⇩

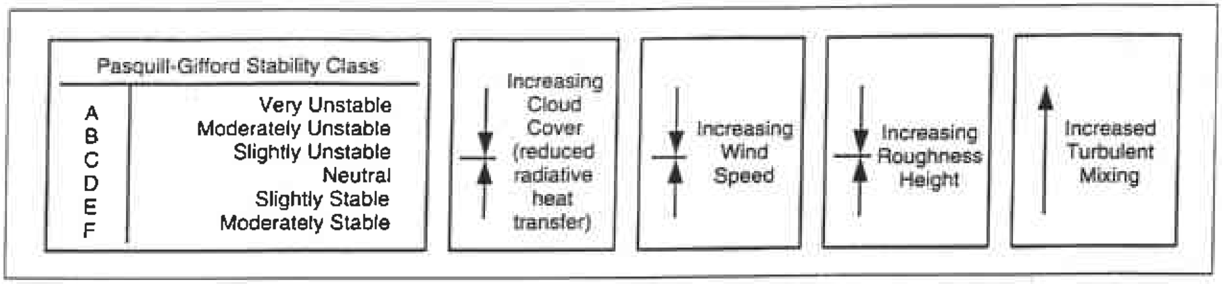


FIGURE A.6. STABILITY CLASSIFICATION FOR AIR TRANSPORT MODELING SOURCE: DEVAULL ET AL. 1994

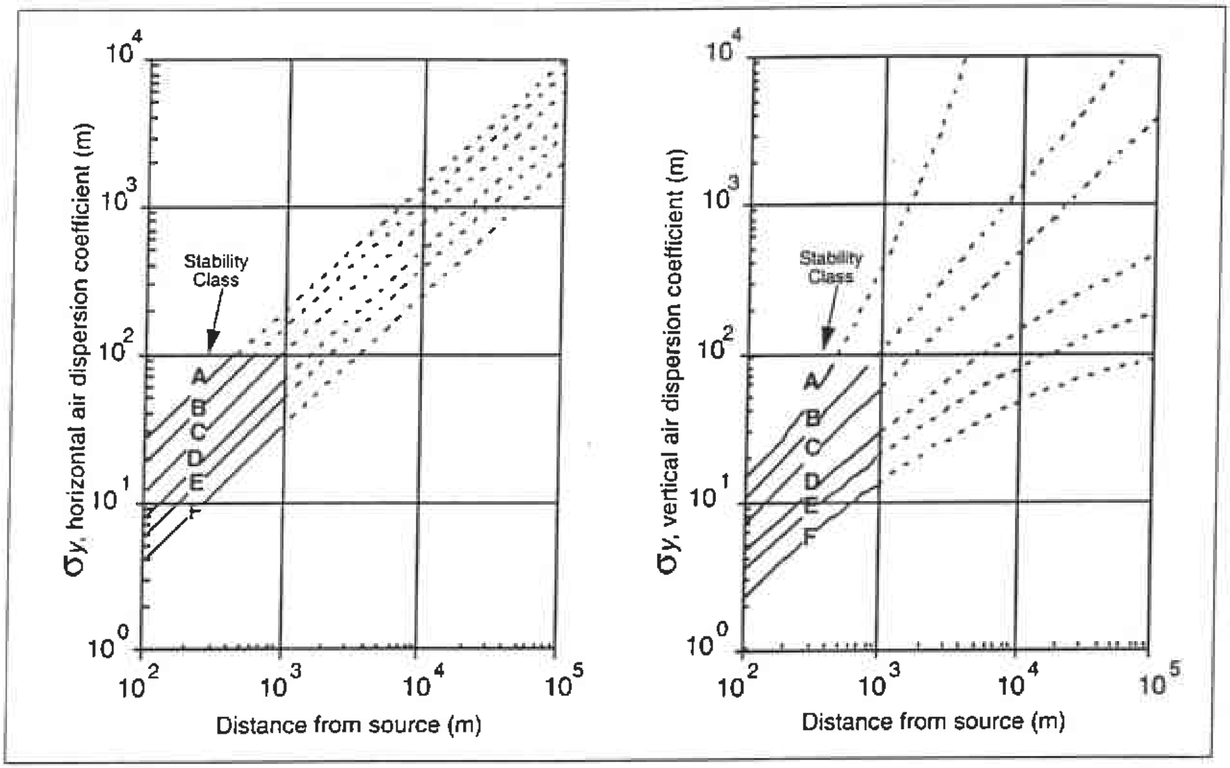


FIGURE A.7. DISPERSION COEFFICIENTS FOR AIR STABILITY CLASSIFICATIONS SOURCE: EPA, 1988

A.4 RBCA Spreadsheet System User's Guide

GENERAL DESCRIPTION

The RBCA Spreadsheet System consists of a group of Microsoft® Excel worksheets integrated by an Excel macro interface. The worksheets and the macro are contained in a Microsoft Excel 5.0 workbook titled ASTMRBCA.XLS. The software is designed to perform risk-based corrective action calculations for selected exposure pathways. Via the point-and-click interface, the user supplies critical information regarding source conditions, exposure pathways, transport mechanisms, and potential receptors. Based on this information, the Spreadsheet System calculates baseline risks and applicable soil and groundwater cleanup standards for each constituent of concern.

As a spreadsheet system, the program does not generate traditional input or output files. Rather all input parameters and calculation results are contained within integrated worksheets which can be saved, viewed on the screen, or selectively printed. Background information on parameter selection

APPENDIX I

TIER 2 EVALUATION INPUTS SUMMARY AND RESULTS TABLES

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Fmr Beacon #574
Site Location: Castro Valley, CA

Job Identification: U065.02
Date Completed: 12/3/96
Completed By: D. van Dam

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	***<u>4</u>***	1
BW	Body Weight (kg)	70	15	35	70	
ED	Exposure Duration (yr)	30	6	16	***<u>4</u>***	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			7.9E+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			-6.9E+01	
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)	***<u>FALSE</u>***				
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	TRUE	
GW.b	Vapor Intrusion to Buildings	FALSE	TRUE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	TRUE	TRUE	
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	TRUE	

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)	1.2E+04	FALSE	1.2E+04	FALSE
S	Inhalation receptor (cm)	1.5E+03	FALSE		TRUE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	1.0E-06	
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	4	1
A	Contaminated soil area (cm^2)	***<u>3.5E+06</u>***		***<u>1.6E+06</u>***
W	Length of affected soil parallel to wind (cm)	***<u>1.5E+03</u>***		***<u>1.0E+03</u>***
W.gw	Length of affected soil parallel to groundwater (c	***<u>1.5E+03</u>***		
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)	***<u>9.6E+02</u>***
Ugw.tr	Groundwater Transport velocity (cm/yr)	***<u>2.5E+03</u>***
Ks	Saturated Hydraulic Conductivity(cm/s)	2.5E-03
grad	Groundwater Gradient (cm/cm)	1.2E-02
Sw	Width of groundwater source zone (cm)	
Sd	Depth of groundwater source zone (cm)	
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	TRUE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	1.0E-03

Soil	Definition (Units)	Value		
hc	Capillary zone thickness (cm)	***<u>1.0E+01</u>***		
hv	Vadose zone thickness (cm)	***<u>6.0E+02</u>***		
rho	Soil density (g/cm^3)	1.7		
foc	Fraction of organic carbon in vadose zone	0.01		
phi	Soil porosity in vadose zone	0.38		
Lgw	Depth to groundwater (cm)	***<u>6.1E+02</u>***		
Ls	Depth to top of affected soil (cm)	***<u>3.0E+02</u>***		
Lsubs	Thickness of affected subsurface soils (cm)	***<u>3.0E+02</u>***		
pH	Soil/groundwater pH	6.5		
		capillary	vadose	foundation
phi.w	Volumetric water content	0.342	0.12	0.12
phi.a	Volumetric air content	0.038	0.26	0.26

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (s^-1)	1.4E-04	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	0.01	

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)	1.2E+03	
ay	Transverse dispersion coefficient (cm)	4.0E+02	
az	Vertical dispersion coefficient (cm)	6.1E+01	
Vapor			
dcy	Transverse dispersion coefficient (cm)	1.8E+02	
dcz	Vertical dispersion coefficient (cm)	1.2E+02	

Site Name: Fmr Beacon #574
Site Location: Castro Valley, CA

Completed By: D. van Dam
Date Completed: 12/3/1996

TIER 2 BASELINE RISK SUMMARY TABLE

	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk Limit(s) Exceeded?	Hazard Quotient		Hazard Index		Toxicity Limit(s) Exceeded?
EXPOSURE PATHWAY	Maximum Value	Target Risk	Total Value	Target Risk		Maximum Value	Applicable Limit	Total Value	Applicable Limit	
AIR EXPOSURE PATHWAYS										
Complete:	4.6E-8	1.0E-6	4.6E-8	N/A	☐	1.2E-2	1.0E+0	1.2E-2	N/A	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	3.1E-20	1.0E-6	3.1E-20	N/A	☐	4.9E-15	1.0E+0	5.9E-15	N/A	☐
SOIL EXPOSURE PATHWAYS										
Complete:	0.0E+0	1.0E-6	0.0E+0	N/A	☐	0.0E+0	1.0E+0	0.0E+0	N/A	☐

CRITICAL EXPOSURE PATHWAY (Select Maximum Values From Complete Pathways)										
	4.6E-8	1.0E-6	4.6E-8	N/A	☐	1.2E-2	1.0E+0	1.2E-2	N/A	☐

Serial: G-349-KIX-
Software: GSI RBCA Spreadsheet
Version: v 1.0

RBCA SITE ASSESSMENT	Tier 2 Worksheet 9.3

Site Name: Fmr Beacon #574
Site Location: Castro Valley, CA
Completed By: D. van Dam
Date Completed: 12/3/1996

GROUNDWATER SSTL VALUES

Target Risk (Class A & B) 1.0E-6
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			X Groundwater Volatilization to Indoor Air		X Groundwater Volatilization to Outdoor Air		Applicable SSTL	SSTL Exceeded ?	Required CRF
CAS No.	Name	(mg/L)	Residential: 400 feet	Commercial: (on-site)	Regulatory(MCL): 400 feet	Residential: (on-site)	Commercial: (on-site) (PEL)	Residential (on-site)	Commercial: (on-site) (PEL)	(mg/L	"■" if yes	Only if "yes" left
71-43-2	Benzene	3.2E+0	>Sol	NA	>Sol	NA	7.5E+2	NA	>Sol	7.5E+2	☐	<1
100-41-4	Ethylbenzene	5.6E-1	>Sol	NA	>Sol	NA	>Sol	NA	>Sol	>Sol	☐	<1
108-88-3	Toluene	7.7E-1	>Sol	NA	>Sol	NA	>Sol	NA	>Sol	>Sol	☐	<1
1330-20-7	Xylene (mixed isomers)	2.9E+0	>Sol	NA	>Sol	NA	>Sol	NA	>Sol	>Sol	☐	<1

Software: GSI RBCA Spreadsheet
Version: v 1.0
Serial: G-349-KIX-808

Why What is NA?

RBCA SITE ASSESSMENT — Tier 2 Worksheet 9.2

Site Name: Fmr Beacon #574 — Completed By: D. van Dam

Site Location: Castro Valley, CA — Date Completed: 12/3/1996

SUBSURFACE SOIL SSTL VALUES (> 3 FT BGS)

Target Risk (Class A & B) 1.0E-6 ■ MCL exposure limit? Calculation Option: 2

Target Risk (Class C) 1.0E-5 ■ PEL exposure limit?

Target Hazard Quotient 1.0E+0

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

CONSTITUENTS OF CONCERN		Representative Concentration	X Soil Leaching to Groundwater			X Soil Volatilization to Indoor Air		X Soil Volatilization to Outdoor Air		Applicable SSTL	SSTL Exceeded ?	Required CRF
CAS No.	Name	(mg/kg)	Residential: 400 feet	Commercial: (on-site)	Regulatory(MCL): 400 feet	Residential: (on-site)	Commercial: (on-site) (PEL)	Residential: 50 feet	Commercial: (PEL) (on-site)	(mg/kg)	"■" if yes	Only if "yes" left
71-43-2	Benzene	7.3E-1	>Res	NA	>Res	NA	1.2E+2	1.6E+1	>Res	1.6E+1	☐	<1
100-41-4	Ethylbenzene	6.5E-1	>Res	NA	>Res	NA	>Res	>Res	>Res	>Res	☐	<1
108-88-3	Toluene	1.5E+0	>Res	NA	>Res	NA	>Res	>Res	>Res	>Res	☐	<1
1330-20-7	Xylene (mixed isomers)	6.4E+0	>Res	NA	>Res	NA	>Res	>Res	>Res	>Res	☐	<1

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Restriction