R02530

THE SAN JOAQUIN COMPANY INC.
1120 HOLLYWOOD AVENUE, SUITE 3, OAKLAND, CALIFORNIA 94602

CORRECTIVE ACTION REPORT

SNK Andante Project

3992 San Pablo Avenue
Emeryville, California

Prepared for:

SNK CAPTEC ANDANTE LLC

August 2003

VOLUME II of V

Site-specific Health Risk Assessment

Project No. 9401.205

TELEPHONE: OAKLAND, CALIFORNIA (510) 336-9118 TRACY, CALIFORNIA (209) 832-2910

Table of Contents

VOLUME II - TIER 2 HEALTH RISK ASSESSMENT

1.0 INTRODUCTION 1
1.1 Site Description and History 1
1.1.1 Site North 1
1.1.2 20th Century History 1
1.2 Site Ownership and Use 2
1.3 Anticipated Future Use 2
1.4 Chemicals of Concern in the Subsurface 2
1.5 Sources of Chemicals of Concern 2
1.5.1 Celi's Alliance Service Station at 4000 San Pablo Avenue 3
1.5.2 Other Sites 4
1.6 Remediation Program 4
1.6.1 Extended Investigation of Areal and Vertical Extent of Affected Subsurface Zone 4
1.6.2 Excavation and Off-site Disposal of Affected Soil 5
1.6.3 Confirmation Sampling in Remedial Excavation 6
1.6.4 Backfilling of Remedial Excavation 6
1.7 Tiered Health Risk Screening and Assessment Process 7
1.7.1 Tier 1 Site-screening Values for Concentrations of COCs in Soil and Groundwater 8
1.7.2 Comparison of COC Concentrations Remaining in Situ with Tier 1 Screening Values 9
2.0 SITE CONCEPTUAL MODEL AND EXPOSURE PATHWAYS 12
2.1 Exposure Pathways 12
2.2 Receptors 13
2.3 Individual Building Models 14
2.4 Risk Assessment Software 15
2.4.1 Use of Johnson-Ettinger Model for Air Volatilization Computations 15
3.0 RISK ASSESSMENT PARAMETERS 17
3.1 Chemicals of Concern in Soil 17
3.1.1 Representative Concentrations of Chemicals of Concern in Soil 18
3.2 Chemicals of Concern in Groundwater 20
3.2.1 Representative Concentrations of Chemical of Concern in Groundwater 21
3.3 Chemical-specific Parameters 21
3.4 Site-specific Soil Transport Parameters 22
3.4.1 Soil Column Properties 22
3.4.1.1 Hydraulic Conductivity 22
3.4.1.2 Dry Bulk Density 23
3.4.1.3 Volumetric Water Content 23
3.4.1.4 Total Porosity 25
3.4.1.5 Volumetric Air Content 25
3.4.1.6 Vapor Permeability 26
3.4.1.7 Capillary Zone Thickness 26
3.4.1.8 Partitioning Parameters 27
3.4.2 Soil Source Zone Characteristics 27
3.4.2.1 Hydrogeology 27
3.4.2.2 Affected Soil Zone 30

3.5 Site- and Building-specific Air Parameters 32
3.5.1 Outdoor Air Pathways 32
3.5.1.1 Air Mixing Zone Height 32
3.5.1.2 Ambient Air Velocity in Mixing Zone 33
3.5.2 Indoor Air Pathway: Building Parameters 33
3.5.2.1 Foundation Areas and Perimeters 33
3.5.2.2 Building Volume/Area Ratio 33
3.5.2.3 Building Air Exchange Rate 33
3.5.2.4 Foundation Thickness and Depth to Bottom of Foundation Slab 34
3.5.2.5 Foundation Crack Fraction 35
3.5.2.6 Volumetric Water and Air Content of Cracks 35
3.5.2.7 Indoor/Outdoor Differential Pressure and Convective Air Flow through Cracks 35
3.5.2.8 Impermeable Barriers 36
3.6 Receptor-specific Parameters 37
3.6.1 Exposure and Averaging Times 37
3.6.2 Body Weight 38
3.6.3 Inhalation Rate 39
3.6.4 Exposure Duration 39
3.6.5 Exposure Frequencies 40
3.6.6 Other Receptor-specific Parameters 41
3.7 Acceptable Health Risks 41
3.7.1 Classification of Carcinogens 42
3.7.2 Health Risk Limits of Carcinogens 42
3.7.3 Toxic Hazard Limits 44
4.0 RESULTS OF HEALTH RISK ASSESSMENTS 45
4.1 Health Risk Computations for Representative Building Models 45
4.2 Sensitivity of Risk Assessment Results to Groundwater Elevation 46
4.3 Results for Residential Use of All Buildings 47
4.4 Summary 48
5.0 REFERENCES 49

TABLES

Table II-1: Results of Analyses of Soil Samples from Exploratory Push Probe Borings
Table II-2: Results of Analyses of Groundwater Samples Recovered from Exploratory Trenches, Tank Pits and Temporary Wells
Table II-3: Results of Analyses of Soil Samples Recovered from Exploratory Trenches and Temporary Wells
Table II-4: Results of Analyses of Soil Samples from Remedial Excavation at former Celi's Alliance Service Station, 4000 San Pablo Avenue
Table II-5: Results of Analyses of Soil Samples Recovered from 40th Street Right-of-Way, Emeryville, California
Table II-6: Results of Analyses of Groundwater Samples Recovered from 40th Street Right-of-Way, Emeryville, California
Table II-7: Results of Analyses of Confirmation Soil Samples Recovered from Remedial Excavation
Table II-8: RWQCB Tier 1 Concentration Limits for Chemicals of Concern in Soil and Groundwater

Table II-9: Chemicals of Concern Remaining in Soil in Floor of Remedial Excavation
Table II-10: Representative Chemicals of Concern Remaining in Post-Remedial Soil
Table II-11: Representative Chemicals of Concern in Post-Remedial Groundwater
Table II-12: Applicable Chemical, Physical, Toxicologic and Carcinogenic Properties of Chemicals of Concern
Table II-13: Chemicals of Concern Remaining in Soil in Floor of Remedial Excavation
Table II-14: Mean Depths to Groundwater Beneath Buildings
Table II-15: Key Building Dimensions
Table II-16: Key Building-specific Modeling Parameters
Table II-17: Building-specific Health Risk Analysis Results
Table II-18: Sensitivity of Carcinogenic Risk and Hazard Index to Varying Depths to Groundwater
Table II-19: High Water Level Carcinogenic Risk and Hazard Index for Residential Occupancy of All Buildings

FIGURES

Figure II-1: Site Location
Figure II-2: Site Plan Prior to Construction
Figure II-3: Architect's Site Plan
Figure II-4: Area of Subsurface Affected by Chemicals of Concern
Figure II-5 Hydrostratigraphic Cross Section A-A' Prior to Excavation
Figure II-6 Hydrostratigraphic Cross Section B-B' Prior to Excavation
Figure II-7 Hydrostratigraphic Cross Section C-C' Prior to Excavation
Figure II-8 Confirmation Soil Sampling Locations
Figure II-9 Hydrostratigraphic Cross Section A-A' Through Back-filled Remedial Excavation
Figure II-10 Hydrostratigraphic Cross Section B-B' Through Back-filled Remedial Excavation
Figure II-11 Hydrostratigraphic Cross Section C-C' Through Back-filled Remedial Excavation
Figure II-12: Exposure Pathways for Human Health Risk Assessments
Figure II-13: Groundwater Contours (04/21/03)
Figure II-14: Floor Slab with Visqueen™ Membrane
Figure II-15: Floor Slab with Liquid Boot® Membrane

APPENDICES

APPENDIX II-A: Risk-based Site Evaluation Process
APPENDIX II-B: Fate and Transport Modeling Methods
APPENDIX II-C: Permeability Tests
APPENDIX II-D: Health Risk Assessment Building 1
APPENDIX II-E: Health Risk Assessment Building 2A
APPENDIX II-F: Health Risk Assessment Building 3A
APPENDIX II-G: Health Risk Assessment Building 6

1.0 INTRODUCTION

This document is Volume II of the *Corrective Action Report - SNK Andante Project, 3992 San Pablo Avenue, Emeryville, California,* which consists of a total of five volumes. It presents Health Risk Assessments for the subject property.

1.1 Site Description and History

The location of the subject property is shown on Figure II-1. Figure II-2 is a site plan showing the property prior the start of construction. Figure II-3 is the architect's drawing showing a plan view of the ground floor elevations of the development that is currently being constructed on the property.

1.1.1 Site North

As is shown on Figures II-1 and II-2, true north at the 3992 San Pablo Avenue site is slightly to the west of the center line of Adeline Street, which runs along the eastern side of the property. However, to simplify discussion, in this Remediation Report we have established a "Site North" that parallels the alignment of San Pablo Avenue, which runs along the western side of the property. Unless otherwise stated, or in cases where true north is shown on drawings, all compass directions referenced in this document should be interpreted in the context of that directional construction.

1.1.2 20th Century History

In the early 20th Century several railroad tracks were constructed through the northern portion what is today 3992 San Pablo Avenue. At that time the balance of the property was occupied by residences, restaurants and commercial property. By the late 20th Century, the rail lines passing through the site became disused, the right-of-way was sold and the tracks were removed *circa* 1970.

Following the removal of the railroad tracks, the majority of the small businesses located on what is today the 3992 San Pablo Avenue property closed and their buildings were demolished, leaving only the King Midas Club, at 3992 San Pablo Avenue, the Key Club at the same 3992 San Pablo Avenue address, and the Key Hotel at 3900½ San Pablo Avenue clustered in the southwestern corner of the property. The remainder of the site was, during that time, used as a parking lot. By 1997 no businesses remained in operation on the site and the property was acquired by the City of Emeryville Redevelopment Agency (**ERDA**). In 2002, all of the remaining structures on the site were demolished so that, in March 2003, it was a paved empty lot. For a more detailed history of the site, see Volume I of this report.

1.2 Site Ownership and Use

In March 2003, SNK Captec Andante LLC (**SNK Captec**) purchased the subject property from the ERDA and, in April 2003, initiated the preliminary stages of redevelopment of the site for mixed commercial and multi-family residential use.

1.3 Anticipated Future Use

It is anticipated that the 3992 San Pablo Avenue property will remain the site of the mixed residential and commercial development currently being constructed for at least the next 30 years. Future uses will depend upon City of Emeryville planning policy and any changes in zoning ordinances. However, given the urban setting of the site, it can be anticipated that any future changes in use of the site will be limited to multi-family, commercial, or light industrial development.

1.4 Chemicals of Concern in the Subsurface

As is detailed in Volume I of this report, a Phase I Environmental Assessment of the 3992 San Pablo Avenue property, which was conducted by SJC in 2000, concluded that it was probable that some portion of the subsurface beneath site where it fronts onto 40th Street was affected by fuel hydrocarbons released on adjacent property (The San Joaquin Company Inc. 2000). That was confirmed by analysis of samples of soil recovered from an array of push probe borings drilled on the site in February 2003 (Apex Envirotech, Inc. 2003). The locations of the exploratory borings are shown in Figure II-2. The results of analyses of samples recovered from those borings are presented in Table II-1.

As has been detailed in Volume I of this report, additional site investigation conducted by SJC that included trenching and installation of groundwater-quality monitoring wells and analysis of data obtained during progress of remediation work revealed that the Andante Project site was significantly affected by chemicals of concern (**COCs**) over the area identified in Figure II-4. The locations of the exploratory trenches with soil sampling locations and the locations of groundwater-quality monitoring wells installed by SJC on the site at an early stage of the remediation program are also shown on Figure II-4. The results of the analyses of the soil and groundwater samples recovered from them are presented in Tables II-2 and II-3, respectively.

1.5 Sources of Chemicals of Concern

The sources of the COCs in the subsurface beneath the Andante Project site are briefly described below.

1.5.1 Celi's Alliance Service Station at 4000 San Pablo Avenue

A gas station known as Celi's Alliance Service Station (**Celi's**), owned by an independent distributor, operated from approximately 1936 until 1994 on the land that had the address 4000 San Pablo Avenue, which is adjacent to, and north of, the Andante Project site at 3992 San Pablo Avenue. Tanks at that service station leaked fuel hydrocarbons into the subsurface.

When the service station closed, the tanks were removed and the Emeryville Redevelopment Agency (**ERDA**) took title to the land by condemnation. By that action, the City of Emeryville became a "responsible party" for the 4000 San Pablo Avenue site.

In 1994, affected soil within the property boundaries of the 4000 San Pablo Avenue site was partially removed by excavation (Woodward-Clyde Consultants 1995). The remedial excavation on that site extended down to 9 ft. BGS, which depth was just above the groundwater table at the elevation it was at that time, and laterally to the boundaries of that site. The southern limit of that excavation was located an average distance of approximately 12.5 feet north of the northern boundary of the 3992 San Pablo Avenue property.

To remove floating product at a thickness of 6.24 in. that had been observed on the water table beneath the Celi's site when first measured on August 1993, a recovery well equipped with an ejector pump was later installed in the northwestern corner of that property. The recovery well was pumped weekly from September 12 through December 5, 1997; a total of 2,035 gallons of free product and water were removed from the subsurface (Woodward-Clyde International Americas 1998a).

The results of analyses of the confirmation samples recovered by Woodward-Clyde from the floor and walls of the remedial excavation opened on the Celi's site are reproduced in Table II-4. The sampling locations are shown on Figure II-4.

Concentrations of gasoline (TPHg) in the soil in the floor of the remedial excavation on the 4000 San Pablo Avenue property ranged from 540 mg/Kg to 1,000 mg/Kg at sampling locations near the southern boundary of the site, which is in close proximity to the property with which this risk assessment is concerned. The concentrations of diesel in the samples recovered from those locations ranged from undetectable to 75 mg/Kg. As can be seen in Table II-4, concentrations of benzene, toluene, ethyl benzene and xylene isomers (the **BTEX** compounds) were detected in the samples recovered from the floor of the remedial excavation. At the sampling locations distributed along the southern wall of the remedial excavation at 4000 San Pablo Avenue, concentrations of gasoline ranged from 20 mg/Kg to 730 mg/Kg with commensurate concentrations of the BTEX compounds. Diesel concentrations in samples recovered from that wall ranged from undetectable to 69 mg/Kg.

Components of fuel hydrocarbons migrated from the Celi's Service Station site and contaminated soil and groundwater beneath the Andante Project site.

1.5.2 Other Sites

In addition to the subsurface beneath the Celi's Service Station site, contamination was found throughout the right-of-way of the 40th Street extension when assessments of the environmental conditions of the subsurface between Adeline Street and San Pablo Avenue were conducted prior to the extension's construction in 1995 (Levine-Fricke 1994a, 1994b, 1994c, 1993a, 1993b).

Although some of the contamination found beneath the 40th Street right-of-way can be attributed to up-gradient dispersion of contaminants in groundwater from the Celis site, it appears that the COCs detected in many of the soil borings and monitoring wells installed in the 40th Street extension right-of-way to the north of the Andante Project site at 3992 San Pablo Avenue had some other source. Possible sources include materials spilled onto the railroad right-of-way previously located on the present-day alignment of that street and down-gradient migration from sites to the east of Adeline Street.

More easily identifiable sources of COCs affecting the subsurface beneath the 40th Street extension that migrated onto the Andante Project site are two 10,000-gal., unregistered underground fuel tanks formerly located some 80 ft. north of the subject property. As is shown on Figure II-4, those tanks were situated on the former site of the San Francisco French Bread Bakery. They were removed from that property in 1989 (Levine-Fricke 1993b). Their former sites are located beneath what is now the fence line that marks the northern boundary of 40th Street so that the now back-filled tank pits are partially beneath the 40th Street right-of-way and partially beneath the adjacent property to the north.

In addition to the soil sampling locations in the remedial excavation opened on the Celis site, Figure II-4 also shows the locations of the soil borings and groundwater-quality monitoring wells installed during the various stages of investigation of the environmental conditions beneath the 40th Street extension right-of-way in the early 1990s. The results of analyses of soil and groundwater samples recovered from those operations are compiled in Tables II-5 and II-6, respectively.

1.6 Remediation Program

Prior to start of construction for the Andante Project site, the affected area of the subsurface on the 3992 San Pablo Avenue property was remediated in compliance with a Remediation Work Plan (The San Joaquin Company Inc. 2003) approved in March 2003 by ACEHCS. The scope of the remediation program is fully described in Volume I of this Corrective Action Report and is summarized below.

1.6.1 Extended Investigation of Areal and Vertical Extent of Affected Subsurface Zone

As has been discussed in Section 1.4 above, the remediation program included an initial phase during which SJC excavated three exploratory trenches and installed ten temporary groundwater-quality monitoring wells to improve understanding of the lateral and vertical extent of the area of the 3992 San Pablo Avenue property affected by the migration of contaminants from the adjacent property to the north. The results of the analyses of the soil and groundwater samples recovered from them are presented in Tables II-2 and II-3, respectively.

1.6.2 Excavation and Off-site Disposal of Affected Soil

Soil affected by COCs in the subsurface beneath the subject property was remediated by excavation and off-site disposal at permitted facilities. The excavated area is shown in plan on Figure II-4. Figures II-5, II-6 and II-7 show cross sections through the subsurface prior to remediation along section lines A-A', B-B' and C-C' that are shown on Figure II-4.

To initiate the remedial excavation, existing concrete and asphalt paving were removed from the site and shipped for recycling in beneficial use. It was also necessary to remove large volumes of buried masonry foundations and structural walls that had been constructed on the site in the early part of the 20th century when the property was the site of warehouses and other commercial structures. Following removal of the paving and foundation materials, clean, unaffected soil was stripped from the surface of the site to depths varying between approximately 1 ft. and 3 ft. below the ground surface **(BGS).** That material was stockpiled on-site for later use as part of the engineered backfill placed in the remedial excavation to restore the site to the grade required for redevelopment.

During the removal of foundation materials, three underground storage tanks of extreme age were discovered on the site at the locations shown on Figure II-4. Two were 1,500-gal. heating oil storage tanks, but the third, which was only 100-gal in capacity, was dry and its past use could not be determined with certainty. However, based on olfactory indicators, it is suspected that, at one time, the small tank contained gasoline or a similar low specific weight petroleum hydrocarbon. All three tanks were removed under the permit and oversight of the ACEHCS and the City of Emeryville Fire Department. As is shown in Table II-2, none of the three tanks was identified as a source of fuel hydrocarbons or other regulated materials that had been found in the subsurface of the 3992 San Pablo Avenue property (Dietz Irrigation 2003b, 2003c).

After clean, surficial soil was removed, the excavation was deepened to remove affected soil from the subsurface. The depth of the remedial excavation generally ranged between 8 ft. and 13 ft. BGS. Locally, the depth of excavation was controlled by the depth required to reach soil unaffected by COCs or the limiting depth beneath which additional excavation would render the Andante redevelopment project economically unviable. However, in most portions of the remediated area, the excavated depth was greater than the depth to the groundwater table so that the most heavily-affected masses of soil were removed. Where excavation extended below the groundwater table, removal was accomplished by excavating cells of limited area to depths up to 2-3 ft. below the extant groundwater table and promptly backfilling them with a crushed rock backfill containing no fines.

The excavation work included removal of buried paleo-stream deposits consisting of loose to very loose sand with some gravel that formed an underground channel of highly-permeable materials and crossed the site from San Pablo Avenue to 40th Street along the southern limit of the remediated area. The deposits are shown in section on Figures II-5, II-6 and II-7. It was necessary to remove the permeable stream deposits not only because they were affected by COCs, but also, for geotechnical engineering purposes because they were susceptible to liquefaction during a seismic event.

The volume of soil excavated from the subsurface, excluding the unaffected soil temporarily stockpiled on the site, amounted to some 7,025 tons, which amounted to some 8,000 cubic yards, which was transported, in 410 truckloads, to Class II landfills (Dietz Irrigation 2003a).

1.6.3 Confirmation Sampling in Remedial Excavation

To confirm that sufficient soil had been removed from the subsurface of the Andante Project site to meet the objectives, over 100 samples of soil were recovered from the floor and walls of the remedial excavation. The results of the analyses of the soil samples are compiled in Table II-7.

Note:

Where data in Table II-7 is in gray script, they apply to soil samples recovered from locations where the excavation was either deepened or widened after the sample was recovered and analyzed. Additional sample(s) were then recovered at that grid location from the floor or wall of the enlarged excavation.

The basic pattern of confirmation sampling was based on a grid system having 20-ft. spacing in both the north to south and the west to east directions. The origination point for the sampling grid was located in the northwestern corner of the 3992 San Pablo Avenue property at the point having the coordinates 0S, 0E shown on Figure II-8.

Note:

To accommodate the final geometry of the remedial excavation, samples were recovered from some locations at points intermediate between the intersection points of the basic sampling grid.)

1.6.4 Backfilling of Remedial Excavation

When the remedial excavation was complete and all confirmation samples had been recovered, with the approval of the ACEHCS Case Officer, the excavation was backfilled. The clean surficial soil from the remediated area that had been stockpiled on the site during the first stages of the remedial program was used as a source for the backfill together with clean soil excavated to permit construction of foundations on other areas of the property.

The backfill material consisted of silty clays and other low permeability materials, which were compacted under engineering control by the project's geotechnical engineer to a relative density of 95%. As is discussed in Section 3.4.1.1, this produced a cap with a thickness varying between 7 ft and 13.5 ft and a hydraulic conductivity of less than 6.0 x 107 cm/sec. over the small volumes of affected soil that remained in the subsurface after remedial excavation had reached its maximum extent. Figures II-9, II-10 and II-11 show cross sections through the backfilled remedial excavation.

1.7 Tiered Health Risk Screening and Assessment Process

Risk-based environmental assessments address the potential for constituent transport from affected media in the source zone to a point of contact with a human or ecological receptor via one or more exposure pathways that may be present under given circumstances. For the present risk assessment, we are concerned with human receptors. For most sites where remediation is required, the primary exposure pathways of concern to human health are: 1) ingestion of contaminated groundwater; 2) release of contaminants from affected soil to groundwater; 3) ingestion of contaminated soil; 4) direct dermal contact with contaminated soil; and 5) inhalation of vapors released from affected soil and/or groundwater.

Risk assessments are commonly performed using a tiered procedure. At the Tier 1 stage, available information regarding COCs in the subsurface is compared to risk limits developed from generic parameters related to the properties of the COCs, the geotechnical and geochemical properties of the subsurface, the use of the affected site, and the characteristics of the receptors that may be present. Tier 1 assessments are used to screen sites affected by COCs to determine whether the contamination present is at concentrations sufficient to pose a significant health risk. At the Tier 1 stage, the data regarding geotechnical and geochemical properties of the subsurface may be limited to qualitative data such as the type and thickness of soils, the groundwater regime, the expected future use of the site, and simple assumptions about the geometry and materials of construction of structures that may be built there. In general terms, if the site is modeled using this type of information and limited data regarding subsurface conditions, the maximum concentrations of one or more COCs that can be present in the affected natural media without risk of a significant deleterious health effect can be assessed by the risk analysis process. These limiting concentrations are known as Risk-based Screening Levels (**RBSLs**) (American Society for Testing and Materials 2000a).

If the concentrations of COCs at a subject site are less than the applicable RBSLs, the screening process normally permits the site to be used for defined purposes without further evaluation. This is permissible because highly-conservative parametric assumptions and limiting exposures are always assumed when performing a Tier 1 assessment. A finding that a given site has concentrations of COCs present that exceed the RBSLs does not mean that any specified use of the site would be prohibited. Such a finding does, however, indicate that additional, more detailed analysis based on quantitative site-specific data should be performed to determine whether the site could be used for a specified purpose without undue risk to ecological or human health. Such detailed analyses are known as Tier 2 assessments and can be used to assess the maximum permissible concentrations of COCs in natural media at the site. These limiting concentrations are known as Site-specific Target Levels (**SSTLs**) because they are based on site-specific rather than more generalized assessment parameters.

The Tier 2 risk assessment procedure can also be used to evaluate the scope of remedial action programs required to render a site free of significant ecological or human health risk or to assess the magnitude of any risks that may remain after remediation is complete. In some cases, it may be necessary or cost-effective to advance the risk assessment process to a third stage. However, Tier 3 risk assessments are not usually performed unless unusually-detailed databases related to the site-specific conditions and the characteristics of the receptors and their exposures are available or it is necessary to assess the beneficial effect of installation of complex systems of engineered barriers to isolate receptors from the sources of COCs.

1.7.1 Tier 1 Site-screening Values for Concentrations of COCs in Soil and Groundwater

The California Regional Water Quality Control Board - San Francisco Bay Region (**RWQCB**), which has jurisdiction over the property at 3992 San Pablo Avenue, has published RBSLs for a large number of COCs affecting soil and groundwater beneath a variety of geological and hydrogeological site conditions that are typical of those commonly found in the San Francisco Bay region (California Regional Water Quality Control Board - San Francisco Bay Region 2001). Those RBSLs, which include levels for both residential and commercial and industrial land use, provide useful guidance for site screening at the Tier 1 risk assessment level.

The RWQCB's RBSLs are based on the most restrictive of a number of criteria that include COC concentration limits designed to protect groundwater from contamination leaching from affected soils, eco-toxicity criteria, ceiling values to prevent odors and similar nuisances, criteria to protect aquatic life, limits to protect the quality of surface waters, as well as concentration limits on soil and groundwater that are set to protect human health. To develop final, limiting RBSLs, the human health risk limits are further subdivided into direct and indirect exposures to the COCs, as well as the effects of inhalation of their vapors or gasses in indoor or outdoor air. With respect to limiting values for concentrations of COCs in indoor air, for the purpose of establishing RBSLs, the RWQCB made highly-conservative default assumptions about the values of parameters required to perform the risk assessment calculations. In general, those assumptions, as well as others related to the properties of geological media and the carcinogenic and toxic properties of the COCs are similar to those that appear in ASTM guidance documents (American Society for Testing and Materials 2002, 2000a). However, for specific risk assessment parameters, the RWQCB elected to use alternate values derived from consideration of California law and regulatory practice, local experience, and the geotechnical, demographic and urban and industrial histories that are typical of the San Francisco Bay region.

The RWQCB guidance document for RBSLs used for site-screening in the San Francisco Bay region includes separate sets of tables of limiting COC concentrations for application to sites where groundwater is or is not a current or potential drinking water source. In each case, sites are further subdivided into those at which the depth to the top of affected soil is greater or less than 3 meters BGS. Guidance is also provided regarding the choice of limiting COC concentrations for sites underlain by predominately fine-grained soils as well as those underlain by predominately coarse-grained soils.

As is discussed in Section 3.1 and 3.2 of this Tier 2 assessment, for the purpose of performing a health risk assessment of the Andante Project site, the COCs to be considered are, benzene, toluene, ethyl benzene, xylene isomers (the **BTEX** compounds), methyl tertiary butyl ether (**MTBE**), naphthalene, and, in a qualitative sense, total petroleum hydrocarbons quantified as diesel (**TPHd**) and total petroleum hydrocarbons quantified as gasoline (**TPHg**), the latter two of which are each mixtures of more than 200 organic compounds.

Groundwater beneath the Andante Project site is not a source of drinking water (California Regional Water Quality Control Board - San Francisco Bay Region 1999). With respect to the depth below the ground surface of the first occurrence of soil affected by COCs, that depth varies across the area of the site from which heavily-affected soil was excavated during the remediation program. As can be seen by examination of Table II-7, which records the depth BGS from which confirmation samples in the floor of the remedial excavation were recovered, the depth to the top of affected soil remaining in place over a large portion of the remediated area is greater than 3 meters (9.8 ft). However, in some areas, the depths to the affected soil are somewhat less, and for reasons of conservatism, SJC elected to use limiting COC concentrations used by the RWQCB to derive RBSLs for sites at which the depth to affected soil is less than 3 meters BGS. Because, as is discussed in Section 3.4.1.1, the permeability of the compacted fine-grained, silty clays used to backfill the remedial excavation is very low, SJC elected to compare the post-remedial concentrations of COCs in the subsurface to the guidance values published by the RWQCB for sites underlain by fine-grained soils.

Pathways related to direct ingestion of or exposure to affected soil or groundwater are not present at the Andante Project site. As is discussed in Section 2.1 of this report, the exposure pathways of concern to human health risk on the subject site are those related to inhalation of indoor and outdoor air affected by vaporization of COCs from affected soil and water present beneath the ground surface. For the purpose of making a Tier 1 screening of the potential negative human health risk due to mixed residential and commercial use of the property, the relevant COC concentration limits are those related to indoor and outdoor air impacts. Due to dispersion by winds and volumetric mixing, exposure to COC vapors in outdoor air imposes less restrictive limits than is the case for indoor spaces where vapors might accumulate.

1.7.2 Comparison of COC Concentrations Remaining in Situ with Tier 1 Screening Values

Limiting concentrations for the relevant COCs in soil and groundwater based on parameters selected by the RWQCB for derivation of RBSLs related to human health risks at sites where groundwater is not a source of drinking water, the depth to affected soil is less than 3 meters and the soils underlying the site are predominately fine-grained are presented in Table II-8. Those values can be compared to the concentrations of the COCs in soil and groundwater remaining beneath the Andante Project site that are presented in Tables II-3 and II-7, in which concentrations that exceed the relevant residential Tier I limits are in bold script.

> **Note:**
>
> When concentrations of COCs in either soil or groundwater are highlighted in **bold** script, it indicates that the cited concentration exceeds the applicable residential Tier 1 screening limit. However, depending upon the site conditions to which the table applies, the concentration limits used to determine the exceeders are those recommended by the RWQCB for either sites where soils are porous or for sites where soils are fine-grained (California Regional Water Quality Control Board - San Francisco Bay Region 2001).
>
> When the purpose of presenting data in a table is to characterize the conditions beneath the subject property prior to the implementation of the remediation program, the limits applicable to *porous* soils are used. Although the soils beneath the Andante Project site are all fine-grained clay or silty-clay materials, that election was made because the soils originally located in the near-surface down to a depth a few feet beneath the groundwater table were imported fill materials that had not been compacted, and on the mass scale, were highly permeable. Conversely, in tables where the data was intended to be considered in the context of the post-remedial condition of the site, the concentration limits used are those recommended for *fine-grained* soils because, after completion of the remediation program and soil improvement work required for the site's foundations, all of the previously-loose fill material was replaced by compacted engineered fill that, as is discussed in Section 3.4.1.1., has a very low permeability.
>
> The type of subsurface material used to determine which concentrations exceed the applicable limits is noted in the footnotes to each table in which highlights occur.

As can be seen by examination of Tables II-3 and II-7, the concentrations of COCs in only a few samples recovered from soil and groundwater that remained in place on the Andante Project site following completion of the remediation program exceeded the applicable limits used as a basis for the Tier 1 RBSLs that are cited in Table II-8. These exceeders occurred only for benzene, except for some samples that contained TPHg at concentrations that exceeded the limits cited in Table II-8. However, in the case of total petroleum hydrocarbons, the values in that Table are ceiling concentrations used as guidance for limits due to odors and other environmental nuisances. Those ceiling concentrations have been used as substitutes for human health risk limits because no criteria have been established for fuel hydrocarbons, which are mixtures of a large number of organic compounds, including those such as benzene that are uniquely considered in quantified risk-based environmental assessments conducted according to the best practice standards.

Although the instances where the concentrations of the COCs in soil samples from the floor and walls of the remedial excavation exceeded the applicable Tier 1 human health risk screening values were few, it was decided, in the interest of conservatism, that performance of a Tier 2 health risk assessment was warranted. Accordingly, to make a more refined evaluation of any remaining risks using site-specific parameters to evaluate whether the remediation program had, in fact, reduced human health risks for the anticipated future use of the site to an acceptable level, SJC performed the Tier 2 assessment reported herein. The procedures used to perform this Tier 2 assessment and the bases for selection of the site-specific parameters used for that purpose are described in the following sections of this report.

2.0 SITE CONCEPTUAL MODEL AND EXPOSURE PATHWAYS

To perform a health risk assessment for site-specific conditions, it is necessary to identify the pathways along which COCs potentially might travel and, if such migration occurs, by what mechanism they may affect a human receptor. These site-specific pathways must then be modeled and their characteristics defined so that the effects of those COCs on the receptors that they may reach can be assessed.

The applicable characteristics of the receptors must also be included in the model so that their sensitivity to the COCs can be properly considered. In addition, different durations and frequencies of exposure to a COC occur on different sites, depending upon the land use, which may be commercial, industrial, recreational, parkland, or residential. In other cases, uses may be mixed and it may be necessary to consider exposures separately due to differing occupancies and use of various areas within a large site.

In the case of the Andante Project at 3992 San Pablo Avenue, there will be a mixture of commercial and residential uses of the buildings that are under construction on the site. The ground floors of some buildings will be used exclusively for commercial purposes, while higher floors will be occupied by residential units. In other buildings, the entire structure, including the ground floor, will be devoted to residences. Finally, one of the major structures on the site will be an automobile parking garage.

Due to the varying uses of the different buildings on the site, the different concentrations of COCs in soil remaining in the subsurface beneath them and the differing depths from their floor slabs to the groundwater table, SJC determined that it was necessary to develop building-specific models for analyses of the potential health risks that might be present in various locations on the property. However, regardless of the use of a building, because the site as a whole will have mixed commercial and residential use, all exterior space on the site was assumed to be used by persons residing in the buildings. The selection of exposure pathways, receptors and construction parameters used in the building-specific models are discussed in Sections 2.1 through Section 2.3 below.

2.1 Exposure Pathways

In its post-remediation condition, there are two sources of COCs at the Andante Project site: 1) groundwater, and 2) a limited volume of affected subsurface soil that remains in situ beneath the floor of the backfilled remedial excavation. Potentially, both the groundwater and affected subsurface soil could release COCs by volatilization. The volatized materials could be released into outdoor air where they would be dispersed, or into enclosed space within buildings where they might accumulate. This affected air could serve as an exposure medium that might adversely affect human receptors. These exposure pathways are shown diagrammatically on Figure II-12.

Flow paths other than volatilization of COCs into outdoor and indoor air could also have been considered in the site model but they are not of concern to the health risk assessment described herein. For example, flow paths related to lateral contaminant transport are not considered because the 3992 San Pablo Avenue property is not the source of the contamination affecting its subsurface. Soil and groundwater beneath the site has been affected by fuel hydrocarbons flowing into it from the former Celi's Service Station property to the north and other off-site locations along the 40th Street right-of-way. Although there will be some degree of cyclical contamination of groundwater beneath the subject property as groundwater rises and falls seasonally through the affected soils, there are no potential points of down-gradient exposure that can be attributed to a primary source of contamination on the 3992 San Pablo Avenue property itself. Volatilization to air from affected surficial soils is not included in the models because all such surficial material was removed from the property by excavation as part of the remediation program.

2.2 Receptors

The health risk assessment must consider three types of human receptors that might be affected by COCs remaining in the subsurface beneath the Andante Project site. They can be classified according to their potential exposures to COCs on the property: 1) the occupants of the residential units being constructed on the property; 2) persons who will work in the commercial spaces that are included on the ground floors of some of the buildings on the property; and 3) construction workers engaged in building the structures. In the case of the residents, this class of human receptor can be further subdivided by age into adults, youths and young children. SJC's conceptual models used in the health risk analyses permit each of those classes and sub-classes of receptors to be considered.

A total of five buildings, which are numbered for identification as Buildings 1, 2, 3, 4 and 6, will be erected on the project site. See Figure II-3 for locations. (There is presently no Building 5 under construction, although such may be incorporated into the project at some time in the future.) Building 6 will be an automobile parking garage. Buildings 3 and 4 will each be made up of four stories of residential units. Buildings 1 and 3 will include three stories of residential units, but in each case, the ground floor will be devoted to commercial use, which includes a restaurant that will occupy the entire ground floor of Building 1. Because of this mixed use, when evaluating health risks due to potential exposures to affected outdoor air, SJC's conceptual models assume that, regardless of a building's use, persons exposed to outdoor air anywhere on the site may include young children. However, where the first floor of a building is dedicated to commercial use, only adult exposures are considered in the models for those buildings; similarly, all construction workers are also assumed to be adults. As is discussed in Sections 3.6.4 and 3.6.5 below, the difference in the duration and frequency of residents', commercial workers' and construction workers' exposure to outdoor or indoor air is also reflected in the models.

2.3 Individual Building Models

As is further discussed in Section 3.4.2.2.1, the depth to, and thickness of, affected soil remaining beneath the remediated area of the site varies from one location to another, as do the mean depths to the groundwater table and the concentrations of COCs in the affected soil left in the subsurface. In addition, the buildings on the project site vary significantly in their principal dimensions and in the occupancies of their ground floors. Accordingly, SJC has performed individual health risk assessments for each building. This approach avoids the use of non-representative site-wide average values for the key input parameters required to assess the health risks. The occupancies, depths to groundwater and depths to the top and the bottom of affected soil remaining in the subsurface used in the building-specific models are cited in Table II-16. Building 4 does not appear in that Table because it is located along the southern boundary of the site, well away from the area of the site that had been affected by COCs.

As is shown on Figure II-8 the footprint of Building 1 is wholly within the area of the 3992 San Pablo Avenue site that required remediation due to the presence of components of fuel hydrocarbons. Therefore, the whole of that Building could be included in a single model used to make a health risk assessment and, as is discussed in Sections 3.1.1 and 3.2.1, to select representative concentrations of COCs in the underlying media and, as is discussed in Sections 3.4.2.1.1 and 3.4.2.2.1, respectively, to assign mean depths to groundwater and the top of affected soil beneath Building 1 based on its specific location on the site. However, for Buildings 2, 3 and 6, that was not the case. Only a portion of the footprints of those buildings extend sufficiently far to the north to be underlain by the remediated area of the site.

In the case of Building 3, as is shown on Figure II-8, the floor slab of only the northern-most residential unit on the ground floor is located so as to be entirely within the remediated area, while the second-most northern residential unit is only partially within the remediated area. Therefore, to perform an adequately-conservative health risk analysis for Building 3, SJC's model uses the building parameters for a single "Type A" unit in what is designated by the developer as Building 3-A, as distinguished from the southern portion of that building, which is designated Building 3-B and contains larger "Type B" units. Also, when modeling that Building, SJC computed representative concentrations of contaminants of concern in soil from sampling locations that were beneath or in proximity to the northern-most Type A unit in Building 3-A because soil remaining in the subsurface in that area is, on average, more severely affected than soil beneath one of the more southerly Type A ground floor units, which are closer to or beyond the southern limit of the remediated area.

To prepare a model for a health risk assessment of Building 2, SJC used a procedure similar to that used for Building 3 to select the building parameters and mean concentrations of COCs in the subsurface. In that case, the model is based on the northern-most ground-floor commercial unit in Building 2-A (see Figure II-8 for location) because, like the northern-most residential unit on the ground floor of Building 3, the footprint of that commercial space is entirely with the remediated area.

Building 6 is an automobile parking structure that has fully open sides, except for low safety walls to prevent vehicles from driving off the parking floors. Therefore, air within the interior of the structure is freely exchanged with outdoor air. Moreover, interior air on all portions of each floor communicates freely with the air in other areas of the same floor, while the inter-floor access and egress ramps also permit extensive intermingling of air between floors.

Without consideration for vehicle exhaust fumes, which are beyond the scope of the present study, it might be reasonable to model conditions on the ground floor of the parking structure (Building 6) as being similar to those outdoors on the project site. However, to maintain a consistency of conservatism in the modeling, for the purpose of this report, Building 6 is treated as if it had enclosed walls and there were no circulation of air between floors. However, only the northern half of the ground floor of that building was considered when building volume, air exchange rates and other building-specific parameters were computed because only that portion is (partially) underlain by the remediated area.

2.4 Risk Assessment Software

SJC used the RBCA Tool Kit for Chemical Releases software published by Groundwater Services of Houston, Texas (Groundwater Services, Inc. 2000) to perform the computations necessary to compute the potential health risks at the Andante Project site. The risk-based site evaluation process simulated by the software is described in detail in Appendix II-A. Appendix II-B describes the fate and transport modeling methods that are employed in the software, including features that permit selection or de-selection of specific COC transport pathways or to select alternate equations used to simulate specific COC transport mechanisms.

2.4.1 Use of Johnson-Ettinger Model for Air Volatilization Computations

The RBCA Tool Kit for Chemical Releases software includes three methods for computation of air volatilization factors. The air volatilization factor is the predicted ambient air concentration, which may be either indoor or outdoor, divided by the source media concentration (*i.e.,* the concentration in soil or groundwater). For indoor air, the user may elect to use the Johnson-Ettinger model (Johnson and Ettinger 1991) for volatilization for either soil or groundwater, or she may specify indoor air volatilization factors computed from other models and input them directly into the software. The equations used for the Johnson-Ettinger model computation for volatilization factors to indoor air from subsurface soil and groundwater are presented as equations CM-4 and CM-6, respectively, on Figure B.2 in Appendix II-B.

Although the Johnson-Ettinger model may overestimate the concentration of COCs in indoor air by a factor varying from 10 to 1,000 (Hartman, 2002), it is widely used in risk assessment analyses and has been approved by the US-EPA (United States Environmental Protection Agency 1995b). Regulatory agencies that have approved the use of the Johnson-Ettinger model include those of the State of Michigan whose Environmental Science Board confirmed its suitability for predicting vapor concentrations in the interiors of buildings after subjecting

3.0 RISK ASSESSMENT PARAMETERS

The ASTM Standard Guide for Risk-Based Corrective Action E2081-00 (American Society for Testing and Materials 2000a) includes suggested values for each of the parameters required for a health risk calculation. If these "default" values were used to compute health risks at a site, it would only be necessary to specify the COCs and their concentrations in soil and groundwater. However, although many of the values cited in the E2081-00 document can be appropriately applied to conditions at actual sites, ASTM did not intend for the values presented in the guidance standard to be universally applied without regard to site-specific conditions. Accordingly, SJC chose risk assessment parameters for the 3992 San Pablo Avenue site based on measured site-specific conditions and made extremely-conservative assumptions designed to ensure that the health risks assessment would yield potentially carcinogenic risk and toxic hazard values highly protective of the health of the project's inhabitants. In many cases, the parameter values selected were considerably more conservative than those suggested for initial screening purposes in the ASTM guidance document. For convenience of reference, the parameter values cited in the ASTM E2081-00 Standard will be referred to as the ASTM "default" values.

For the exposure pathways that must be considered at the subject property, the model input parameters can be categorized into those concerning the following elements of a health risk assessment model:

1. Chemicals of concern in soil
2. Chemicals of concern in groundwater
3. Chemical-specific parameters
4. Site-specific soil transport parameters
5. Site- and building-specific air parameters
6. Receptor-specific parameters
7. Acceptable health risks

The site-specific data and the parametric assumptions made by SJC for the purpose of performing the Health Risk Assessment for the Andante Project site are discussed below.

Note:

The software used to perform the risk calculations is capable of analyzing risks associated with many exposure pathways that are inapplicable to conditions at the subject property. Accordingly, the following discussion is limited to a description of the input parameters of relevance to the site conceptual model discussed in Section 2.0 above.

3.1 Chemicals of Concern in Soil

The subsurface beneath a portion of the property at 3992 San Pablo Avenue is affected by releases of fuel hydrocarbons and probably by mineral spirits. Each of those materials is a mixture of a large number of organic and other chemicals. Diesel and gasoline are each composed of hundreds of individual chemicals. Some of those chemicals are carcinogenic and others are toxic to humans, but the large majority are not known to cause adverse health effects to persons exposed to them.

It is standard practice at sites where the subsurface has been affected by a discharge of fuel hydrocarbons to quantify the total petroleum hydrocarbons present in soil according to one or more classifications of those materials. The classifications are made by consideration of the number of carbon units in the molecular chains of the components of a given fuel such as gasoline or diesel. This practice was followed at the Andante Project site. However, although evaluation of environmental risks due to the effects of fuel hydrocarbons can be made based on quantification of the various classifications of petroleum hydrocarbons in affected media, and may be useful when there is significant concern about such effects as odors, use of total petroleum hydrocarbon concentration data does not provide sufficient information about the concentration of individual carcinogenic or toxic chemicals that are actually present in the affected subsurface media to permit health risks to be reliably computed. For those reasons, ASTM guidance documents call for health risk analyses at sites where fuel hydrocarbons have been released to the subsurface to be based on the key carcinogenic and toxic components of such fuels, such as the BTEX compounds (American Society of Testing and Materials 2002). Accordingly, SJC used that method to perform health risk analyses for the Andante Project site.

In addition to analysis of samples for TPH(g) and TPH(d), SJC analyzed soil samples recovered from the floor of the remedial excavation for the BTEX compounds, fuel oxygenates, ethylene dibromide, ethanol and polynuclear organic compounds. Of those, only the BTEX and the fuel oxygenate MTBE were detected in any of the soil recovered from sampling locations of concern to the building-specific risk analyses performed. (Selection of sampling locations used to develop representative concentrations of COCs are discussed in Section 3.1.1.1 below). Accordingly, benzene, toluene, ethyl benzene, xylene isomers and MTBE were included as COCs in soil beneath buildings when the health risks for the site were calculated. Benzene is a known human carcinogen and the other compounds considered in the risk analyses are toxic when present in the human environment at sufficiently high concentrations.

3.1.1 Representative Concentrations of Chemicals of Concern in Soil

The RBCA Tool Kit for Chemical Releases software permits the concentrations of COCs in soil beneath a site to be specified at more than one location. This enables representative concentrations to be used in the risk assessment analyses performed for sites where there is significant variability in the concentrations from location to location within the subsurface.

To develop representative concentrations of COCs in soil, SJC considered the concentrations in soil samples recovered from each sampling location beneath a given building or the portion of a building for which a risk assessment was made. For this purpose it was assumed that, in addition to the results of analyses directly beneath the footprint of a building or part of a building, soil in the subsurface within a distance up to 20 ft. beyond the perimeter of a building floor slab potentially could affect the environmental condition within, or in the vicinity of a building.

Table II-9 identifies the sampling point locations shown on Figure II-8 and the results of analyses of soil samples recovered from them that were used to develop representative concentrations of COCs in the affected soil that remains in place beneath each building on the site for which a health risk assessment was required. The sampling locations shown in Table 11-9 have been extracted from the database of analytical results compiled in Table II-7 by excluding results from all sampling points except those at which samples were recovered on the floor of the remedial excavation when it reached its maximum depth at a given location.

Notes:

1. Because the concentrations of COCs measured in soil samples recovered from sampling locations within 20 ft. of the building perimeters were included in the databases used to develop representative concentrations, some sampling locations appear in Table II-9 in association with more than one building.

2. The results of analyses of soil samples recovered from sampling location 30S-40E that is included in Table II-7 are excluded from Table II-9 because, as is discussed in Section 3.2.1 below, at that sampling point a small pit was excavated into the floor of the remedial excavation to assess the thickness of affected soil remaining in-situ and to recover a sample of groundwater after the remedial excavation was complete. Use of those data in developing a representative concentration of COCs in soil would not have been conservative because no detectable concentration of any COC was present in the subject samples which were recovered from that pit.

The RBCA Tool Kit for Chemical Releases software provides several options for computing a representative concentration for a COC in either soil or groundwater from a suite of location-specific concentrations. These options include computation of a mean, a maximum, or an upper confidence limit value. The user may choose to compute mean values as either arithmetically or geometrically.

To provide conservative representative values for the concentrations of COCs in soil, SJC used the statistical 95% upper confidence limit values computed from the concentrations detected in samples recovered from the specific sampling locations applicable to each separate building model. The 95% upper confidence limit is the concentration that has a 95% probability that it will not be exceeded within the area of the subsurface being characterized. Upper confidence limits are computed relative to the mean of the data set being statistically analyzed. For data sets having normal distributions, SJC used the arithmetic mean for the purpose of computing the upper confidence limit concentration, but for data sets with a log-normal distribution, the geometric mean was used.

The representative concentrations of the COCs in soil used in the risk assessments for each building on the Andante Project site are cited in Table II-10 The complete suite of concentrations used to compute the representative concentrations are included in the output of the risk assessment calculations that are presented in Appendix II-D, II-E, II-F and II-G, together with statistical parameters for each data set.

3.2 Chemicals of Concern in Groundwater

Groundwater-quality data from beneath the site at 3992 San Pablo Avenue was evaluated from information available from groundwater-quality monitoring wells installed on the adjacent property to the north, which includes the former location of Celi's Service Station, where fuel hydrocarbons had leaked into soil and groundwater, and from a limited number of groundwater-quality monitoring wells on other sites adjacent to the northern boundary of the Andante Project site, which are, today, beneath 40th Street. Available data from those wells are presented in Table II-6.

As is detailed in Volume I of this report, no groundwater was detected in any of the large number of borings drilled on the Andante Project site at the early stages of subsurface investigation for the redevelopment project. The apparent absence of groundwater in those borings can be accounted for by the short time that they remained open. However, being aware of the shallow groundwater conditions in the neighborhood, SJC, as part of our pre-remediation investigation, opened three exploratory trenches and installed a total of 10 temporary groundwater-quality monitoring wells that were left open for sufficient time for groundwater to permeate into them from the low permeability soil formations in the first 20 ft. beneath the ground surface. The locations of the SJC wells are shown on Figure II-13. As is recorded in Table II-3, the groundwater in several of these wells was significantly affected by releases of fuel hydrocarbons from the land to the north of the property and contained high concentrations of components of fuel hydrocarbons.

The exploratory trenches and many of the temporary groundwater-monitoring wells were constructed in soils that were heavily contaminated by gasoline, diesel, and, to some degree, mineral spirits, and these conditions were reflected in the high concentrations of BTEX compounds detected in samples recovered from them. However, during the remediation program conducted on the site, the contaminated soil through which they were constructed was removed down to depths significantly below the mean groundwater elevation. Moreover, the volume of contaminated soil to which groundwater was exposed was unusually large at the time samples were recovered from the trenches and temporary monitoring wells. As is detailed in Section 3.4.2.1.1 below, this was due to the extremely high water table resulting from the record rainfall that occurred in the area in the period immediately following trench excavation and monitoring well installation. Accordingly, the groundwater-quality data obtained from those trenches and monitoring wells reflect unusually severe pre-remediation conditions rather than representative conditions applicable to the health risk assessments that are the subject of this report, which assessments are focused on post-remediation site conditions.

For the same reasons as applied to the case of affected soils, SJC, when making the health risk assessments considered individual COCs in affected groundwater rather than basing the assessments on concentrations of total petroleum hydrocarbons in that medium. In the case of the groundwater, the polynuclear aromatic compound, naphthalene, was detected in addition to the benzene, toluene, ethyl benzene, xylene isomers and MTBE that was detected in soil samples recovered from the floor of the remedial excavation. Based on these findings, benzene, toluene, ethyl benzene, xylene isomers, MTBE and naphthalene were included as COCs in groundwater when the health risks for the buildings on the subject property were calculated.

3.2.1 Representative Concentrations of Chemical of Concern in Groundwater

For the purpose of modeling site conditions for the health risk assessments, the concentrations of COCs in groundwater were taken from results of analyses of a groundwater sample recovered from a deep pit excavated into the bottom of the remedial excavation, through soil that remained in situ after the maximum depth of the remedial excavation was reached, to a depth beneath the groundwater table as it was located at the time. That pit was excavated at the direction of the ACEHCS Case Officer to enable groundwater beneath the remediated area of the site to be sampled and to investigate the thickness of affected soil remaining after the remediation program was completed. It was located at sampling location 30S-40E, which is shown on Figure II-8. The results of the analyses of the sample of groundwater recovered from the pit at that location are included in Table II-3, together with results obtained from samples recovered from pre-remediation trenches and temporary groundwater-quality monitoring wells.

The groundwater sample designated 30S-40E is considered to be conservatively representative of groundwater conditions beneath the remediated site because: a) that sampling location is within the area of the site most severely affected by the releases of fuel hydrocarbons that migrated onto the property from sites to its north; and b) the sampling location is in an area where affected soil will remain in contact with groundwater, which is not the case in several other parts of the remediated area where all affected soil was removed by excavation. To ensure conservatism for the purpose of the risk assessment analyses, it was assumed that the concentrations of COCs present in the groundwater sample recovered from 30S-40E were present at all points beneath the buildings being constructed on the site, even though it is known that concentrations at other locations, such as near the margins of the remediated area, are, in fact, considerably lower. (See Table II-3 and Figure II-4.)

The concentrations of COCs in groundwater that were used in the risk assessments are presented in Table II-11.

3.3 Chemical-specific Parameters

The physical, chemical, toxicological and carcinogenic properties of the COCs present at the Andante Project site (*i.e.*, benzene, toluene, ethyl benzene, xylene isomers, MTBE and naphthalene) for the exposure pathways of concern are presented in Table II-12.

In each case, the suite of parameters was taken from the library of chemical databases provided in the modeling software by its developer, Groundwater Services, Inc. (2000). All COC parameter values used in the software were obtained from sources in the standard chemical and risk assessment literature.

Note:

The chemical data for the COCs that are included in the output documentation generated by the software also cite additional properties of the chemicals beyond those presented in Table II-12, but those relate to exposure pathways not present on the 3992 San Pablo Avenue property.

3.4 Site-specific Soil Transport Parameters

For the flow paths considered in the health risk assessment for the subject property, the following site-specific soil column characteristics and soil properties were used.

3.4.1 Soil Column Properties

Soil column properties for the Andante Project are discussed below.

3.4.1.1 Hydraulic Conductivity

The ASTM default value for vertical hydraulic conductivity of soil is 1.0×10^{-2} cm/sec, which is typical of a sand or silty sand. This assumption is clearly invalid for the Andante Project site where the soils are predominantly silty clays.

To obtain reliable site-specific values for vertical conductivity of the soil, SJC obtained direct laboratory measurements of the hydraulic conductivity of two representative samples of soil from the 3992 San Pablo Avenue site. These were the in situ silty clay from the floor of the remedial excavation and soil from the clean material that was stockpiled on the site before it was used as a low-permeability backfilling and capping material for the remediated area.

The hydraulic conductivity tests were conducted by the Fugro West, Inc. laboratory in Oakland, California. In each case, a constant head permeameter was used to measure the hydraulic conductivity of the soil after it had been compacted to 90% relative density, according to procedure D1557-00 published by the ASTM (American Society for Testing and Materials 2000c). The data sheets from the hydraulic conductivity tests together with the related soil density data are reproduced in Appendix II-C. The measured hydraulic conductivities of the soils were as follows:

Hydraulic Conductivity of Silty Clay: 1.73×10^{-8} cm/sec.

Hydraulic Conductivity of Compacted Fill: 5.65×10^{-7} cm/sec.

As is discussed in Section 3.4.2.1, for the purpose of the health risk assessment analyses, the mean elevation of the water table beneath the site was set at an elevation that falls within the thickness of the compacted fill placed over the remediated area. The hydraulic conductivity of that fill was taken to be 5.65×10^{-7} cm/sec. This is a conservative assumption because the actual hydraulic conductivity of the low permeability soil in the capping fill is, in fact, less than that value because the fill was placed according to a specification that called for a measured in situ relative density of 95% or greater, for which the hydraulic conductivity of the compacted soil would be less than for a relative density of 90%.

3.4.1.2 Dry Bulk Density

The dry bulk density of the backfill material was 100.3 lb/ft^3 relative density as measured during the hydraulic conductivity test procedure (see Appendix II-C). In Standard International Units, that density is expressed as 1.61 Kg/L. The equivalent ASTM default value is 1.7 Kg/L.

Note:

As noted above, the dry density measured in association with the conductivity test was performed on soil compacted to a relative density of 90%. The actual dry density of the low permeability fill was 95% or greater.

3.4.1.3 Volumetric Water Content

The ASTM default values for volumetric water content of soil are 12.0% for the vadose zone and 34.2% for the capillary fringe.

The water content of the fill material when compacted to 90% was measured at the time that the hydraulic conductivity tests were conducted at 18.7% by weight. Definition of water content by weight has been used in geotechnical engineering for at least a century and is defined as:

$$M_w = \text{(Weight of water)} / \text{(Weight of solids)} \qquad \textit{Equation (1)}$$

In recent years, persons having no background in the engineering geosciences frequently define water content according to the following equation:

$$M_v = \text{(Volume of water)} / \text{(Volume of solids, water and air)} \qquad \textit{Equation (2)}$$

Unfortunately, M_v cannot be measured directly in either the field or laboratory. This usage is commonly the case in software used to compute health risk assessments based on the ASTM E2081-00 standard.

In the case of the soil used as compacted fill materials at the Andante Project site, values of M_v can be computed from the measured value of M_w and other data provided by the hydraulic conductivity test and its associated compaction curve that are reproduced in Appendix II-C.

The results of the compaction tests shown in Appendix II-C for the compacted fill placed in the remedial excavation show that, at a dry density of 110.9 lb/ft^3, the moisture content of the fill was 12.8% by weight. However, if it is assumed that the mean specific gravity of the soil particles is 2.65, which is typical of silty clays of the type with which we are concerned, then, under the same conditions, but with sufficient moisture present to eliminate all air voids, the moisture content of the soil would be 19.2% by weight.

According to *Equation 1*, when the weight of solids in a 1.0 ft^3 sample of the compacted soil, which is fully saturated, is 110.9 lbs, the water, which has a specific gravity of 1.0, would have a weight of 21.29 lbs and its volume would be 21.29 lb / (62.4 lb/ft^3 X 1.0), or 0.3412 ft^3.

Using the values computed above, *Equation 2* for a 1.0 ft^3 sample yields the results:

M_v (saturated) = 0.3412 ft^3 / 1.0 ft^3

Thus, the volumetric moisture content of the saturated soil was 0.3412, or 34.12%,

and the unsaturated moisture content at 90% compaction was:

$M_v = [(0.128 \times 110.9 \text{ lb}) / 62.4 \text{ lb/ft}^3] / 1.0 \text{ ft}^3$

so that the volumetric moisture content of the unsaturated soil at 90% compaction would be 0.2275, or 22.75%.

However, as noted previously, the fill material was actually compacted to a relative density of 95%, so that the in situ unsaturated moisture content of the compacted fill is actually less than that measured for soil compacted to 90%. Thus, using the unsaturated moisture content for soil in the 90% compacted condition yields a conservative value when used for the purpose of performing a health risk assessment.

Note:

As is discussed in Section 3.4.1.5 below, it was conservatively assumed that the capillary fringe would, in fact, contain some air, the actual value of the volumetric water content of the capillary fringe (*i.e.*, the saturated zone of the soil) that was used for this health risk assessment was 33%.

3.4.1.4 Total Porosity

Total porosity, n, is defined as the ratio between the volume of voids in soil to the total volume. When a sample is fully saturated, n is equal to M_v, the volumetric water content.

As was discussed in Section 3.4.1.3 above, the saturated volumetric water content at a relative compaction of 90% for the engineered fill placed in the remediated area of the Andante Project site would be 34.12%. Thus,

$n = 0.3412$

compared to the ASTM default value of 0.38. However, the value of 0.3412 used in the health risk analyses is conservative because the fill was actually compacted to a relative density of 95%.

3.4.1.5 Volumetric Air Content

The volumetric air content of a soil is defined as the ratio of the volume of air in the sample to the total volume of the sample. As was computed in Section 3.4.1.3, in the vadose zone, where, for the purpose of this analysis, it was conservatively assumed that the clean, engineered fill material placed in the remedial excavation would be compacted to 90% relative density, the volumetric water content of the soil would be 22.75%, but when the same soil is fully saturated, its moisture content would be 34.12%.

At full saturation, the volumetric air content of the sample is zero and water completely fills all of the void space. Conversely, when the sample is completely dry, the pores in the soil would contain only air and the volumetric air content would be equal to the total porosity of the sample. At intermediate moisture content, the volumetric air content of the soil is equal to the difference between its volumetric water content and the total porosity.

The total porosity (n) of the soil used as backfill at the Andante Project, which includes the soil in the vadose zone of the site in its post-remedial condition, has been calculated in Section 3.4.1.4 as 0.3412 and, for the same conditions, the volumetric water content of the soil was computed in Section 3.4.1.3 to be 22.75%. Thus, the

$$\text{Volumetric Air Content in Vadose Zone} = 0.3412 - 0.2275$$

$$= 0.1137$$

$$= 11.37\%$$

In the capillary fringe above the water table, all pore space would theoretically be completely full of water and its volumetric air content would be zero. The ASTM default value is 0.038, which might be the appropriate value if the compacted fill on the site were a clayey sand or a sandy clay, but is unreasonably high for a situation where the soil is predominantly formed from clay-sized particles and consequently high capillary pressures are generated. However, to provide for a thoroughly conservative risk assessment, we assumed that a small amount of air would actually be present in the capillary fringe, and assigned a volumetric air content of 0.01 to that zone, which, based on the available literature, is appropriate for a silty clay such as the soil at the Andante Project site (Connor, *et. al.*, 1997). Thus, for the purpose of the health risk analyses, the

Volumetric Air Content in Capillary Fringe = 0.010

= 1.00%

Note:

Because it was assumed that the capillary fringe contained some air, it was necessary to adjust the volumetric water content in that zone. The adjusted capillary zone volumetric water content is computed as follows:

M_v Capillary Fringe = Porosity (n) - Volumetric air content of capillary fringe

= M_v Capillary Fringe = 0.3412 - 0.01

= 0.3312

= 33.12%

3.4.1.6 Vapor Permeability

Due to the formation of water menisci at the locations where soil particles touch, the gas or vapor permeability of a partially-saturated soil is extremely low. In practice, this parameter is difficult to measure, even in a laboratory. The ASTM default value is 9.8×10^{-4} cm/sec (1.1×10^{-11} ft^2), which would be appropriate for a sand. However, based on the available literature, a more appropriate value for the silty clays that form the fill material above the affected zone of the subsurface at the Andante Project site would be 9.8×10^{-9} cm/sec (1.1×10^{-16} ft^2) (Connor, *et. al.*, 1997). Accordingly, the latter value was used for the health risk assessments presented in this report.

3.4.1.7 Capillary Zone Thickness

The ASTM default for capillary zone thickness is 0.16 ft. (5 cm). That value is extremely low and would be highly non-conservative if used in a health risk assessment, even if the soil were a sand. It is grossly so for the silty clays actually present on the subject property. To provide an appropriately conservative value for the capillary zone thickness, SJC assumed a capillary thickness of 5.0 ft. for the health risk analyses reported herein. That value is compatible with data available in the standard literature (Guymon 1994, Technical Advisory Committee 1996).

3.4.1.8 Partitioning Parameters

The values used in the health risk analyses for the fraction of organic carbons and pH in the soil beneath the site that affect phase partitioning of the COCs in the affected soil zone are described below.

3.4.1.8.1 Fraction Organic Carbon

The ASTM default value for the fraction of organic carbon in soil is 0.01. The fraction of organic carbon in soils has a major effect on the ability of chemicals to sorb to soil particles. However, even if no organic carbon is present, the out of balance electromagnetic molecular forces on the surface of very fine soil particles such as those that form clay can cause chemicals to sorb. Where organic content is present, as is the case in the silty organic clays at the Andante Project site, sorption increases rapidly with increasing organic carbon content. Thus, while the ASTM default value of 0.01 may be appropriate for a sand formation containing a small fraction of organic materials, it significantly under-represents the chemical sorption onto clayey soils, which, in addition to their electromagnetic sorption capacity, frequently contain significant fractions of organic carbons. Accordingly, SJC used an organic carbon fraction of 0.02 for the health risk analyses reported herein. That value, while conservative for silty clay, is compatible with reported values for local soils on the eastern side of San Francisco Bay (Spence and Gomez 1999).

3.4.1.8.2 Soil/Water pH

The ASTM default value for the pH of the soil and groundwater is 6.8, which, given the temporal variations that frequently occur in that parameter, is an appropriate value for most soils and groundwater and, thus, was used when making the health risk analyses reported herein.

3.4.2 <u>Soil Source Zone Characteristics</u>

3.4.2.1 Hydrogeology

The site-specific values for the hydrogeologic characteristics required as input for the health risk analyses are discussed below.

3.4.2.1.1 Depth to Water-bearing Unit

The depth to the water-bearing unit (*i.e.*, the depth to the phreatic surface) is an important parameter that affects the concentrations of COCs in indoor and outdoor air above a contaminated subsurface. If the groundwater is shallow, the potential concentrations of airborne COCs are higher compared to a situation where groundwater is deeper in the same formation affected by the same concentrations of COCs. At many locations, the depth to the first water-bearing unit may differ significantly from season to season. However, the modeling procedure used to compute the concentrations of COCs in indoor and outdoor air can accept only a single input parameter for the depth to groundwater. Thus, to avoid excessively conservative or unacceptably non-conservative results from a health risk assessment, it is important to use a conservative, but reasonably representative value for depth to groundwater in the model.

In the case of the SNK Andante site, SJC elected to use the mean depth to groundwater beneath a building as the representative value for this parameter. That choice is conservative because groundwater elevations beneath the site vary seasonally in response to rainfall in the local area and in the Berkeley and Oakland hills to the east. If precipitation were distributed uniformly throughout the year, the mean depth to groundwater beneath the site would, in fact, be an accurate representation of the mean hydrogeologic condition because the model would reflect a situation in which groundwater elevation would be between the mean and the highest elevation for one half of the year and between the mean and the lowest elevation for the other half of the year. However, in the Oakland-Emeryville area, precipitation is not evenly distributed throughout the year. In fact, on average, more than 82% of the rainfall occurs between the months of November and March (Kozlowski 2003). Thus, groundwater elevations are usually above their mean range during that period, but significantly lower during the remaining seven months of the reporting year (July 1 - June 30). Therefore, use of the mean groundwater elevation to compute the depth to groundwater for the purpose of the health risk analyses is conservative, because, in actuality, groundwater is at lower elevations than that depth for more than half of the year.

Groundwater elevational data is available for the site at 3992 San Pablo Avenue and adjacent property from measurements made in the groundwater-quality monitoring wells installed by SJC that are described in Volume I of this report and those installed by a number of consultants retained by the City of Emeryville and its predecessors to investigate contamination beneath the 40th Street right-of-way. Those data are presented in Table II-13 and the well locations are shown on Figure II-4.

As can be seen in Table II-13, groundwater elevational data is available from measurements made in WCEW-1 for all four seasons of the 1997-1998 climatic year. The lowest elevation recorded was 30.98 ft. MSL on September 26, 1997. That elevation was taken to be representative of the lowest elevation reached by the groundwater during a typical year. In that well, the highest elevation occurred on March 13, 1988, at 33.12 ft. MSL. To ensure a conservative approach, however, SJC used an alternate representative elevation for high groundwater when computing mean groundwater elevations for the health risk assessments. That value for the high seasonal groundwater elevation was developed as follows.

SJC installed temporary groundwater-quality monitoring wells on the Andante property on April 14, 2003. The wells were of two types: shallow standpipe-type wells that extended to depths up to 12 ft. BGS, and deeper wells penetrating to 20 ft. BGS. The latter wells were equipped with self-expanding bentonite seals located at a depth of approximately 12 ft. BGS and screened casings over the interval 15-20 ft. BGS. The shallow wells were designed to investigate groundwater conditions in the near-surface soils where earlier investigations had indicated that groundwater may be temporarily perched following local precipitation. The deeper wells equipped with the seals at a depth of approximately 12 ft. BGS were designed to investigate groundwater quality and groundwater elevation in deeper zones, where there is a more stable groundwater regime. Within 24 hours of the installation of the wells, heavy precipitation fell on the site and, over the following two weeks, heavy rainfall recurred periodically, so that, by the end of the month, the National Weather Service reported the wettest conditions for the month of April ever recorded in the Oakland-Emeryville area. On April 14, April 16 and April 21, 2003, SJC measured the depth to groundwater in all of the temporary wells installed on the property. Those data are included in Table II-13.

Because it required some time for the self-expanding bentonite seals installed in the deeper wells to fully expand and serve to isolate the screened interval from water infiltrating down the open borehole from the surface, to ensure that the depth to groundwater measurements were applicable to conditions after the well seals were fully functional, SJC used the results of the measurements taken on April 21, 2003 in Monitoring Wells SCJ MW-T2A, SCJ MW-T4A, and SCJ MW-T5A as representative of groundwater elevations and gradients at the site in that month. The groundwater contours for April 21, 2003 are shown on Figure II-13. Given the record rainfall in April 2003, the elevations represented by those contours have been taken to represent conservatively the highest groundwater elevation that occurs during any given year.

Inspection of Figure II-13 shows that Monitoring Well WCEW-1, which was located near the northeastern corner of the intersection of San Pablo Avenue and 40th Street, is on, or close to, the projection of the 35.5 ft. groundwater elevation contour developed from the depth to groundwater measurements made in the monitoring wells on the Andante Project site on April 21, 2003. Thus, Well WCEW-1 is co-gradient to points on the Andante Project site that are connected by that 35.5 ft. groundwater elevation contour. This permits the lowest groundwater elevation recorded in Well WCEW-1 (*i.e.*, 30.98 ft. MSL) to be matched with the high elevation of 35.5 ft. MSL shown on Figure II-13 for its co-gradient locations. Thus, the representative range of groundwater elevations is conservatively estimated to be between 30.98 ft and 35.5 ft, MSL at points along the groundwater contour for the 35.5 ft. elevation that was derived from the April 21, 2003 measurements made in the deep wells on the Andante site. For this seasonal range of elevations, the mean is 33.24 ft. MSL.

Having established the mean groundwater elevation along one line on the Andante Project site, it is possible to estimate the corresponding elevations at other up-gradient and down-gradient locations, if it is assumed that the groundwater gradient of 0.02 ft/ft. computed from the measurements made in Monitoring Wells SCJ MW-T2A, SCJ MW-T4A, and SCJ MW-T5A on April 21, 2003 can be considered generally representative of groundwater gradients beneath the site at other times. Then, from estimates of groundwater elevations on the up-gradient (eastern) and down-gradient (western) sides of the buildings, a mean value for the elevation of groundwater beneath a given building can be established.

Each of the buildings under construction on the subject property has a ground floor slab, the surface of which is set at a pre-determined elevation. Accordingly, the depth to groundwater beneath each building can be computed by subtracting the representative mean groundwater elevation beneath that building from its ground floor slab surface elevation. The ground floor slab elevations for Building 1, 2-A North, 3-A and 6 are shown in Table II-14, together with the mean representative groundwater elevations computed by the method described above, and those values have been subtracted to yield the mean representative depth to groundwater beneath each building.

Note:

In the health risk modeling process, the depth of the unsaturated soil zone (*i.e.*, the soil column thickness) is computed by subtracting the capillary zone thickness (*i.e.*, 5 ft.; see Section 3.4.1.7 above) from the depth to groundwater. In the health risk assessment software, depth to groundwater is also described as "depth to water-bearing unit." The values used in the health risk assessments for depth to groundwater and soil column thickness are shown in Table II-14.

3.4.2.2 Affected Soil Zone

The site-specific values for the affected soil zone characteristics required as input for the health risk analyses are discussed below.

3.4.2.2.1 Depths to Top and Bottom of Affected Soils

To characterize the geometry of the areas where affected soil will remain beneath buildings, SJC considered conditions at each sampling point beneath a building and at each sampling point falling within 20 ft. of the footprint of a building.

The depth to the top of affected soil was computed to be the difference between the elevation of the top of the floor slab for the building for which the risk assessment was being made and the elevation of the bottom of the remedial excavation at that point which was recorded at the time each soil sample was recovered. This suite of calculations included those for sampling points at which no detectable concentrations of COCs were found in the floor of the remedial excavation. A representative depth to the top of affected soil beneath the building was then taken to be the mean of the depths computed from the data gathered at each of the included sampling points.

The inclusion of data from sampling locations at which no affected soil is present in the subsurface might appear to be excessively conservative. However, as discussed below, because the absence of affected soil at a given location can be represented by assigning a zero thickness to that material, the apparent excess conservatism engendered by including sampling locations at which no COCs were detected can be eliminated. In the general case, where a measurable concentration of a COC is present at a given sampling point and is also present at surrounding sampling points, the effect of the method used to model the thickness of the affected soil zone and the distribution of concentrations of COCs in subsurface soils is to represent concentrations of COCs at un-sampled intermediate locations as the mean of the concentration measured at the specified sampling point and at the surrounding sampling points, and to represent the thickness of affected soil at intermediate locations as the mean of its thicknesses at the same set of data points. In the special case, where a given COC is undetected at a specific sampling point, but a measurable concentration of that COC is detected at any of the surrounding sampling points, the method conservatively assumes that the concentration of the COC in the soil between the specified point and the surrounding sampling points is one-half of the mean of the concentrations measured at the sampling points where it was detected. Similarly, in that special case, the modeling procedure sets the thickness of the affected soil at intermediate locations to vary between zero and the mean of the thicknesses measured at the sampling points where affected soil was present.

To compute the representative depth to the base of the affected soil zone beneath a building, the thickness of affected soil at each of the included sampling points was considered. At each sampling location in the floor of the remedial excavation in which no detectable concentration of any COC was detected, a value of zero was assigned to the thickness of affected soil.

Note:

If affected soil is located below the water table, COCs cannot be released from it by the process of vaporization. Such soil may contribute dissolved COCs to groundwater, which itself may cause those materials to migrate along available pathways and affect receptors on the ground surface, within buildings or at other locations, but that scenario does not directly affect computations of health risk due to vaporization of COCs from soil. It is, therefore, erroneous to assume that COCs vaporize from submerged soil when computing health risks at a site. For each of the buildings modeled in this present study, the conservatively-established representative depth to groundwater was less than the mean depth to the top affected soil left in place when the remediation program conducted on the site was complete. Thus, for the representative conditions modeled, no COC vapors would be released from subsurface soil.

Although details of the concentrations of COCs in both soil and groundwater were included in the input to the RBCA Tool Kit for Chemical Releases software used to perform the health risk calculations, care was taken to adapt the computational models to account correctly for the lack of vaporization of those chemicals from submerged soils. In the case of the standard representative models for each building, the adaptation consisted of setting the input values for the depth to both the top and bottom of the affected soils zone to be the same as the depth used for the depth to the top of the water-bearing unit. The effect of that procedure was to cause the software to compute a zero thickness for the zone of soil affected by the COCs so that, in the risk computation process, no account would be taken of chemical vapors that otherwise might be computed as emitting from the submerged soil. Conversely, when extreme drought conditions during which groundwater levels might fall to very low elevations, were modeled (see Section 4.1), the actual values of the mean depths to the top and bottom of the zone of affected subsurface soil were used as input to the software. In those cases, the depth to groundwater was set equal to the modeled depth to the bottom of the zone of affected soil so that vapors emitted from the affected subsurface soil were included in the health risk calculations, because, under such circumstances, the affected soil was no longer submerged.

3.4.2.2.2 Affected Soil Area

As was discussed in Section 2.3 above, because several of the key parameters, such as depth to groundwater, depth to top and bottom of affected soil remaining in situ, and the occupancy of the first-floor units is building-specific at the Andante Project site, separate health risk analyses were made for each building. Accordingly, in making the analyses, the plan area (or partial plan area, as applicable) of the ground floor level of each building was used to define the affected soil area in each case. The building plan areas used in the analyses are listed in Table II-15.

3.4.2.2.3 Length of Affected Soil Parallel to Assumed Wind Direction

Wind directions in the San Francisco Bay area vary considerably both seasonally and daily, depending upon the regional weather patterns and relative temperatures in the Central Valley of California and along the Pacific coast. Although the prevailing wind direction, based on statistical analysis of weather records, is generally stated to be from the northwest, for the purpose of the health risk analyses and to ensure an appropriate degree of conservatism, SJC assumed that the wind would at all times blow in the direction parallel to the longest dimension of the zone of affected soil (*i.e.,* the area of the site where soils affected by COCs were remediated). Further, although a separate risk analysis assessment was made for each building, it was conservatively assumed that, for the purpose of evaluating the potential effect of the COCs that remain in situ beneath the site, the whole of that area could affect outdoor air quality for any of the buildings. Accordingly, SJC used 235 ft., which, as can be scaled from Figure II-4, is the longest dimension (*i.e.,* west to east) of the area beneath which the subsurface was affected by significant concentrations of COCs.

3.5 Site- and Building-specific Air Parameters

For the flow paths considered in the health risk assessment for the Andante Project site, the following site-specific air parameters were used.

3.5.1 Outdoor Air Pathways

For the pathways of concern to the present health risk assessment, the outdoor air pathway parameters of concern are the outdoor air mixing zone height and the ambient air velocity in the mixing zone.

3.5.1.1 Air Mixing Zone Height

The ASTM default outdoor air mixing zone height is 6.56 ft. (200 cm), which reflects the breathing area of an average person. SJC also used this value in the health risk analyses reported herein.

3.5.1.2 Ambient Air Velocity in Mixing Zone

The wind speed in the outdoor air mixing zone affects the concentrations of COCs in outdoor air because it has a major influence on the dispersion of those chemicals. The ASTM default value for the wind speed (*i.e.*, the ambient air velocity) in the outdoor mixing zone is 7.38 ft/sec (225 cm/sec). Actual wind speed data is available from an anemometer located at the East Bay Municipal Utility Districts' sewage treatment plant in Oakland, approximately 0.9 miles west-southwest of the subject property. The mean annual wind speed for that site was 10.56 ft/sec (322 cm/sec) in 1997 (San Francisco Bay Area Air Quality Management District 1997). SJC used that value in the health risk analyses reported herein.

3.5.2 <u>Indoor Air Pathway: Building Parameters</u>

The parameters related to indoor air pathways for each building in the Andante Project are discussed below.

3.5.2.1 Foundation Areas and Perimeters

The foundation areas and perimeters for each building or applicable portion of the building are shown in Table II-15.

3.5.2.2 Building Volume/Area Ratio

The building volume/area ratio expresses the volume of the indoor space in a building as a ratio of the total volume indoor space to its floor area. In the case of the Andante Project buildings, that ratio is equal to the floor-to-ceiling heights of the ground floors of the applicable commercial or residential units. The floor-to-ceiling heights and associated volume/area ratios for each building or applicable portion of the building are shown in Table II-15.

> **Note**:
>
> In the case of a Type A residential unit in Building 3-A, a floor-to-ceiling height of 8.5 ft. was used to compute the volume/area ratio because, in that unit type, over a portion of the floor area, the ceiling height is 9.0 ft, but in other areas of the unit it is 8.0 ft.)

3.5.2.3 Building Air Exchange Rate

The building air exchange rate quantifies how much outdoor air is exchanged with indoor air in buildings. In residences not equipped with air conditioning systems, that value is affected in large measure by natural ventilation that occurs through windows and the opening and closing of exterior doors.

The ASTM default for residential units is 0.5 air changes per hour (**ACH**), which is equivalent to 0.00014 volumes per second. However, that value does not consider the local climate. In hot climates, residents will leave doors and windows open for long periods during the day, thus providing natural ventilation that is significantly above the continental mean. Conversely, in colder regions, or where winters are more inclement and extended, residences will remain relatively closed up, with associated lowering of air exchange rates for much of the year.

Emeryville, which is located on the eastern shore of San Francisco Bay, has a very temperate climate with only minor seasonal variations in average temperature. In fact, Lawrence Berkeley National Laboratory's Environmental Energy Technologies Division considers a value of 2.0 ACH to be reasonable for residences in California generally (Spence and Gomez 1999). SCJ used that value, which is equivalent to 0.00057 volume exchanges per second, for analyses of health risks for residential units on the Andante Project site.

Air exchange rates in occupied commercial buildings are usually considerably higher than those in residential buildings. This is frequently due to mechanical ventilation systems and other equipment installed to control the work environment. The ASTM air exchange rate default for commercial buildings is 0.83 ACH (0.00023 exchanges per second). However, when the outside temperature is between 60° F and 70° F, Pacific Gas & Electric Company's (**PG&E**) Energy Center in San Francisco, California, recommends that buildings should be ventilated with 100% fresh air because that method is more efficient than use of artificially-cooled or processed air.

Given the climate on the eastern shore of San Francisco Bay and the heating, ventilating and air conditioning (HVAC) engineering considerations noted above, Spence and Gomez used an air exchange rate of 5.0 ACH (0.0014 exchanges per second) when analyzing health risks for a general class of commercial buildings in the region (Spence and Gomez 1999). SJC also adopted that exchange rate for commercial space at the Andante Project site. Although that value is higher than the ASTM default, it is considered appropriately conservative when making health risk assessment for the commercial units. It is particularly conservative in the case of Building 1, which will feature a restaurant on the ground floor. Compliance with building codes and adherence to good HVAC engineering practices require such facilities to be equipped with extensive exhaust systems that operate at capacities that must be greater than specified minimums and that exhaust large volumes of air from the interior to the exterior of the facility, thus promoting frequent exchanges of the total volume of air within the restaurant.

3.5.2.4 Foundation Thickness and Depth to Bottom of Foundation Slab

Structurally, the buildings under construction on the Andante site have exterior wall and interior columns founded on individual footings. The ground floors are underlain by a 5-in. thick concrete slab reinforced with No. 4 (0.5-in. diameter) deformed bars at 18 in. on center in both directions. For the purpose of making an analysis of the flow of vapors of COCs into the interior spaces, and without considering the impermeable membranes that were laid beneath them, in the context of making the health risk evaluation, the slabs provide significant barriers to that migration. Therefore, their thickness and the degree to which they may become cracked are critical parameters that must be considered when computing the concentrations of gasses or vapors of COCs that might accumulate inside the buildings. To reflect the design of the buildings' foundation and floor slab system, a value of 5 in. (0.42 ft.) was used for both the "foundation thickness" and "depth to bottom of foundation slab" parameters that must be input to the risk assessment software.

3.5.2.5 Foundation Crack Fraction

The ASTM default for the areal fraction of cracks in a building foundation or floor slab is 0.01, or 1.0%. However, most practitioners consider this value to be unreasonably high, particularly for modern floor slab construction such as that at the Andante Project where, as is noted in Section 3.5.2.4 above, the floor slabs are heavily reinforced. SJC assumed that the actual areal fraction of cracks that might develop in the floor slabs in the buildings on the subject property would be 0.001, or 0.1%. That value is supported by data from buildings constructed in California that has been reported by the American Society of Heating, Refrigerating and Air Conditioning Engineering (American Society of Heating, Refrigerating and Air Conditioning Engineering 1981).

3.5.2.6 Volumetric Water and Air Content of Cracks

The more air present in foundation or basement-wall cracks, the more easily a volatilized chemical can infiltrate a building. However, it is unreasonable to assume that cracks in a floor slab would remain free of dirt or water throughout the life of the building. Even if the slab surface remained exposed, the cracks would gradually begin to fill with dirt after they formed. In reality, the slab surfaces in the Andante Project buildings will be covered with tile, carpeting and other flooring materials, which will, themselves, serve to obstruct the flow of air through the cracks regardless of when they are formed and, in many cases, will be laid on adhesives and other sealants that are likely to fill completely cracks that are formed during and shortly after the building construction period. Moisture can also infiltrate cracks, and be trapped there under capillary tension, particularly in fine or hairline cracks such as those that might form in the heavily reinforced slabs of the Andante Project buildings.

The ASTM default values for the volumetric water content and the volumetric air content of cracks are 0.12 (12%) and 0.26 (26%), respectively. For the reasons stated above, those proportions reflect highly-conservative assumptions about free air in the cracks that might permit convective air flow from the subsurface into the interior of the buildings. Therefore, SJC has elected to use those values as the input required for the health risk analyses reported herein.

3.5.2.7 Indoor/Outdoor Differential Pressure and Convective Air Flow through Cracks

The assumed differential pressure between indoor air and outdoor air is an important parameter controlling convective air flow through cracks in floor slabs and through openings in a building's skin. The rate of convective air flow, in turn, influences the concentrations of vapors of COCs that may accumulate in the interior air. If there is no differential pressure between the interior of a building and the outdoors, there is no convective air flow through foundation slabs. These latter conditions are set as the ASTM defaults for health risk analyses. However, in SJC's opinion, the assumption is non-conservative, particularly with respect to commercial buildings, because those structures frequently have interior air pressures that are less than ambient outdoor pressures. Low interior air pressures are particularly common in restaurants such as the one that is planned for the first floor of Building 1 on the Andante Project site because building code requirements and good HVAC engineering practices require enhanced exhaust system flow rates in the vicinity of cooking ranges and other heat- and fume-generating equipment. Negative pressures can also occur in commercial buildings used for purposes other than restaurants and may also be present in residential units, although conditions in restaurants usually represent the upper range of differential pressures that develop between indoor and outdoor air.

Empirical values of relative interior to exterior differential air pressures, including the maximum measured in buildings subject to low interior pressure have been measured in the field (DiPersio and Fitzgerald 1995, Bonnefous, *et. al.* 1992). These measurements include those published by Nazaroff, who concluded that, with respect to infiltration of vapors of COCs, differential pressure can be as great as 0.01 psi (Nazaroff, *et. al.* 1987). For consistent conservatism in the health risk analyses for the potentially-affected structures on the subject property, SJC used that pressure differential, which would generate significant convective upward air flow through any cracks that may develop in the floor slabs. That value was used for both commercial and residential units, even though it is recognized that it is extremely conservative when applied to the residential units, which will not be equipped with the powerful exhaust systems that might be installed in a restaurant.

3.5.2.8 Impermeable Barriers

In the general case, a 10-mil. thick impermeable membrane with watertight sealed joints overlapped a minimum of 6 in. was specified by the architect to be installed over the footprint of each building on the Andante Project site. The Visqueen™ brand of polyethylene film was used to form the specified barrier. As is shown on Figure II-14, it was installed beneath the floor slabs under a 2-in layer of sand used as a screed. Visqueen™ is an effective barrier to migration of moisture and vapor upward into the interior space of the building and provides a significant barrier to COCs in gaseous form migrating along the same pathway. However, it is not designed as a gas-proof membrane, and therefore cannot be relied upon to exclude 100% of the COCs that might migrate into building interiors.

In selected areas of the site where, prior to implementation of the remediation program, concentrations of COCs in near-surface soil had exceeded the Tier I risk assessment limits established by the RWQCB, the Visqueen™ material beneath the floor slab was replaced by a 60-mil. thick membrane of Liquid Boot®. That membrane is a seamless, elastomeric material that is impermeable to the gaseous phases of the COCs at the Andante Project site. It has been tested according to ASTM Standard D542-95 and found to be resistant to deterioration in the presence of components of fuel hydrocarbons such as benzene (American Society for Testing and Materials 2001). As applied beneath the floor slabs of buildings on the Andante project site, it was sprayed over a geotechnical-style substrate by a qualified subcontractor approved by LBI Technologies, Inc. of Santa Ana, California, the manufacturer of Liquid Boot®. The membrane was also installed vertically along the sides of buildings' exterior strip footings, column bases and around each utility pipe or other penetration passing through the floor slab, all of which were installed prior to its application. This technique ensured that the membrane formed a complete seal against ingress of the gaseous and vapor phases of COCs into the buildings' interior spaces.

A typical detail of the placement of the Liquid Boot® membrane beneath building floor slabs is shown on Figure II-15. As is noted in Table II-15, that gas-tight membrane was installed beneath the ground floor slabs of the whole of Building 1, under the ground floor slabs of the two northern-most commercial units in Building 2-A and under the slabs of the two northern-most Type A residential units on the ground floor of Building 3-A.

In making the health risk analyses for the buildings on the 3992 San Pablo Avenue site, no account whatsoever was taken of the presence of the impermeable barriers beneath the ground floor slabs. In the case of the Visqueen™ membrane under Building 6, this means that the computed health risks due to the presence of components of COCs remaining on the subsurface following remediation of the site are very much greater than is actually the case because the Visqueen™ will essentially eliminate the vapors and greatly reduce the transfer of gasses from the subsurface into the interior of the garage. In the cases of Buildings 1, 2-A and 3-A, the impermeable Liquid Boot® membrane will, in fact, eliminate the transfer of any quantity of COCs, whether in vapor or gaseous form, through the floor of the buildings into the interior space.

Due to the placement of the impermeable barriers beneath the buildings' slabs, health risks due to migration of COCs into the buildings via this pathway will be, in reality, zero. However, for the purpose of the analyses reported herein, and to maintain a consistent degree of conservatism, SJC did not include either the Visqueen™ or Liquid Boot® membranes in the building/subsurface system models used for the health risk analyses reported herein.

3.6 Receptor-specific Parameters

A health risk analysis must include consideration of the characteristics of the potential "receptors" (*i.e.*, the exposed humans) of COCs that might migrate from the affected zones of subsurface soil and groundwater. Because both carcinogenic and toxic effects of exposure to COCs are, in most cases, cumulative with time and more acutely affect persons having a low body weight, such as children, the frequency and total duration of exposure to a chemical or combination of COCs, and the weight of the person exposed must be considered carefully.

3.6.1 Exposure and Averaging Times

The ASTM guidance documents assume, as a default, that the length of time used to normalize statistically the intake of a carcinogen is 70 years for residential, commercial and construction environments. That default is also the standard upon which the United States

Environmental Protection Agency's (**US-EPA**'s) carcinogenic and toxicity data are based. SJC's model assumes the same length of time for statistical normalization.

For the purpose of making the health risk assessments, SJC assumes that the concentrations of carcinogens remain constant over the average exposure time, which is very conservatively assumed to be 30 years for persons in residential environments and 25 years for commercial workers. This is a very conservative assumption because concentrations of carcinogens will actually decrease over time due to natural attenuation.

The ASTM default for the averaging times for non-carcinogenic health effects are also 30 years for residential and 25 years for commercial or industrial environments, which are also highly conservative. SJC's model adopts those values, but sets the averaging time for non-carcinogenic effects for construction workers to be one year, which better matches actual construction working conditions on the subject site than does the ASTM default value of 25 years.

3.6.2 Body Weight

Although body weight is known to be an important variable influencing the effects of carcinogens and toxic chemicals on human health, the ASTM default for body weight is set at 70 Kg (154 lbs), which is, in the United States, the approximate mean weight of individuals between the ages of 6 and 75 years (United States Environmental Protection Agency 1989a). However, the US-EPA also cites the mean body weight of children between the ages of 0 and 6 years as 15 Kg (33 lbs) (United States Environmental Protection Agency 1996, 1991a, 1991b). For the purposes of evaluating health risks related to the ingestion of soil and water or when related to swimming in affected surface waters, it is SJC's practice to consider different ingestion rates during the first 6 years of a person's life as differentiated from the remainder of that life. In addition, to take advantage of available health risk data regarding dermal exposure to affected soil or surface water, it is SJC's practice to also consider the mean body weight of youths between the ages of 0 and 16 years, for which we use 35 Kg (77 lbs), which has been statistically established by the US-EPA (United States Environmental Protection Agency 1992).

Note:

Although the body weights of receptors of different ages appear in the output of the health risk analyses presented in Appendices II-D through II-G (*i.e.*, they are used in relation to parameters for which "Age Adjustments" are made), they are cited there only for reasons of formality because no exposure to affected soil occurs on the Andante Project site. Following remediation, any such material that remained on the site was buried at considerable depth below the surface. Similarly, exposure to contaminated surface water, which, if present, would call for modeling of different ingestion rates and skin surface areas for persons of different ages, is not an issue that needs to be addressed for either on-site or off-site locations in the Tier 2 analyses for the subject property.

3.6.3 Inhalation Rate

The RBCA Tool Kit for Chemical Releases software used to perform the health risk calculations does not contain equations that use age, body weight or inhalation rate in the context of potential exposure pathways that might lead to inhalation of COCs. This is because the calculations made in the software are based on reference *concentrations* as opposed to reference *doses* for non-carcinogens, and *unit risk* factors as opposed to *slope* factors for carcinogens (Groundwater Services, Inc. 2003). See Page A-12 in Appendix II-A for the applicable equations.

A reference *concentration* (*RfC*) is an estimate of a maximum continuous inhalation exposure of a human population (including sensitive subgroups such as young children) to a toxic non-carcinogen below which no there would be no significant risk of deleterious effects over the average lifetime of the population. A *unit risk* factor (URF) is the upper-bound excess lifetime cancer occurrence in a population of 1,000,000 due to continuous inhalation exposure to a carcinogen at a concentration of 1.0 $\mu g/m^3$ in air. Both RfC and URF values are independent of inhalation rate or body weight.

Although the equations used in the RBCA Tool Kit for Chemical Releases software make no assumptions with regard to inhalation rate, it would be possible to scale the exposure duration or exposure frequency values (see Sections 3.6.4 and 3.6.5 below) used for the analysis of any given site model to account for varying inhalation rates. However, SJC did not do this because: a) the reference concentrations and unit risk factors that are used for each COC in our calculations are based on lifetimes studies of human populations that already account for varying inhalation rates with age; and b) it would not be conservative scale either the exposure duration or exposure frequency values. For example, if it was decided to reflect a 10 m^3 /day inhalation rate, which is typical of a young child, instead of a 20 m^3 /day inhalation rate that might be proposed for a physically active commercial worker (United States Environmental Protection Agency 1996, 1997), then the default exposure duration of 350 days per year would be reduced to 350 x 10/20 = 175 days/year which would not yield such conservative results for health risks as would be the case when the unmodified ASTM default value of 350 days/year is used.

3.6.4 Exposure Duration

Exposure duration is the number of years over which an individual is assumed to be exposed to a COC. The ASTM default value for exposure durations are 30 years for residential sites and 25 years for commercial and industrial sites. SJC's model also uses those values for adults potentially exposed to COCs in commercial environments. However, when considering residents of the Andante Project site, depending upon the exposure pathway being evaluated, SJC divided the total 30-year exposure duration into two parts based on the age of the human receptor. Depending upon the availability of data in the published literature, that division occurred at the age of 6 years or at the age of 16 years. Where age adjustments related to young children between the ages of 0 and 6 years were applied, an exposure duration of 6 years was used to that period of a person's life. Similarly, in cases where age adjustments were made for persons between the ages of 0 and 16 years, an exposure duration of 16 years was used for that period of life. In either of those situations, the years spent as a child or young person were subtracted from the total 30-year exposure duration that would have been used if no age weighting had been applied. For the remaining 24 or 14 years, as applicable, of the exposure duration, a person was assumed to be at an adult weight. To account for the total effects of a 30-year exposure duration, the time periods over which the exposed person was assumed to have different body weights due to their age were added together.

The ASTM default exposure durations are highly conservative and are the same as the values proposed by the US-EPA, which values are based on analysis of 1983 United States Census Bureau data (United States Environmental Protection Agency 1989a). SJC's consideration of age weighting adds significantly to that conservatism.

The degree of conservatism applied to the health risk assessments by SJC's use of age weighting adjustments to the ASTM default values for exposure durations can be gauged by considering the following characteristics of the Census Bureau data used by the US-EPA when deriving its assumptions for exposure durations. Emeryville is an urban area and the US-EPA exposure durations include statistical data from rural areas where population mobility tends to be significantly lower than in the urban communities on the eastern side of San Francisco Bay. These factors have been studied by Israeli and Nelson (1992), who report that in the United States, 95% of all urban households stay in one residence for no more than 21.7 years while, regardless of their rural or metropolitan environment, 95% of western households move from one residence to another every 17.1 years. With respect to commercial and industrial land use scenarios, the United States Bureau of Labor Statistics reports that 50% of workers move from one job to another every four years (United States Bureau of Labor Statistics 1988).

In the case of construction workers, SJC modeled the exposure duration to be one year, which is, again, highly conservative because, over the duration of the construction program at the Andante Project site, individual workers will spend less than a typical maximum of three months on the site due to the changing trade skills required. Similarly, a one-year exposure for construction work on any future maintenance or reconstruction work at the site is also highly conservative.

3.6.5 Exposure Frequencies

Exposure frequency is the number of days per year that a person is assumed to be exposed to a COC. The ASTM default residential and commercial exposure frequencies, which are based on guidance from the US-EPA, are 350 days per year and 250 days per year, respectively. Because of the limited duration over which construction workers might be exposed to COCs in the subsurface, the frequency of exposure of those workers is set at 180 days per year (United States Environmental Protection Agency 1996). SJC used the same exposure frequencies when computing health risks at the Andante Project site. ASTM also has a separate default value for swimming-event frequency for residential land use, which is set at 12 events per year, but consideration of such events is not applicable to the Andante Project site where no surface waters are present.

The general residential exposure frequency of 350 days per year applies to both indoor and outdoor exposure to inhaled vapors of COCs. In both applications, that frequency is extremely conservative because, with the exception of 15 days per year when it is assumed that a resident would be on vacation, the frequency implies that a person would spend 24 hours of each day at home. In the case of indoor exposure, it takes no consideration of time spent away from home such as, in actuality, is required to meet work schedules, perform errands and participate in such events as weekend trips. Conversely, for the outdoor exposure scenario, the default residential exposure frequency is based on the assumption that a resident at the 3992 San Pablo Avenue property would spend 24 hours per day on the site but outside his home, a situation that is clearly conservative when outdoor air exposures are considered.

The ASTM default exposure frequency of 250 days per year for commercial workers, which was also adopted by SJC for the health risk assessments reported herein, is based on a five-day work week for 50 weeks of the year. This value is conservative because it does not provide for national holidays or additional time off work that typically amounts to 10 - 20 days per year.

3.6.6 Other Receptor-specific Parameters

For reasons of formality, the presentation of the output from the health risk analyses that are compiled in Appendices II-D through II-G include receptor-specific parameters for pathways such as those related to ingestion of surface waters and consumption of fish caught in such waters that are not present on the Andante Project site. The values cited in the appendices for such parameters, although they are not actually used in the computations made for the subject site, are all either ASTM default values or highly-conservative numbers derived from reliable sources.

3.7 Acceptable Health Risks

Health risks are expressed in two forms: carcinogenic risk factor and toxic hazard quotient. The carcinogenic risk is expressed as the projected increase in the number of persons that become affected by cancer due to extended exposure to the conditions on the subject site compared to the general population not exposed to the site conditions. For example, a carcinogenic risk factor of 1.0×10^{-6} expresses the risk where there would be one additional occurrence of cancer in a population of one million persons exposed to the conditions at the site, compared to the number of incidents of cancer found in a reference population of one million persons not exposed to the environmental conditions at the site.

The toxic hazard quotient is a measure of the severity of exposure for a period of time to a given COC that can be tolerated by a person exposed to that chemical by any pathway (*e.g.*, inhalation of contaminated air, ingestion of contaminated soil, or dermal contact with contaminated soil) or combination of pathways without suffering any toxicological symptoms due to that exposure. It is expressed as a ratio between the level of exposure to a given COC compared to an established reference dose below which no adverse health effects are experienced even when exposure is prolonged. A closely related parameter is the "toxicity hazard index" which is the sum of the toxic hazard quotients of two or more COCs at a given site due to the exposure of a particular receptor. A toxicity hazard index of 1.0 reflects the maximum tolerable limit to which a person can be exposed without suffering negative health effects. A toxic hazard index of less than 1.0 reflects the degree to which the anticipated exposure is less than that required to induce negative health effects. As the toxic hazard index rises above 1.0, its value reflects the severity of the toxicity of the environment to which a receptor is exposed.

On a given site, persons may be exposed to risks due to the presence of more than one carcinogenic and/or toxic chemical and the exposures may be via more than one pathway. Accordingly, to assess health risk properly, it is necessary to consider the cumulative affect on health due to the presence of all of the COCs present and, if multiple pathways between the source and the receptor are present, their cumulative effects must also be considered. For the health risk assessments presented herein, SJC computed the cumulative risks of all COCs present due to their migration via all applicable pathways.

3.7.1 Classification of Carcinogens

Carcinogens are classified by the US-EPA according to a system that is based on the weight of available evidence that they are, or are suspected to be, human carcinogens. Carcinogens are classified according to alphabetic nomenclature that is based on the weight of available evidence that a given chemical is or is suspected to be a human carcinogen. Chemicals known to be potent human carcinogens are classified as "A" carcinogens, while non-carcinogenic chemicals are given the classification "D." At the Andante Project site, only one known human carcinogen - benzene - has been detected in the subsurface. Benzene is a Class A carcinogen. The other COCs at the Andante Project site (see Sections 3.1 and 3.2) are toxic materials, but are not known to be carcinogenic; thus, they fall into the "D" classification.

3.7.2 Health Risk Limits of Carcinogens

Although there is a general perception that a risk factor of 1.0×10^{-6} represents an established upper limit of acceptable carcinogenic health risk promulgated in State and Federal regulations, that is not, in fact, the case. The US-EPA has indicated that the appropriate risk limit applicable to a specific site or a specific form of exposure should fall within the range 1.0×10^{-6} to 1.0×10^{-4}. The origin of the 1.0×10^{-6} limit appears to have been a recommended risk-based limit for residues of animal drugs found in human food-grade meat (United States Food and Drug Administration [**FDA**] 1973). That target risk level represents, essentially, a zero risk (Malander 2002).

As the inherently conservative nature of risk assessment calculations has been recognized as risk-based evaluation of environmentally compromised sites and other potential human exposures have been more widely used in regulatory decision-making, other, less stringent, risk level guidelines have been legislated or adopted. For example, in its Hazardous Waste Management Systems Toxicity Characteristics Revisions, the US-EPA selected a single level of 1.0×10^{-5} based on that Agency's belief that, due to the extremely conservative nature of the exposure scenarios employed in risk-based health risk assessments and the underlying health criteria used, a 1.0×10^{-5} risk level is realistic and appropriate as a practical target limit to protect the health of an exposed population (United States Environmental Protection Agency 1995a).

California State Proposition 65 (The Safe Drinking Water and Toxic Enforcement Act of 1986) enforcement is also based on a limiting target risk of 1.0×10^{-5}. Proposition 65 requires the governor of California to publish annually a list of chemicals known to the State to cause cancer or reproductive toxicity. All businesses that might expose individuals to a listed chemical must post a clear warning of such risk on the business premises, unless there is "no significant risk" posed by the chemical in question. The State of California has defined "no significant risk" as less than one excess case of cancer per one-hundred thousand individuals, which corresponds to target risk of 1.0×10^{-5}.

Target carcinogenic risk limits are not values that are derived from the health risk assessment calculation or from the carcinogenic or toxicological properties of any given chemical or combination of chemicals. In fact, as is evidenced by the discussion above, any selected health risk limit is, in fact, an arbitrary value that represents the perspective of a given regulatory agency, a local community, or an interest group about what constitutes an acceptable risk to human health in the context of its social, political and economic milieu. For example, the City of Oakland had preliminarily established a risk limit of 1.0×10^{-6} to develop Tier 1 risk-based assessment guidelines, but, after extensive input from representatives of a wide range of local interests that included regulatory agencies, consulting engineers, community improvement groups, minority business associations, the Sierra Club and a wide cross-section of Oakland residents, set a health risk limit of 1.0×10^{-5} for Tier 2 health risk assessments (Spence and Gomez 1999).

ASTM recommends a target carcinogenic health risk of 1.0×10^{-5} for risk-based assessments at petroleum release sites and describes that value as representative of *de minimus* risk (American Society for Testing and Materials 2002). SJC is firmly of the opinion that the 1.0×10^{-5} limit is applicable to the 3992 San Pablo Avenue site because: a) below that level there is, as had been stated by the State of California in the context of Proposition 65, as well as by other regulatory bodies, no significant risk to exposure from a known carcinogen; b) given the approximations inherent to Tier 2 health risk computations, health risk targets set lower than 1.0×10^{-5} have no practical mathematical significance other than a representation of what is, in reality, a *zero* health risk; and c) the City of Oakland's election to use a health risk of 1.0×10^{-5} for sites in that city that include geologic, hydrogeologic, climatic and economic and socio-political environments that are essentially identical to those in the City of Emeryville, including those of the Andante Project site, properly reflects all of the factors that should be considered when setting a site-specific target risk level. However, the RWQCB, which has jurisdiction of the site at 3992 San Pablo Avenue in Emeryville, uses a target risk of 1.0×10^{-6} when preparing RBSLs (California Water-quality Control Board - San Francisco

Bay Region 2001). Accordingly, when evaluating the results of the Tier 2 risk assessment for subject property that are reported herein, SJC compared the carcinogenic risk to that 1.0 x 10^{-6} target risk level.

3.7.3 Toxic Hazard Limits

For non-carcinogenic health effects, the results of most health risk assessments are compared with a toxic hazard quotient of 1.0, which represents the threshold value below which no adverse health effects are experienced by exposed populations and is the ASTM default value for Tier 2 risk assessments. This value is based on the precedents set by the US-EPA in its Risk Assessment Guidance for Superfund (**RAGS**) (United States Environmental Protection Agency 1989b). It was also adopted by the City of Oakland, but with a requirement to address cumulative risk, if necessary (*i.e.*, to consider the toxic hazard *index*), when it developed its guidelines for Tier 2 health risk assessments (Spence and Gomez 1999). With respect to this measure of health risk, SJC concurs with both the US-EPA and the City of Oakland and we normally set both the target health risk quotients and the health risk index at 1.0 when evaluating specific sites where the environment has been impaired. The RWQCB, however, in preparing its RBSLs for affected soil and groundwater in the San Francisco Bay region, elected to use target quotients at the unusually conservative value of 0.2, although its guidance document provides an option for site-specific adjustment of that value (California Water Quality Control Board - San Francisco Bay Region 2001). To conform to the RWQCB's regulatory guidance, in evaluating the results of the health risk assessments reported herein, SJC also adopted that extremely-conservative criterion and set both the target quotients and the target index at 0.2.

4.0 RESULTS OF HEALTH RISK ASSESSMENTS

The RBCA Toolkit for Chemical Releases software was used to compute the health risks that might be associated with the use of Buildings 1, 2-A, 3-A and 6 on the 3992 San Pablo Avenue site. The output from the software is presented in Appendices II-D, II-E, II-F and II-G.

4.1 Health Risk Computations for Representative Building Models

The results presented in the Appendices apply to the conservatively-developed, building-specific models and the highly-conservative parameters for the COC transport pathways that are actually present on the Andante Project site (see Section 2.1). In each case, the results presented in the Appendices are for models in which the depths to groundwater and other key parameters are assigned the representative values that were selected by the procedures described in Section 3.0. The key parameters for each of the buildings modeled are presented in Table II-16.

> **Note:**
>
> The exposure pathway flow charts included in the computer output presented in Appendices II-D through II-G represent affected surficial soils as being a source media for COCs. However, in actuality, that is not the case at the Andante Project property. All affected soils are deeply buried beneath the site. The presence of affected surficial soils as a source medium in the diagram generated by the software is an artifact of the computer code. It appears on a flowchart whenever the user elects to use the option whereby vaporization from subsurface soils is computed by both the Johnson-Ettinger method and the ASTM method for surface soils, so that the results of the ASTM calculation can be set as an upper limit, which might otherwise be exceeded due to the limitations of the Johnson-Ettinger computational method. The source media and COC migration pathways actually present on the Andante Project site are correctly represented on Figure II-12.

The results of the health risk analyses presented in Appendices II-D through II-G are summarized in Table II-17. Those results are based on the highly-conservative parameters defined in Sections 2.0 and 3.0 above. As expected, the highest values computed for the cumulative carcinogenic risks and toxic hazard indices are associated with the indoor air exposure pathways. Their highest numerical values, 4.3×10^{-7} and 2.1×10^{-2}, respectively, are associated with the indoor air pathway for Building 3-A, which will have residences on the ground floor. However, all of the carcinogenic risk and toxic hazard index values reported in Table II-17 are far below the highly-conservative limits that were set, respectively, at 1.0×10^{-6} and 0.2.

When considering the numerical values of the cumulative carcinogenic risks and toxic hazard indices presented in Table II-17 that were computed in the health risk analyses, it is important to note that such values are so low, as are the target risk and target toxicity indices set for the project, that they have essentially no quantifiable meaning. What they do indicate is that the results of the health risk computations performed using the highly-conservative parametric values selected for the analyses indicate that residents and workers on the Andante Project site would be exposed to no increase in risk to their health due to the presence of COCs in the subsurface. As was noted in Section 3.7.2, even the excess cumulative carcinogenic risk limit of 1×10^{-6} used as a benchmark for the assessments described in this report was originally established by the FDA to represent a zero risk to human health due to the presence of minute traces of carcinogens in food (United States Food and Drug Administration 1973). The computed carcinogenic risk values presented in Table II-17 are all significantly lower than even that extreme criterion. As has been noted by Malander (2002), when such low health risk values are computed for sites where fuel hydrocarbons have been released to the subsurface, they indicate that risks are actually absent.

4.2 Sensitivity of Risk Assessment Results to Groundwater Elevation

As was discussed in Section 3.4.2.1.1, the representative depths to groundwater used in the risk assessment models for each building were conservatively selected. However, it is recognized that under unusual conditions, such as those that prevailed in April 2003, the groundwater table beneath the site can rise to shallow depths that would temporarily bring affected groundwater closer to the underside of the building floor slabs than was modeled in the health risk analyses presented in Appendices II-D through II-G, the results of which are compiled in Table II-17

To investigate the effects of differences in groundwater table elevation on the assessments of carcinogenic risks and hazard indices, the health risk assessments were run for two additional conditions: a) where the groundwater table beneath the buildings was assumed to be at its highest elevation based on measurements made in April 2003 in monitoring wells installed on the 3992 San Pablo Avenue property; and b) where the groundwater table was assumed to be at an elevation based on the lowest elevation recorded in monitoring wells at the Celi's gas station, which was formerly located immediately to the north of the Andante Project site. In these cases, the depth to groundwater for the high-groundwater case was modeled as being 2.26 ft. above the groundwater elevation assumed for the standard representative models and 2.26 ft. below that elevation for the risk analyses performed for the low groundwater condition.

Note:

Where applicable, the 5-ft dimension used in the risk analyses for the capillary zone thickness was appropriately reduced so that the models of the high-groundwater elevation cases did not imply that the top of the capillary zone was at an elevation higher than the ground surface.

The results of the studies of the sensitivity of predicted carcinogenic risks and toxicity indices to groundwater elevation are presented in Table II-18, which documents the results for the mean groundwater elevation cases (*i.e.,* for the models that use the conservatively-developed representative groundwater elevations for each building), the low groundwater elevation cases, and the high groundwater elevation cases for the indoor air pathway, which is the critical pathway for each building.

As was noted in Section 3.4.2.2.1, it is important to recognize that even for the assumed low-groundwater elevation conditions that were modeled to generate the health risk analysis results presented in Table II-18, in no case was the groundwater elevation modeled to be lower than the mean elevation of the top of the affected soil remaining in the subsurface after the remediation program conducted at the site was complete. This is because the floor of the remedial excavation was generally deeper than the depth to groundwater when the water table was at the lowest elevation recorded in the immediate vicinity of the Andante Project site. Under those circumstances, COCs will not vaporize from affected soil and the risk analyses will be sensitive only to the depth from the ground surface to the contaminated groundwater.

To ensure that if, under some extraordinary circumstances such as a prolonged severe drought, the water table were to fall to a depth below the bottom of the affected soil zone so that COCs might vaporize and reach outdoor air or indoor spaces on the site, supplemental health risk calculations were also made for that scenario. In each case, both the computed carcinogenic risks and toxic hazard indices remained in a very low range that indicated no actual health risks would be present on the site. For example, in the case of the critical indoor air exposure pathway for residential use of Building 3-A, the computed cumulative carcinogenic risk under those assumed drought conditions is 4.17×10^{-7} and the hazard index is 1.9×10^{-2}, which values are lower than the values of 4.5×10^{-7} and 2.2×10^{-2}, respectively, that were computed for the case of very high groundwater beneath the same building.

4.3 Results for Residential Use of All Buildings

To evaluate the heath risks at the subject property under conditions, however unlikely, that all the ground floors of all buildings on the site were to be used for residential purposes, the risk assessment analyses were, finally, computed for the case of an abnormally-high water table (*i.e.,* groundwater at a depth 2.26-ft. shallower than the conservatively-developed representative condition) and 100% residential use of both outdoor and indoor environments on the site. The results of those additional health risk assessments are shown in Table II-19.

As can be seen in the Table, the cumulative carcinogenic risk and the toxic hazard index for each of the buildings studied, even if the ground floors were all used for residential purposes, are well below the very low limiting values set for the project. In fact, the computed risks are, again, so low as to have little numerical meaning other than to demonstrate the absence of any health risks.

4.4 Summary

In summary, it can be stated that the health risk assessments conducted for the Andante Project site at 3992 San Pablo Avenue in Emeryville, California, demonstrate that there will be no increased health risk to occupants of the residences or commercial spaces that are being constructed on the property compared to those encountered by the general population.

Cumulative carcinogenic risks and toxic hazard indices computed for both conservatively-developed representative site conditions and for extreme scenarios were all considerably lower than the very conservative target risk limits set for the project. The risk assessments were made without consideration for natural attenuation of the concentrations of COCs in the subsurface which, because the sources of those chemicals (off-site leaking underground fuel storage tanks) have been removed, which will cause the concentrations of COCs in the limited volumes of soil and groundwater beneath the Andante Project site to fall steadily with time. Furthermore, in making the risk computations, no account was taken of the impermeable barriers placed below the floor slabs of the buildings (see Figures II-14 and II-15). This extremely-conservative approach to the risk assessments included exclusion of any consideration for the beneficial presence of the impermeable Liquid Boot® membranes that were placed beneath Buildings 1, 2-A and 3-A, which barriers act to exclude any gasses or vapors that might otherwise, however improbably, penetrate upward into the interior spaces of the buildings.

5.0 REFERENCES

American Industrial Health Council (1994), *Exposure Factors Sourcebook*. American Industrial Health Council, Washington, D.C., 1994.

American Society for Testing and Materials (2002), *E1739-95 (2002) Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. American Society for Testing and Materials, West Conshohocken, Pennsylvania. 2002.

American Society for Testing and Materials (2001), Practice *D543-95 Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents*. West Conshohocken, Pennsylvania, 2001.

American Society for Testing and Materials (2000a), *Standard Guide for Risk-Based Corrective Action*, ASTM Standard E2081-00, American Society for Testing and Materials, West Conshohocken, Pennsylvania. November 2000.

American Society for Testing and Materials (2000b), *Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites,* ASTM Standard E-1739-95 American Society for Testing and Materials, West Conshohocken, Pennsylvania, 2000.

American Society for Testing and Materials (2000c), *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft^3 (2,700 kN-m/m^3)),* ASTM Standard D1557-00, American Society for Testing and Materials, West Conshohocken, Pennsylvania, 2000.

American Society for Testing and Materials (1998a), *Standard Guide for Risk-Based Corrective Action,* ASTM Standard PS-104, American Society for Testing and Materials, Philadelphia, Pennsylvania, 1998.

American Society for Testing and Materials (1998b), *Standard Guide for Remediation by Natural Attenuation (RNA),* ASTM Standard E-1943, American Society for Testing and Materials, Philadelphia, Pennsylvania, 1998.

American Society for Testing and Materials (2000), *Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites,* ASTM Standard E-1739-95 American Society for Testing and Materials, Philadelphia, Pennsylvania, 2000.

American Society of Heating, Refrigerating and Air Conditioning Engineering (1981), *ASHRAE Handbook: 1981 Fundamentals*.

Apex Envirotech, Inc. (2003), *Results of Limited Subsurface Investigation - Andante Redevelopment Project, 3992 San Pablo Avenue, Emeryville, CA*. Report prepared for SNK Development Inc., March 3, 2003.

Bonnefous, Y. C., A. J. Gadgil, W. J. Fisk, R. J. Prill, A. R. Nematollahl (1992), "Field Study and Numerical Simulation of Subslab Ventilation Systems," *Environmental Science & Technology,* Vol. 26(9), pp. 1752-1759, 1992.

California Regional Water Quality Control Board - San Francisco Bay Region (2001), *Application of Risk-Based Screening Levels and Decision Making to Sites with Impacted Soil and Groundwater. Volume 1: Summary Tier 1 Lookup Tables.* Interim Final Document, December 2001.

California Regional Water Quality Control Board - San Francisco Bay Region (1999), *East Bay Plane Groundwater Basin Beneficial Use Evaluation Report - Alameda and Contra Costa Counties, C.,* California Regional Water Quality Control Board - San Francisco Bay Region Groundwater Committee. June 1999

Connor, J. A., R. L. Bowers, S. M. Paquette and C. J. Newell (1997), "Soil Attenuation Model for Derivation of Risk-based Soil Remediation Standards," proceedings of National Ground Water Association Petroleum Hydrocarbons Conference, Houston, TX, 1997.

Dietz Irrigation (2003a), *Contractor's Report of Remediation* - 3992 San Pablo Avenue, Emeryville, CA. Prepared for SNK Captec Andante LLC. June 2003.

Dietz Irrigation (2003b), *Addendum to Contractor's Report of Tank Closure* - 3992 San Pablo Avenue, Emeryville, CA. Prepared for SNK Captec Andante LLC. June 2003.

Dietz Irrigation (2003c), *Contractor's Report of Tank Closure* - 3992 San Pablo Avenue, Emeryville, CA. Prepared for SNK Development Inc. May 2003.

DeVaull, G. E., J. A. King, R. L. Lantzy and D. J. Fontaine (1994), *An Atmospheric Dispersion Primer: Accidental Releases of Gases, Vapors, Liquids, and Aerosols to the Environment*, American Institute of Chemical Engineers, New York, NY, p. 22.

DiPersio, T., J. Fitzgerald (1995), *Guidelines for the Design, Installation, and Operation of Sub-slab Depressurization Systems,* Massachusetts Department of Environmental Protection Northeast Regional Office, December 1995.

Fisher, L. J., L. M. Abriola, R. H. Kummler, D. T. Long and K. G. Harrison (2001), *Evaluation of the Michigan Department of Environmental Quality's Generic Groundwater Volatilization to Indoor Air Inhalation Criteria*, Michigan Environmental Sciences Board, Lansing, Michigan, May 2001.

Groundwater Services, Inc. (2003), *RBCA Toolkit for Chemical Releases, and RBCA Tool Kit for TRRP: Frequently Asked Questions.* Groundwater Services, Inc Web Site at http://www/gsi-net.com/Software/faq_rbca_chem.htm

Groundwater Services, Inc. (2000), Computer Software. *RBCA Toolkit for Chemical Releases, Version 1.3a*. Houston, Texas, 2000.

Guymon, G. L. (1994), *Unsaturated Zone Hydrology*. Prentice-Hall, Inc., New Jersey, 1994.

Hartman, B (2002), *Reevaluating the Upward Vapor Migration Risk Pathway*, LUSTLine Bulletin No. 41, pp 21-23, 2002

Howard, P. H., R. S. Boethling, W. F. Jarvis, W. M. Meylan and E. M. Michalenko (1991), *Handbook of Environmental Degradation Rates*, Lewis Publishers, Inc., Chelsea, MI, 1991.

Israeli, M. and Nelson, C. B. (1992), "Distribution and expected time of residence for U.S. households," *Risk Analysis*, Vol. 12(1):65-72

Johnson, P. C. and R. A. Ettinger (1991), "Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings," *Environmental Science and Technology*, Vol. 25, No 8, pp 1444-1452, 1991.

Kozlowski, Dan (2003), San Francisco Bay Area Climate Graphs: National Weather Service Website at http://www.wrh.noaa.gov/Monterey/tabular-rain.html.

Levine-Fricke (1994a), *Summary of Environmental Activities, Proposed 40th Street Extension, Emeryville, California.* Prepared for Catellus Development Corporation. Dated November 1984.

Levine-Fricke (1994b), *Report on Removal of Six Underground Fuel Storage Tanks and Associated Piping, Celis Alliance Fueling Station, 4000 San Pablo Avenue, Emeryville, California.* Prepared for Catellus Development Corporation. Dated July 1994.

Levine-Fricke (1994c), *Further Soil and Groundwater Investigation, Fuel Station, 40th Street Right-of-Way, Emeryville, California.* Prepared for Catellus Development Corporation. Dated March 1994.

Levine-Fricke (1993a), *Phase II Investigation Results, Proposed 40th Street Right-of-Way, Emeryville, California.* Prepared for Catellus Development Corporation. Dated September 1993.

Levine-Fricke (1993b), *Phase I Environmental Site Assessment, 40th Street Right-of-Way, Emeryville, California.* Prepared for Catellus Development Corporation. Dated June 1993.

Malander, Mark (2002), *Selection of Carcinogenic Target Risk Levels for Soil and Groundwater Remediation*, Office of Underground Storage Tanks, United States Environmental Protection Agency website at http://www.epa.gov/OUST/rbdm/sctrlsgw.htm, August 2002.

Nazaroff, W. W., S. R. Lewis, S. M. Doyle, B. A. Moed, A. V. Nero (1987), "Experiments on Pollutant Transport into Residential Basements by Pressure-Driven Airflow," *Environmental Science and Technology,* Vol. 21, pp. 459-466, 1987.

Newell, C. J., R. K. McLeod and J. R. Gonzales (1996), *BIOSCREEN Natural Attenuation Decision Support System User's Manual,* Air Force Center for Environmental Excellence, Brooks AFB, Texas, 1996.

San Francisco Bay Area Air Quality Management District (1997), Oakland Wind Rose Data. Available from Agency Office.

The San Joaquin Company Inc. (2003), *Remediation Work Plan, SNK Andante Project, 3992 San Pablo Avenue, Emeryville, California.* Report prepared for SNK Development Inc., March 2003.

The San Joaquin Company Inc. (2000), *Phase I Environmental Site Assessment - 3992 San Pablo Avenue, Emeryville, California: Andante Project.* Report prepared for SNK Development Inc., September 2000.

Spence, L. R., and M. M. Gomez (1999), *Oakland Benzene Partitioning Study: Synopsis.* Available from the City of Oakland Environmental Services Division.

Technical Advisory Committee, Oakland Urban Land Development Program (1996), Meeting. May 31, 1996.

United States Bureau of Labor Statistics (1988), *Labor Force Statistics Derived from the Current Population Survey, 1948-1987.* U.S. Department of Labor, Washington, D.C.

United States Environmental Protection Agency (1997), *Exposure Factors Handbook.* Office of Research and Development. Document No. EPA/600/P-95/002Fc.

United States Environmental Protection Agency (1996), *Soil Screening Guidance: Technical Background Document.* Office of Solid Waste and Emergency Response. Document No. EPA/540/R-95/128.

United States Environmental Protection Agency (1995a), Hazardous Waste Management System Toxicity Characteristics Revisions. *Federal Register* 55: 11798-11863.

United States Environmental Protection Agency (1995b), Review of Mathematical Modeling for Evaluating Soil Vapor Extraction Systems. Office of Research and Development Document No. EPA/540/R-95/513. 1995

United States Environmental Protection Agency (1992a), *Dermal Exposure Assessment: Principles and Applications, Interim Report.* Document No. 600/8-91/011B. 1992.

United States Environmental Protection Agency (1992b), *Supplemental Guidance to RAGS: Calculating the Concentration Term,* Publication 9285.7-08, 1992.

United States Environmental Protection Agency (1991a), *Risk Assessment Guidelines for Superfund, Volume I - Human Health Evaluation Manual, Part B: Development of Risk-Based Preliminary Remediation Goals,* Document No. EPA/540/R-92/003, NTIS No. PB92-963333.

United States Environmental Protection Agency (1991b), *Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors,* Interim Final. OSWER Directive 9285.5-03, NTIS No. PB91-921314.

United States Environmental Protection Agency (1989a), *Exposure Factors Handbook,* US-EPA Office of Health and Environmental Assessment. Document No. 600/8-89/043.

United States Environmental Protection Agency (1989b), *Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual, Part A.* Office of Emergency and Remedial Response. Document No. EPA/540/1-89/003.

United States Environmental Protection Agency (1988), *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources,* US-EPA Document No. 450/4-88/010, 1988.

United States Food and Drug Administration (1973), "Compounds Used in Food-producing animals." Criteria and Procedures for Evaluating Assays for Carcinogenic Residues in Edible Products of Animals. *Federal Register* 42: 10412-10437.

Woodward-Clyde International-Americas (1998a), Letter: Subject - *Request for Site Closure Former Celis Alliance Fuel Station at 4000 San Pablo Avenue, Emeryville California. Emeryville, California,* Xinggang Tong, PE to Ms Susan Hugo, Division of Environmental Health Services, Department of Environmental Health, Alameda County Health Agency. Dated October 15, 1998.

Woodward-Clyde International Americas (1998b), *Phase I Environmental Site Assessment for the King Midas Club, 3992 San Pablo Avenue, Emeryville, California.* Prepared for City of Emeryville Redevelopment Agency. 1998.

Woodward-Clyde Consultants (1997), *Proposed Approach for Development of Site-Specific Target Levels for Soil and Groundwater - 40th Street Right-of-Way, Emeryville, California.* Prepared for City of Emeryville Redevelopment Agency. Dated February 5, 1997.

Woodward-Clyde Consultants (1995), *Report on Soil Remediation at the Former Celis Alliance Fueling Station, 4000 San Pablo Avenue, Emeryville, California.* Prepared for City of Emeryville Redevelopment Agency. Dated January 6, 1995.

Woodward-Clyde Consultants (1994), *Workplan for Additional Site Investigation and Limited Soil Excavation - Former Celis Alliance Fuel Station at 4000 San Pablo Avenue, Emeryville California. Emeryville, California.* Prepared for the City of Emeryville Redevelopment Agency. Dated June 17, 1994.

Xu, M. and Y. Eckstein (1995), "Use of Weighted Least-Squares Method in Evaluation of the Relationship between Dispersivity and Scale," *Journal of Ground Water*, Vol. 33(6), p. 905-908, 1995.

TABLE II -1

RESULTS OF ANALYSES OF SOIL SAMPLES
FROM EXPLORATORY PUSH PROBE BORINGS [1]

Sample ID	Date Sampled	Depth BGS ft.	TPHd (diesel) mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	MTBE mg/Kg	Total Lead mg/Kg
AE GP-1@5'	02/05/03	5	ND	ND	ND	ND	ND	ND	ND	6.35
AE GP-2@5'	02/05/03	5	ND	ND	0.0093	ND	ND	ND	ND	8.83
AE GP-2@8'	02/05/03	8	69	**1,600**	**6.6**	**30**	19	150	ND	4.16
AE GP-3@5'	02/05/03	5	1.6	ND	0.0081	ND	0.014	ND	ND	6.70
AE GP-4@8'	02/05/03	8	34	400	**1.6**	1.9	7.7	35	ND	4.58
AE GP-5@5'	02/05/03	5	130	42	0.17	0.013	0.69	0.48	ND	8.07
AE GP-5@10'	02/05/03	10	1.2	31	**0.31**	ND	0.53	1.7	0.0086	3.80
AE GP-6@5'	02/05/03	5	ND	ND	ND	ND	ND	ND	ND	10.3
AE GP-6@11'	02/05/03	11	ND	ND	ND	ND	ND	ND	ND	6.03
AE GP-7@5'	02/05/03	5	13	1.8	ND	0.0061	0.019	0.0055	ND	10.3
AE GP-7@10'	02/05/03	10	11	25	0.12	ND	1.2	0.23	0.0069	5.42
AE GP-8@10'	02/05/03	10	3.4	ND	ND	ND	ND	ND	ND	3.01
AE GP-9@5'	02/05/03	5	**1,100**	**12,000**	**19**	**270**	**230**	**1,300**	0.061	16.7
AE GP-10@6'	02/05/03	6	**420**	**870**	**3.0**	8.8	9.3	46	ND	8.41
AE GP-11@5'	02/05/03	5	6.2	**4,900**	**3.3**	61	**92**	**590**	ND	7.92
AE GP-11@10'	02/05/03	10	**630**	26	**0.34**	0.5	0.61	2.5	ND	6.84
AE GP-12@8'	02/05/03	8	ND	ND	ND	ND	ND	ND	ND	6.05
AE GP-13@8'	02/05/03	8	1.5	40	**0.66**	ND	1.6	3.2	0.0075	2.83
AE GP-16@5'	02/05/03	5	1.4	1.3	ND	ND	ND	ND	ND	5.57
AE GP-17@5'	02/05/03	5	ND	ND	ND	ND	ND	ND	ND	5.06
AE GP-18@5'	02/05/03	5	ND	ND	ND	ND	ND	ND	ND	6.52
AE GP-18@10'	02/05/03	10	15	ND	ND	ND	ND	ND	ND	2.17
AE GP-21@7'	02/05/03	7	ND	ND	ND	ND	ND	ND	ND	6.10
AE GP-22@7'	02/05/03	7	ND	ND	ND	ND	ND	ND	ND	4.46
AE GP-23@7'	02/05/03	7	41	ND	ND	ND	ND	ND	ND	4.58
AE GP-24@7'	02/05/03	7	140	ND	ND	ND	ND	ND	ND	4.28
AE GP-25@7'	02/05/03	7	54	ND	ND	ND	ND	ND	ND	4.58
AE GP-26@5'	02/05/03	5	ND	ND	ND	ND	ND	ND	ND	5.31
AE GP-27@5'	02/05/03	5	ND	ND	ND	ND	ND	ND	ND	4.14
AE GP-28@5'	02/05/03	5	ND	ND	ND	ND	ND	ND	ND	3.73
AE GP-29@5'	02/05/03	5	ND	ND	ND	ND	ND	ND	ND	5.05

Notes:

(1) Data Source Apex Envirotech, Inc. Subsurface Results Report, Table 1

(2) ND = Not Detected above the Method Detection Limit (MDL).

(3) Concentrations in **bold** script exceed the San Francisco Bay Area RWQCB's limits for human health risk used to establish residential RBSLs for chemicals in porous soils at sites where groundwater is not a source of drinking water.

TABLE II-2

RESULTS OF ANALYSES OF SOIL SAMPLES RECOVERED FROM EXPLORATORY TRENCHES, TANK PITS AND TEMPORARY WELLS

Sample ID	Date Sampled	Depth BGS ft.	TPHd (diesel) mg/Kg	Mineral Spirits mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	TBA mg/Kg	MTBE mg/Kg	TAME mg/Kg	DIPE mg/Kg	ETBE mg/Kg	1,2-DCA mg/Kg	EDB mg/Kg	Ethanol mg/Kg	PNA (Napthalene) mg/Kg	Total Lead mg/Kg
ET2-N-6.5	03/24/03	6.5	110 [3]	n/a [2]	**510** [5]	**1.1**	3.7	10	65	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a
ET2-N-9	03/24/03	9.0	46 [3]	n/a	400	**2.8**	8.2	7.9	45	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a
ET2-S-7	03/24/03	7.0	ND [1]	n/a	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		n/a	n/a
ET1-S-6	03/25/03	6.0	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a		n/a	n/a
ET3-E-8	03/25/03	8.0	1.2	n/a	1.2	0.030	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a		n/a	n/a
Tank 1 - N	04/29/03	10.0	ND	54	31 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	5.6
Tank 1 - S	04/29/03	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	2.4
Tank 1P - 20N	04/29/03	3.0	230 [3]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a
Tank 1P - 40N	04/29/03	3.0	1.2 [3]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a
Tank 3	05/22/03	7.8	ND	ND	n/a	ND	ND	ND	ND	0.0080	0.0081	ND	ND	ND	ND	ND	n/a	n/a	n/a
SJC-MW-T1-7.5	04/11/03	7.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T1-11.5	04/11/03	11.5	3.5 [3]	ND [3]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T2-8	04/11/03	8.0	18	ND [3]	250	**1.4**	3.5	5.2	27	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T2A-5	04/11/03	5.0	130	ND [3]	**660**	ND	1.4	9.9	75	ND	ND	ND	ND	ND	n/a	n/a		**1.8**	n/a
SJC-MW-T2A-9	04/11/03	9.0	8.3	ND [3]	**500**	**0.5**	0.5	0.5	2	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T2A-15.5	04/11/03	15.5	6.1	ND [3]	ND	ND	ND	ND	0.012	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T2A-19.5	04/11/03	19.5	1.2	ND [3]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T3-8	04/11/03	8.0	2.4	ND [3]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T3-12	04/11/03	12.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a		n/a	n/a
SJC-MW-T4-8	04/11/03	8.0	12	ND [3]	ND	ND	ND	ND	1.8	0.01	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T4A-5	04/11/03	5.0	2.9	ND [3]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T4A-12	04/11/03	12.0	14	ND [3]	76	ND	ND	0.98	3.1	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T4A-15.5	04/11/03	15.5	4.2	ND [3]	ND	ND	ND	ND	ND	ND	0.0052	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T4A-20	04/11/03	20.0	4.6	ND [3]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T5-5	04/11/03	5.0	34	ND [3]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T5-7.5	04/11/03	7.5	12	ND [3]	ND	ND	ND	0.57	2.4	ND	ND	ND	ND	ND	n/a	n/a		ND	n/a
SJC-MW-T5A-5	04/11/03	5.0	9.3	ND [3]	ND	0.0086	ND	0.019	ND	0.0068	ND	ND	ND	ND	n/a	n/a		0.29	n/a
SJC-MW-T5A-10	04/11/03	10.0	71	ND [3]	**1,500**	**4.40**	17.0	26.0	150.0	ND	ND	ND	ND	ND	n/a	n/a		0.35	n/a
SJC-MW-T5A-15.5	04/11/03	15.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a		n/a	n/a

Sample ID	Date Sampled	Depth BGS ft.	TPHd (diesel) mg/Kg	Mineral Spirits mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	TBA mg/Kg	MTBE mg/Kg	TAME mg/Kg	DIPE mg/Kg	ETBE mg/Kg	1,2-DCA mg/Kg	EDB mg/Kg	Ethanol mg/Kg	PNA (Napthalene) mg/Kg	Total Lead mg/Kg
SJC-MW-T5A-19.5	04/11/03	19.5	ND	ND	ND	ND	ND	ND	0.011	ND	0.014	ND	ND	ND	n/a	n/a		n/a	n/a
SJC-MW-T6-5	04/11/03	5.0	48	ND [3]	**1,300**	**4.2**	15	23	140	ND	ND	ND	ND	ND	n/a	n/a		**1.1**	n/a
SJC-MW-T6-11.5	04/11/03	11.5	20	ND [3]	180	ND	ND	2.3	120	ND	ND	ND	ND	ND	n/a	n/a		0.50	n/a
SJC-MW-T7-7.5	04/11/03	7.5	37	ND [3]	**2,000**	**9.1**	**41**	35	**230**	ND	ND	ND	ND	ND	n/a	n/a		0.91	n/a
SJC-MW-T7-11.5	04/11/03	11.5	150	ND [3]	**1,600**	**8.2**	**33**	31	200	ND	ND	ND	ND	ND	n/a	n/a		**2.1**	n/a

Notes:

(1) ND = Not Detected above the Method Detection Limit (MDL).

(2) n/a = Not analyzed

(3) The laboratory reports that the detected hydrocarbon does not match its Diesel standard. The hydrocarbon detected appears to be a mixture of Diesel and Mineral Spirits, but the components of the mixture, all of which were in the Diesel range, were insufficiently distinct to quantify them separately.

(4) Does not match laboratory's standard for gasoline.

(5) Concentrations in **bold** script exceed the San Francisco Bay Area RWQCB's limits for human health risk used to establish residential RBSLs for chemicals in porous soils at sites where groundwater is not a source of drinking water.

TABLE II - 3

RESULTS OF ANALYSES OF GROUNDWATER SAMPLES RECOVERED FROM EXPLORATORY TRENCHES AND TEMPORARY WELLS

Sample ID	Date Sampled	TPHd (diesel) µg/L	Mineral Spirits µg/L	TPHg (gasoline) µg/L	Benzene µg/L	Toluene µg/L	Ethyl-benzene µg/L	Total Xylenes µg/L	TBA µg/L	MTBE µg/L	TAME µg/L	DIPE µg/L	ETBE µg/L	1,2-DCA µg/L	EDB µg/L	Ethanol µg/L	PNA (Naphthalene) µg/L
ET2-C-W	03/24/03	**20,000** [3]	n/a	**510,000**	1,100	3,700	10,000	65,000	ND [1]	ND	ND	ND	ND	ND	ND	ND	n/a [2]
SJC-MW-T1	04/16/03	380 [4]	ND	280	1.7	ND	0.54	ND	ND	6.3	ND	ND	ND	ND	ND	ND	n/a
SJC-MW-T2	04/16/03	**7,900** [4]	ND	**33,000**	460	1,200	1,300	8,300	ND	15	ND	ND	ND	ND	ND	ND	n/a
SJC-MW-T2A	04/16/03	**6,700** [4]	ND	**63,000**	1,400	2,000	3,300	17,000	ND	ND	ND	ND	ND	ND	ND	ND	n/a
SJC-MW-T3	04/16/03	320 [4]	ND	ND	ND	0.71	ND	ND	ND	0.59	ND	ND	ND	ND	ND	ND	n/a
SJC-MW-T4	04/16/03	360 [4]	ND	670	94	1.9	83	120	ND	0.93	ND	ND	ND	ND	ND	ND	n/a
SJC-MW-T4A	04/16/03	740 [4]	ND	**5,700**	120	4	630	790	ND	78	ND	ND	ND	ND	ND	ND	n/a
SJC-MW-T5	04/16/03	320 [4]	ND	610	130	2.1	54	90	ND	1.4	ND	ND	ND	ND	ND	ND	n/a
SJC-MW-T5A	04/16/03	**5,400** [4]	ND	**34,000**	2,700	2,200	2,100	9,000	ND	ND	ND	ND	ND	ND	ND	ND	n/a
SJC-MW-T6	04/16/03	4,500 [4]	ND	**24,000**	1,900	1,900	1,100	6,200	ND	ND	ND	ND	ND	ND	ND	ND	n/a
SJC-MW-T7	04/16/03	**6,100** [4]	ND	**45,000**	3,400	4,800	1,700	9,300	ND	ND	ND	ND	ND	ND	ND	ND	n/a
30S-40E (Water)	05/15/03	3,200 [4]	ND	**23,000**	1,500	2,400	730	3,700	ND	74	ND	ND	ND	ND	ND	ND	140

Notes:

(1) ND = Not Detected above the Method Detection Limit (MDL).

(2) n/a = Not Analyzed.

(3) Chromatogram for this sample indicates that the only analyte in the C_8 to C_{24} range is Mineral Spirits.

(4) The laboratory reports that the detected hydrocarbon does not match its Diesel Standard.

(5) Concentrations in **bold** script exceed the San Francisco Bay Area RWQCB's limits for human health risk used to establish residential RBSLs for chemicals in fine-grained soils at sites where groundwater is not a source of drinking water.

TABLE II - 4

RESULTS OF ANALYSES OF SOIL SAMPLES FROM REMEDIAL EXCAVATION AT FORMER CELI'S ALLIANCE SERVICE STATION 4000 SAN PABLO AVENUE

Note: All the samples cited in this table were recovered from a depth of approximately 9.5 ft BGS.

Sample ID	TRPH mg/Kg	TPHd (diesel) mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg
Samples Recovered from Walls of Excavation [3]							
WC N-1	ND	21	**920**	**2.6**	21	11	57
WC N-2	ND	10	250	0.097	0.83	2.5	11
WC N-3	ND	96	390	**0.38**	3	3.6	17
WC N-4	160	310	85	0.16	ND	1.0	1.3
WC W-1 [5]	ND	ND	ND	ND	ND	ND	ND
WC W-2	ND	34	230	**0.34**	0.61	2.3	6.9
WC W-3	ND	180	20	0.012	0.01	0.029	0.043
WC W-4	150	**500**	80	ND	0.073	0.26	0.99
WC S-1 [5]	n/a	n/a	**800**	**1.7**	6	9.9	41
WC S-2 [5]	ND	60	430	**0.4**	0.2	4	12
WC S-3 [5]	n/a	n/a	**730**	**1.4**	ND	11	1.7
WC S-4 [5]	ND	25	**560**	ND	ND	5.6	13
WC E-1	n/a	n/a	240	**0.33**	3.5	3.4	16
WC E-2	ND	2	170	**0.81**	3.4	1.8	8.9
WC E-3	n/a	n/a	**660**	**2.9**	18	9.2	46
WC E-4 [5]	ND	5.2	380	**2.6**	12	4.9	24
Samples Recovered From Floor of Excavation [4]							
WC B-C-1	ND	68	260	0.081	0.11	2	8.4
WC B-O&G-1	ND	160	490	**2.4**	9.9	6.3	27
WC B-D-1	15,000	**18,000**	**650**	**3.8**	1.7	8.1	17
WC B-G-1 [5]	120	ND	**540**	**0.64**	ND	6.5	12
WC B-C-2 [5]	ND	75	**1,000**	**2.4**	10	11	49
WC B-C-3	ND	29	**690**	**2.2**	15	7.3	39

Notes:

(1) Data: Woodward-Clyde Consultants, Remediation Report, January 1995, Figure 4.
(2) ND = Not Detected above the Method Detection Limit (MDL).
(3) Soil samples recovered from approx. 8 ft. B.G.S.
(4) Floor of excavation approx. 9.5 ft. B.G.S.
(5) Sampling location near property boundary shared with 3992 San Pablo Avenue.
(6) n/a = Not Analyzed.
(7) Concentrations in **bold** script exceed the San Francisco Bay Area RWQCB's limits for human health risk used to establish residential RBSLs for chemicals in porous soils at sites where groundwater is not a source of drinking water.

TABLE II-5

RESULTS OF ANALYSES OF SOIL SAMPLES RECOVERED FROM 40TH STREET RIGHT-OF-WAY, EMERYVILLE, CALIFORNIA

Sample ID	Date Sampled	Depth BGS	TRPH [2]	TPHd Diesel	TPHg (gaso-line)	TPHmo (motor oil)	Ben-zene	Toluene	Ethyl-ben-zene	Total Xylenes	Methy-lene Chloride	Alaclor 1260	Naphth-alene	2-Methyl-naphth-alene	4-Methyl-phenol
		ft.	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*
LFSB1-7.0	08/08/93	7	290	240	850	27	5.4	ND [4]	25	42	n/a [3]	n/a	n/a	n/a	n/a
LFSB1-9.5	08/08/93	9.5	130	220	180	ND	0.89	1.1	4.3	18	n/a	n/a	n/a	n/a	n/a
LFSB1-14.5	08/08/93	14.5	60	ND	7.4	ND	0.44	0.44	0.14	0.61	n/a	n/a	n/a	n/a	n/a
LFSB2-7.0	08/08/93	7	160	790	780	57	8	ND	31	140	n/a	ND	n/a	n/a	n/a
LFSB2-9.5	08/08/93	9.5	210	200	720	ND	2.4	5.2	15	59	n/a	n/a	n/a	n/a	n/a
LFSB2-14.5	08/08/93	14.5	43	ND	1	12	0.2	0.21	0.021	0.12	n/a	ND	n/a	n/a	n/a
LFSB3-9.5	08/07/93	9.5	37	11	580	ND	9.7	50	15	90	n/a	ND	n/a	n/a	n/a
LFSB3-14.5	08/07/93	14.5	37	ND	0.9	ND	0.092	0.16	0.031	0.17	n/a	ND	n/a	n/a	n/a
LFSB4-7.0	08/08/93	7	70	13	380	ND	3	5.2	8.2	18	n/a	n/a	n/a	n/a	n/a
LFSB4-14.5	08/08/93	14.5	210	ND	ND	ND	0.026	0.005	0.019	0.023	n/a	n/a	n/a	n/a	n/a
LFSB5-7.0	08/08/93	7	37	15	410	ND	2.4	0.6	16	6.3	n/a	n/a	n/a	n/a	n/a
LFSB5-14.5	08/08/93	14.5	93	ND	ND	ND	0.011	ND	0.008	0.008	n/a	n/a	n/a	n/a	n/a
LFSB6-9.5	08/08/93	9.5	67	51	490	ND	2.7	ND	15	15	n/a	n/a	n/a	n/a	n/a
LFSB6-14.5	08/08/93	14.5	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LFSB7-9.5	08/07/93	9.5	170	52	750	66	2.5	8.5	22	93	n/a	n/a	n/a	n/a	n/a
LFSB7-14.5	08/07/93	14.5	ND	ND	2.8	ND	ND	ND	0.029	0.03	n/a	n/a	n/a	n/a	n/a
LFSB8-9.5	08/08/93	9.5	130	110	2,800	ND	22	9.5	82	290	n/a	n/a	n/a	n/a	n/a
LFSB8-14.5	08/08/93	14.5	37	ND	ND	11	0.009	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LFSB9-7.0	08/07/93	7	ND	14	210	ND	2.8	13	5.1	29	n/a	n/a	n/a	n/a	n/a
LFSB9-9.5	08/07/93	9.5	n/a	n/a	1,200	n/a	14	81	26	140	n/a	n/a	n/a	n/a	n/a
LFSB9-14.5	08/07/93	14.5	77	ND	ND	ND	0.079	0.059	0.011	0.041	n/a	n/a	n/a	n/a	n/a
LFSB10-7.0	08/07/93	7	n/a	n/a	73	n/a	2.6	4.7	1.6	7.7	n/a	n/a	n/a	n/a	n/a
LFSB10-9.5	08/07/93	9.5	40	ND	1,100	ND	ND	7.8	ND	22	n/a	n/a	n/a	n/a	n/a
LFSB10-14.5	08/07/93	14.5	ND	ND	8.6	ND	0.48	0.29	0.1	0.48	n/a	n/a	n/a	n/a	n/a

Sample ID	Date Sampled	Depth BGS	TRPH [2]	TPHd Diesel	TPHg (gaso-line)	TPHmo (motor oil)	Ben-zene	Toluene	Ethyl-ben-zene	Total Xylenes	Methy-lene Chloride	Alaclor 1260	Naphth-alene	2-Methyl-naphth-alene	4-Methyl-phenol
		ft.	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*
LFSB11-14.5	08/09/93	14.5	40	ND	ND	11	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LFSB12-1.0	08/09/93	1	**4,600**	ND	ND	400	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB12-3.0	08/09/93	3	420	**560**	**6,500**	64	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB13-5.0	08/09/93	5	63	ND	23	ND	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB13-6.5	08/09/93	6.5	37	ND	13	ND	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB14-2.0	08/09/93	2	**2,200**	ND	42	480	n/a	n/a	n/a	n/a	n/a	0.22	n/a	n/a	n/a
LFSB14-4.5	08/09/93	4.5	47	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB15-4.5	08/09/93	4.5	480	140	**4,700**	12	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB15-6.0	08/09/93	6	120	59	**3,700**	14	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB16-4.5	08/09/93	4.5	60	ND	9	ND	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB16-6.0	08/09/93	6	53	ND	8	ND	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB17-4.5	08/09/93	4.5	70	40	260	ND	ND	22	12	69	**2.6**	ND	1.6	1.8	0.4
LFSB17-6.0	08/09/93	7	50	70	440	ND	ND	27	8	43	**2.0**	ND	0.57	0.63	ND
LFSB17-12.0	08/09/93	12	47	130	**500**	190	**190**	9	4	23	**0.660**	ND	**1.7**	1.8	ND
LFSB18-1.0	08/09/93	1	**2,200**	ND	1	320	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB18-3.0	08/09/93	3	**1,100**	ND	ND	390	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB19-1.5	08/09/93	1.5	**2,200**	ND	ND	530	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LFSB19-3.0	08/09/93	3	**3,600**	ND	1	**740**	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a
LF-1-4.5	08/07/93	4.5	77	220	**550**	16	**0.84**	1.2	5.6	2.7	n/a	n/a	n/a	n/a	n/a
LF-1-9.5	08/07/93	9.5	ND [4]	18	470	ND	**0.97**	ND	6.6	8.9	n/a	n/a	n/a	n/a	n/a
LF-1-14.5	08/07/93	14.5	60	16	8.4	ND	0.14	0.17	0.081	0.37	n/a	n/a	n/a	n/a	n/a
LF-2-9.5	08/07/93	9.5	30	14	**740**	ND	**4.70**	35	13	68	n/a	n/a	n/a	n/a	n/a
LF-2-14.5	08/07/93	14.5	ND	ND	ND	ND	0.009	0.012	ND	0.015	n/a	n/a	n/a	n/a	n/a
LF-3-9.5	08/07/93	9.5	37	ND	75	ND	0.062	0.28	1.1	1.1	n/a	n/a	n/a	n/a	n/a
LF-3-14.5	08/07/93	14.5	ND	ND	ND	ND	0.014	ND	0.01	0.007	n/a	n/a	n/a	n/a	n/a
LF-B1-2	08/30/94	2	ND	ND	0.8	n/a	0.008	ND	0.016	0.085	n/a	n/a	n/a	n/a	n/a
LF-B1-5	08/30/94	5	30	ND	110	n/a	**0.840**	0.520	3.200	12	n/a	n/a	n/a	n/a	n/a
LF-B1-10	08/30/94	10	30	ND	**690**	n/a	**12**	**50**	18	99	n/a	n/a	n/a	n/a	n/a
LF-B2-2	08/30/94	2	10	ND	110	n/a	**0.6**	2.9	3.3	16	n/a	n/a	n/a	n/a	n/a
LF-B2-5	08/30/94	5	10	1	66	n/a	**0.37**	0.8	0.79	3.5	n/a	n/a	n/a	n/a	n/a
LF-B2-10	08/30/94	10	30	ND	**830**	n/a	**13**	**52**	21	110	n/a	n/a	n/a	n/a	n/a
LF-B3-2	08/30/94	2	80	ND	440	n/a	**8.5**	36	12	58	n/a	n/a	n/a	n/a	n/a
LF-B3-5	08/30/94	5	200	8	**810**	n/a	**14**	**62**	22	100	n/a	n/a	n/a	n/a	n/a

Sample ID	Date Sampled	Depth BGS ft.	TRPH [2] mg/Kg	TPHd Diesel mg/Kg	TPHg (gaso-line) mg/Kg	TPHmo (motor oil) mg/Kg	Ben-zene mg/Kg	Toluene mg/Kg	Ethyl-ben-zene mg/Kg	Total Xylenes mg/Kg	Methy-lene Chloride mg/Kg	Alaclor 1260 mg/Kg	Naphth-alene mg/Kg	2-Methyl-naphth-alene mg/Kg	4-Methyl-phenol mg/Kg
LF-B3-10	08/30/94	10	50	ND	390	n/a	**7.1**	22	7.2	38	n/a	n/a	n/a	n/a	n/a
LF-B4-2	08/30/94	2	40	ND	49	n/a	0.14	0.12	2.3	11	n/a	n/a	n/a	n/a	n/a
LF-B4-5	08/30/94	5	**1,300**	28	**8,800**	n/a	**6.8**	7.3	**190**	**870**	n/a	n/a	n/a	n/a	n/a
LF-B4-10	08/30/94	10	110	3	**510**	n/a	**1.1**	0.96	3.4	13	n/a	n/a	n/a	n/a	n/a
LF-B5-2	08/30/94	2	10	ND	0.4	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B5-5	08/30/94	5	**2,400**	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B5-10	08/30/94	10	ND	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B6-2	08/30/94	2	20	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B6-5	08/30/94	5	10	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B6-10	08/30/94	10	ND	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B7-2	08/30/94	2	10	ND	27	n/a	**0.42**	ND	0.75	0.05	n/a	n/a	n/a	n/a	n/a
LF-B7-5	08/30/94	5	ND	ND	16	n/a	**0.67**	ND	ND	0.025	n/a	n/a	n/a	n/a	n/a
LF-B7-10	08/30/94	10	20	ND	**520**	n/a	**7.4**	**30**	14	78	n/a	n/a	n/a	n/a	n/a
LF-B8-2	08/30/94	2	50	5	3.4	n/a	**0.2**	ND	0.56	0.02	n/a	n/a	n/a	n/a	n/a
LF-B8-5	08/30/94	5	ND	ND	14	n/a	**0.3**	0.01	0.26	ND	n/a	n/a	n/a	n/a	n/a
LF-B8-10	08/30/94	10	20	ND	140	n/a	**2.1**	5.8	4	21	n/a	n/a	n/a	n/a	n/a
LF-B9-2	08/30/94	2	20	ND	2.8	n/a	**0.33**	0.005	0.41	0.07	n/a	n/a	n/a	n/a	n/a
LF-B9-5	08/30/94	5	ND	ND	40	n/a	**1.2**	0.013	2.6	0.15	n/a	n/a	n/a	n/a	n/a
LF-B9-10	08/30/94	10	20	ND	190	n/a	**4.3**	11	5.5	28	n/a	n/a	n/a	n/a	n/a
LF-B10-2	08/30/94	2	150	ND	29	n/a	0.038	0.048	0.18	1.2	n/a	n/a	n/a	n/a	n/a
LF-B10-5	08/30/94	5	30	ND	13	n/a	ND	0.02	0.05	ND	n/a	n/a	n/a	n/a	n/a
LF-B10-10	08/30/94	10	ND	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B11-2	08/30/94	2	20	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B11-5	08/30/94	5	ND	ND	1	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B11-10	08/30/94	10	40	ND	250	n/a	**1.1**	0.35	4.4	21	n/a	n/a	n/a	n/a	n/a
	08/30/94	2	30	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B12-5	08/30/94	5	ND	ND	0.9	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B12-10	08/30/94	10	30	ND	160	n/a	**0.97**	0.19	4.1	20	n/a	n/a	n/a	n/a	n/a
LF-B13-2	08/30/94	2	**600**	220	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B13-5	08/30/94	5	40	10	4.2	n/a	ND	ND	0.02	ND	n/a	n/a	n/a	n/a	n/a
LF-B13-10	08/30/94	10	20	3	6.9	n/a	**0.36**	ND	0.45	0.13	n/a	n/a	n/a	n/a	n/a
LF-B14-2	08/30/94	2	410	ND	ND	n/a	ND	ND	ND	ND	0.670	n/a	n/a	n/a	n/a
LF-B14-5	08/30/94	5	ND	ND	1.6	n/a	0.01	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B14-10	08/30/94	10	ND	ND	2.9	n/a	0.006	ND	0.01	ND	**1.1**	n/a	n/a	n/a	n/a
LF-B15-2	08/30/94	2	420	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a

Andante Project, 3992 San Pablo Ave., Emeryville, CA

Sample ID	Date Sampled	Depth BGS	TRPH [2]	TPHd Diesel	TPHg (gaso-line)	TPHmo (motor oil)	Ben-zene	Toluene	Ethyl-ben-zene	Total Xylenes	Methy-lene Chloride	Alaclor 1260	Naphth-alene	2-Methyl-naphth-alene	4-Methyl-phenol
		ft.	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*	*mg/Kg*
LF-B15-5	08/30/94	5	ND	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B15-10	08/30/94	10	20	ND	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B16-2	08/30/94	2	50	10	ND	n/a	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a
LF-B16-5	08/30/94	5	ND	ND	28	n/a	0.16	ND	0.96	0.037	n/a	n/a	n/a	n/a	n/a
LF-B16-10	08/30/94	10	20	ND	130	n/a	**2.5**	5.4	2.6	15	n/a	n/a	n/a	n/a	n/a

Notes:

(1) Data Source: Levine-Fricke (1994a)
(2) TRPH = Total Recoverable Petroleum Hydrocarbons
(3) n/a = Not Analyzed
(4) ND = Not Detected above the Method Detection Limit (MDL).
(5) Concentrations in **bold** script exceed the San Francisco Bay Area RWQCB's limits for human health risk used to establish residential RBSLs for chemicals in porous soils at sites where groundwater is not a source of drinking water.

TABLE II-6

RESULTS OF ANALYSES OF GROUNDWATER SAMPLES RECOVERED FROM
40TH STREET RIGHT-OF-WAY, EMERYVILLE, CALIFORNIA

Sample ID	Date Sampled	TRPH [2] µg/L	TPHd (diesel) µg/L	TPHg (gasoline) µg/L	TPHmo (motor oil) µg/L	Benzene µg/L	Toluene µg/L	Ethyl-benzene µg/L	Total Xylenes µg/L	MTBE µg/L	PNA (Napthalene) µg/L
LF-1AG	08/07/93	**11,000**	**41,000**	**100,000**	ND	**13,000**	9,400	3,100	14,000	n/a	n/a
LF-2AG	08/07/93	ND [3]	95	**13,000**	ND	**2,400**	2,900	500	2,000	n/a	n/a
LF-3AG	08/07/93	ND	780	**11,000**	ND	**1,500**	170	2,900	5,100	n/a	n/a
WCEW-1	09/26/97	n/a [4]	**41,000**	**180,000**	ND	**2,800**	4,900	3,100	12,000	ND	120
	12/05/97	n/a	95	**4,700**	ND	**2,100**	1,800	2,500	10,000	340	170
	03/13/98	n/a	780	**7,700**	ND	**2,500**	1,300	1,000	3,400	570	420
	06/02/98	n/a	780	**3,400**	**550**	**2,100**	460	910	2,990	350	1,000

Notes:

(1) Data Sources: Levine-Fricke (1994c), Woodward-Clyde International-Americas (1998a)
(2) TRPH = Total Recoverable Petroleum Hydrocarbons
(3) ND = Not Detected above the Method Detection Limit (MDL).
(4) n/a = Not Analyzed.
(5) Concentrations in **bold** script exceed the San Francisco Bay Area RWQCB's limits for human health risk used to establish residential RBSLs for chemicals in porous soils at sites where groundwater is not a source of drinking water.

SJC

TABLE II-7

RESULTS OF ANALYSES OF CONFIRMATION SOIL SAMPLES RECOVERED FROM REMEDIAL EXCAVATION

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	Mineral Spirits mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	TBA mg/Kg	MTBE mg/Kg	TAME mg/Kg	DIPE mg/Kg	ETBE mg/Kg	1,2-DCA mg/Kg	EDB mg/Kg	Etha-nol mg/Kg	PNA (Naphthalene) mg/Kg
0S-40E	05/09/03	30.90	9.62	110[3]	n/a	150	ND	ND	ND	13	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-40E Wall (N)	05/15/03	31.90	8.62	3.9[3]	n/a	**540**	ND	ND	8.8	45	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-60E	05/09/03	32.40	8.08	69[3]	n/a	**2,300**	ND	37	44	**240**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-60E Wall (N))	05/15/03	33.40	7.08	10[3]	n/a	320	ND	ND	4.2	14	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-80E	05/09/03	31.90	8.94	8.1	n/a	**870**	**6.0**	15	16	79	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-80E Wall (N)	05/15/03	32.90	7.94	31[3]	n/a	**630**	ND	13	11	74	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-100E	05/16/03	30.84	10.21	21[3]	n/a	**890**	ND	20	17	100	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-100E Wall (N)	05/16/03	31.84	9.21	21[3]	n/a	**1,200**	ND	30	29	160	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-120E	05/14/03	31.10	10.16	7.2	n/a	1.74	0.031	ND	0.037	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-120E Wall (N)	05/15/03	32.10	9.16	66[3]	n/a	**1,100**	**8.1**	ND	17	100	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-140E	05/14/03	31.29	10.35	140[3]	n/a	90[4]	ND	ND	2.3	1.1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-180E	05/12/03	33.99	8.51	37[3]	n/a	110[4]	ND	ND	1.6	1.4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
0S-200E	05/06/03	33.95	8.96	2.9[3]	ND	5.9	0.036	ND	0.13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0S-220E	05/06/03	34.20	8.75	2.5[3]	ND	9.6	**0.21**	ND	0.68	0.058	ND	ND	ND	ND	ND	ND	ND	ND	ND
0S-230E Wall(N)Sand	05/28/03	33.20	9.89	34[3]	ND	450	ND	0.76	0.86	37	ND	ND	ND	ND	ND	ND	ND	ND	3.8
10S-225E Wall (E)	05/27/03	33.20	9.83	ND	n/a	ND	ND	ND	0.013	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-10E	05/09/03	30.44	10.78	2.1[3]	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-10E Wall (N)	05/09/03	31.44	9.78	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-20E	05/13/03	33.86	5.80	69[3]	n/a	350	ND	2.0	6.0	30	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-40E	05/11/03	31.25	9.27	28	n/a	200	**2.3**	8.1	3.9	19	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a
20S-60E	05/11/03	32.75	7.73	40	n/a	**860**	**9.9**	30	14	79	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-100E	05/16/03	30.44	10.64	48[3]	n/a	**2,000**	**18**	43	39	190	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Andante Project, 3992 San Pablo Ave., Emeryville, CA

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	Mineral Spirits mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	TBA mg/Kg	MTBE mg/Kg	TAME mg/Kg	DIPE mg/Kg	ETBE mg/Kg	1,2-DCA mg/Kg	EDB mg/Kg	Etha-nol mg/Kg	PNA (Naphthalene) mg/Kg
20S-120E	05/12/03	31.15	10.14	16 [3]	n/a	1,100	6.4	22	19	93	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-140E	05/14/03	31.29	10.81	120 [3]	n/a	2,000 [4]	ND	ND	62	110	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-140E (Deep)	05/27/03	30.45	11.65	70 [3]	n/a	2,000	7.8	ND	38	87	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-160E	05/13/03	31.10	11.00	84 [3]	n/a	460	ND	ND	7.2	32	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-160E (Deep)	05/13/03	28.26	13.50	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-180E	05/12/03	34.18	8.01	6.5 [3]	n/a	730	5	ND	14	49	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-180E(A)	05/27/03	33.26	8.93	2.8 [3]	n/a	ND	ND	ND	ND	0.02	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-200E	05/07/03	35.44	7.50	2.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
20S-220E	05/09/03	34.48	8.50	1.7	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20S-220E Wall (E)	05/09/03	35.48	7.50	2.1 [3]	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
30S-40E (13.6)	05/15/03	26.92	13.60	2.1 [3]	ND	ND	ND	ND	ND	ND	0.0051	ND	ND	ND	ND	ND	ND	ND	ND
30S-40E (15.0)	05/15/03	24.52	15.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
35S-200E	05/09/03	34.45	8.46	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
35S-200E Wall (S)	05/09/03	35.45	7.47	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-0E	05/09/03	34.73	4.97	1.5 [3]	n/a	ND	ND	ND	ND	0.057	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-0E Wall (W)	05/09/03	35.73	3.97	ND	n/a	ND	ND	ND	ND	0.018	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-20E	05/13/03	32.46	7.67	140 [3]	n/a	840	3.3	19	14	74	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-20E (A)	05/14/03	32.13	7.95	13 [3]	n/a	200	1.9	3.0	3.5	18	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-60E	05/15/03	31.64	8.83	75 [3]	n/a	1,100	6.7	15	18	110	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-80E	05/14/03	31.10	9.62	110 [3]	n/a	2,400	15	35	46	250	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-80E(Deep)	05/27/03	28.00	12.73	1.0 [3]	n/a	ND	ND	ND	ND	0.02	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-100E	05/27/03	30.00	11.04	ND	n/a	78	0.72	ND	1.8	8.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-120E	05/27/03	30.69	10.56	4.9 [3]	n/a	440	3.6	3.7	8.4	39	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-140E	05/12/03	31.31	10.32	21 [3]	n/a	65	ND	ND	1.1	6.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-140E	05/21/03	30.21	11.39	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-160E	05/06/03	35.56	6.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a
40S-160E Wall(S)	05/08/03	36.56	5.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a
40S-160E	05/21/03	35.05	6.50	3.7 [3]	n/a	ND	ND	ND	0.0097	0.018	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-160E Wall(S)	05/21/03	35.05	5.50	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
40S-180E	05/06/03	33.99	8.16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a
40S-180E Wall(E)	05/06/03	34.99	7.16	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
40S-200E	05/07/03	36.40	6.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	Mineral Spirits mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	TBA mg/Kg	MTBE mg/Kg	TAME mg/Kg	DIPE mg/Kg	ETBE mg/Kg	1,2-DCA mg/Kg	EDB mg/Kg	Etha-nol mg/Kg	PNA (Naphthalene) mg/Kg
40S-200E Wall(E)	05/07/03	37.40	5.50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a
50S-180E	05/06/03	33.47	8.51	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a
50S-180E Wall(S)	05/06/03	34.47	7.51	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a
60S-0E	05/09/03	31.90	7.47	91[3]	n/a	**1,100**	**3.4**	20	22	120	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-20E	05/16/03	30.93	8.92	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-40E	05/16/03	31.59	8.26	20[3]	n/a	**1,500**	**12**	12	28	140	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-60E	05/13/03	31.94	8.81	150[3]	n/a	**600**	ND	ND	8.0	37	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-80E	05/14/03	31.94	8.50	17[3]	n/a	240	2.0	ND	3.0	11	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-80E(A)	05/14/03	30.74	9.70	110[3]	n/a	2,500	12	16	41	230	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-80E(Deep)	05/27/03	27.61	12.83	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-100E	05/20/03	30.40	10.35	1.3[3]	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-100E Wall (S)	05/20/03	29.40	9.35	ND	n/a	ND	ND	ND	0.011	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-120E	05/20/03	28.81	12.15	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-140E	05/21/03	30.21	11.13	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60S-140E Wall (S)	05/21/03	31.21	10.13	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
70S-135E	05/20/03	28.81	12.15	ND	n/a	ND	ND	ND	0.012	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
70S-135E Wall (S)	05/20/03	29.81	11.15	1.3[3]	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-0E	05/05/03	32.31	8.43	68[3]	ND	470	ND	ND	7.1	21	ND	ND	ND	ND	ND	ND	ND	n/a	0.46
80S-0E Wall (W)	05/05/03	33.31	7.43	8.1	ND	100	ND	ND	1.4	1.4	ND	ND	ND	ND	ND	ND	ND	n/a	ND
80S-0E (DEEP)	05/19/03	28.15	10.80	6.5[3]	n/a	ND	ND	ND	0.0068	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-20E	05/13/03	32.02	8.11	3.3[3]	n/a	51	ND	ND	0.91	2.4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-40E	05/20/03	29.04	11.58	14[3]	n/a	1,100	ND	ND	22	98	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-40E (DEEP)	05/23/03	26.80	13.82	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-60E	05/23/03	26.75	13.09	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-80E	05/19/03	28.70	11.40	4[3]	n/a	95	0.77	ND	2.3	7.6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-80E Wall (S)	05/19/03	29.70	10.40	47[3]	n/a	77	**0.81**	ND	1.7	7.3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-80E(Deep)	05/27/03	28.01	12.09	2.8[3]	n/a	1.0	ND	ND	0.017	0.0079	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-100E	05/13/03	28.41	12.00	69[3]	n/a	**500**	ND	ND	8.8	28	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-120E	05/15/03	32.42	8.20	1.4[3]	n/a	90	**1.6**	ND	3.3	2.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
80S-120E Wall (S)	05/15/03	33.42	7.20	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Andante Project, 3992 San Pablo Ave., Emeryville, CA

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	Mineral Spirits mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	TBA mg/Kg	MTBE mg/Kg	TAME mg/Kg	DIPE mg/Kg	ETBE mg/Kg	1,2-DCA mg/Kg	EDB mg/Kg	Etha-nol mg/Kg	PNA (Naphthalene) mg/Kg
100S-0E	05/05/03	31.08	7.61	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a
100S-0E Wall (W)	05/05/03	32.08	6.61	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a
100S-20E	05/16/03	30.24	8.91	71[3]	n/a	1,000	ND	ND	27	70	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
100S-20E (A)	05/19/03	26.91	12.24	9.6[3]	1.8[4]	ND	ND	ND	0.035	0.0074	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
100S-40E	05/21/03	26.45	12.80	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
100S-60E	05/22/03	29.06	9.33	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
100S-60E Wall (S)	05/23/03	30.03	8.33	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
100S-80E	05/22/03	29.06	10.78	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
100S-80E Wall (S)	05/22/03	30.06	9.78	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
100S-100E	05/13/03	32.65	8.65	ND	n/a	ND	0.087	ND	0.091	0.052	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
115S-60E	05/22/03	29.06	10.38	1.6[3]	n/a	2.2	ND	ND	0.023	0.034	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
115S-60E Wall (S)	05/22/03	30.06	9.38	4.3[3]	n/a	180	ND	ND	2.3	3.1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
120S-0E	05/05/03	29.69	8.80	5.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	ND
120S-0E Wall (W)	05/05/03	30.69	7.80	ND	ND	1.4	ND	ND	0.0083	ND	ND	0.0053	ND	ND	ND	ND	ND	n/a	n/a
120S-0E Wall (S)	05/05/03	30.69	7.80	ND	n/a	ND	ND	ND	0.014	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
120S-20E	05/15/03	29.23	9.72	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
120S-40E	05/16/03	29.33	9.73	6.8[3]	n/a	130[4]	ND	ND	3.2	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
120S-40E Wall (S)	05/16/03	30.33	8.73	ND	n/a	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
120S-40E Wall (S)	05/22/03	30.06	9.00	ND	n/a	ND	ND	ND	0.014	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Notes:

(1) ND = Not Detected above the Method Detection Limit (MDL).
(2) n/a = Not analyzed
(3) The laboratory reports that the detected hydrocarbon does not match its Diesel Standard.
(4) The laboratory reports that the detected hydrocarbon does not match its Gasoline Standard.
(5) Concentrations in **bold** script exceed the San Francisco Bay Area RWQCB's limits for human health risk used to establish residential RBSLs for chemicals in fine-grained soils at sites where groundwater is not a source of drinking water.
(6) Sample data in gray script are for samples recovered from locations where the excavation was later deeped or widened.
(7) Samples recovered from sampling location 30S-40E were taken from the bottom of a small pit dug beneath the local elevation of the floor.

TABLE II -8

RWQCB TIER 1 CONCENTRATION LIMITS FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER [1, 2]

Chemical of Concern	Limiting Concentrations to Protect Human Health [3]			
	Soil		Groundwater	
	Residential mg/Kg	Commercial mg/Kg	Residential µg/L	Commercial µg/L
Benzene	0.18	0.39	5,800	24,000
Toluene	310	520	530,000	530,000
Ethyl benzene	230	430	170,000	170,000
Total Xylene Isomers	210	210	160,000	160,000
MTBE	68	290	490,000	2,100,000
Naphthalene	310	1,100	31,000	31,000
TPHd	500 [4]	1000 [4]	5,000 [4]	ne [5]
TPHg	500 [4]	1000 [4]	5,000 [4]	ne [5]

Notes:

(1) With respect to COCs in soil, limits cited, except as noted, are for human health risk (indoor air impacts) at sites where groundwater is not a source of drinking water and affected soil is present at less than 3 meters BGS.

(1) With respect to COCs in groundwater, limits cited, except as noted, are for human health risk (indoor air impacts) at sites where groundwater is not a source of drinking water and affected soil is present at less than 3 meters BGS.

(3) Limits cited are for indoor air impacts, which, for COCs listed, are the most stringent criteria.

(4) Limits cited for Total Petroleum Hydrocarbons are ceiling values (odors, etc.). No limits related to human health risk have been established for these COCs other than those for components such as the BTEX compounds.

5) ne = not established in the RWQCB RBSL guidance document (California Regional Water Quality Control Board - San Francisco Bay Region 2001).

TABLE II-9

CHEMICALS OF CONCERN REMAINING IN SOIL IN FLOOR OF REMEDIAL EXCAVATION

Building 1 (Complete Building)

Floor slab elevation	*40.00 ft.*
Mean elevation: floor of remedial excavation	*31.09 ft.*
Lowest elevation of top of clean soil below affected zone in subsurface	*27.61 ft.*
Mean elevation: bottom of affected soil	*27.88 ft.*
Mean depth: floor slab to bottom of remedial excavation	*8.91 ft.*
Mean depth to bottom of affected zone in subsurface	*12.12 ft*
Mean thickness of affected soil remaining in situ	*3.21 ft.*

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	MTBE mg/Kg	Depth to Floor of Excavation ft.	Thickness Affected Soil ft.
0S-40E	05/09/03	30.90	9.62	110 [3]	150	ND	ND	ND	13	n/a	9.10	3.29
0S-60E	05/09/03	32.40	8.08	69 [3]	**2,300**	ND	37	44	**240**	n/a	7.60	4.79
0S-80E	05/09/03	31.90	8.94	8.1	**870**	**6.0**	15	16	79	n/a	8.10	4.29
0S-100E	05/16/03	30.84	10.21	21 [3]	**890**	ND	20	17	100	n/a	9.16	3.23
0S-120E	05/14/03	31.10	10.16	7.2	1.74	0.031	ND	0.037	ND	n/a	8.90	3.49
0S-140E	05/14/03	31.29	10.35	140 [3]	90 [4]	ND	ND	2.3	1.1	n/a	8.71	3.68
20S-10E	05/09/03	30.44	10.78	2.1 [3]	ND	ND	ND	ND	ND	n/a	9.56	2.83
20S-20E	05/13/03	33.86	5.80	69 [3]	350	ND	2.0	6.0	30	n/a	6.14	6.25
20S-40E	05/11/03	31.25	9.27	28	200	**2.3**	8.1	3.9	19	ND	8.75	3.64
20S-60E	05/11/03	32.75	7.73	40	**860**	**9.9**	30	14	79	n/a	7.25	5.14
20S-100E	05/16/03	30.44	10.64	48 [3]	**2,000**	**18**	43	39	190	n/a	9.56	2.83

Building 1 continued on next page.

Building 1, *continued*

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	MTBE mg/Kg	Depth to Floor of Excavation ft.	Thickness Affected Soil ft.
20S-120E	05/12/03	31.15	10.14	16[3]	**1,100**	**6.4**	22	19	93	n/a	8.85	3.54
20S-140E (Deep)	05/27/03	30.45	11.65	70[3]	**2,000**	**7.8**	ND	38	87	n/a	9.55	2.84
40S-0E	05/09/03	34.73	4.97	1.5[3]	ND	ND	ND	ND	0.057	n/a	5.27	7.12
40S-20E (A)	05/14/03	32.13	7.95	13[3]	200	**1.9**	3.0	3.5	18	n/a	7.87	4.52
40S-60E	05/15/03	31.64	8.83	75[3]	**1,100**	**6.7**	15	18	110	n/a	8.36	4.03
40S-80E(Deep)	05/27/03	28.00	12.73	1.0[3]	ND	ND	ND	ND	0.02	n/a	12.00	0.39
40S-100E	05/27/03	30.00	11.04	ND	78	**0.72**	ND	1.8	8.6	n/a	10.00	2.39
40S-120E	05/27/03	30.69	10.56	4.9[3]	440	**3.6**	3.7	8.4	39	n/a	9.31	3.08
40S-140E	05/21/03	30.21	11.39	ND	ND	ND	ND	ND	ND	n/a	9.79	0.00
60S-0E	05/09/03	31.90	7.47	91[3]	**1,100**	**3.4**	20	22	120	n/a	8.10	4.29
60S-20E	05/16/03	30.93	8.92	ND	ND	ND	ND	ND	ND	n/a	9.07	0.00
60S-40E	05/16/03	31.59	8.26	20[3]	**1,500**	**12**	12	28	140	n/a	8.41	3.98
60S-60E	05/13/03	31.94	8.81	150[3]	**600**	ND	ND	8.0	37	n/a	8.06	4.33
60S-80E(Deep)	05/27/03	27.61	12.83	ND	ND	ND	ND	ND	ND	n/a	12.39	0.00
60S-100E	05/20/03	30.40	10.35	1.3[3]	ND	ND	ND	ND	ND	n/a	9.60	2.79
60S-120E	05/20/03	28.81	12.15	ND	ND	ND	ND	ND	ND	n/a	11.19	0.00

Building 2A (Northern Commercial Unit)

Floor slab elevation	*39.05 ft.*
Mean elevation: floor of remedial excavation	*29.43 ft.*
Lowest elevation of top of clean soil below affected zone in subsurface	*26.45 ft.*
Mean elevation: bottom of affected soil	*27.40 ft*
Mean depth: floor slab to bottom of remedial excavation	*9.62 ft*
Mean depth to bottom of affected zone in subsurface	*11.65 ft*
Mean thickness of affected soil remaining in situ	*2.03 ft*

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	MTBE mg/Kg	Depth to Floor of Excavation ft.	Thickness Affected Soil ft.
60S-0E	05/09/03	31.90	7.47	91[3]	**1,100**	**3.4**	20	22	120	n/a	7.15	5.45
60S-20E	05/16/03	30.93	8.92	ND	ND	ND	ND	ND	ND	n/a	8.12	0.00
60S-40E	05/16/03	31.59	8.26	20[3]	**1,500**	**12**	12	28	140	n/a	7.46	5.14
60S-60E	05/13/03	31.94	8.81	150[3]	**600**	ND	ND	8.0	37	n/a	7.11	5.49
80S-0E (DEEP)	05/19/03	28.15	10.80	6.5[3]	ND	ND	ND	0.0068	ND	n/a	10.90	1.70
80S-20E	05/13/03	32.02	8.11	3.3[3]	51	ND	ND	0.91	2.4	n/a	7.03	5.57
80S-40E (DEEP)	05/23/03	26.80	13.82	ND	ND	ND	ND	ND	ND	n/a	12.25	0.00
80S-60E	05/23/03	26.75	13.09	ND	ND	ND	ND	ND	ND	n/a	12.30	0.00
100S-0E	05/05/03	31.08	7.61	ND	ND	ND	ND	ND	ND	ND	7.97	0.00
100S-20E (A)	05/19/03	26.91	12.24	9.6[3]	1.8[4]	ND	ND	0.035	0.0074	n/a	12.14	0.46
100S-40E	05/21/03	26.45	12.80	ND	n/a	ND	ND	ND	ND	ND	12.60	0.00
100S-60E	05/22/03	29.06	9.33	ND	ND	ND	ND	ND	ND	n/a	9.99	0.00
115S-60E	05/22/03	29.06	10.38	1.6[3]	2.2	ND	ND	0.023	0.034	n/a	9.99	2.61

Building 2-A continued on next page.

Building 2-A, *continued*

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	MTBE mg/Kg	Depth to Floor of Excavation ft.	Thickness Affected Soil ft.
120S-0E	05/05/03	29.69	8.80	5.8	ND	ND	ND	ND	ND	ND	9.36	3.24
120S-20E	05/15/03	29.23	9.72	ND	ND	ND	ND	ND	ND	n/a	9.82	0.00
120S-40E	05/16/03	29.33	9.73	6.8 [3]	130 [4]	ND	ND	3.2	ND	n/a	9.72	2.88

Building 3A (Northern-most "Type A" Residential Unit)

Floor slab elevation	*41.00 ft.*
Mean elevation: floor of remedial excavation	*29.61 ft.*
Lowest elevation of top of clean soil below affected zone in subsurface	*26.74 ft.*
Mean elevation: bottom of affected soil	*27.84 ft*
Mean depth: floor slab to bottom of remedial excavation	*11.39 ft*
Mean depth to bottom of affected zone in subsurface	*13.16 ft*
Mean thickness of affected soil remaining in situ	*1.77 ft*

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	MTBE mg/Kg	Depth to Floor of Excavation ft.	Thickness Affected Soil ft.
60S-60E	05/13/03	31.94	8.81	150 [3]	**600**	ND	ND	8.0	37	n/a	9.06	5.19
60S-80E(Deep)	05/27/03	27.61	12.83	ND	ND	ND	ND	ND	ND	n/a	13.39	0.00
60S-100E	05/20/03	30.40	10.35	1.3 [3]	ND	ND	ND	ND	ND	n/a	10.60	3.65
60S-120E	05/20/03	28.81	12.15	ND	ND	ND	ND	ND	ND	n/a	12.19	0.00
80S-60E	05/23/03	26.75	13.09	ND	ND	ND	ND	ND	ND	n/a	14.25	0.00
80S-80E(Deep)	05/27/03	28.01	12.09	2.8 [3]	1.0	ND	ND	0.017	0.0079	n/a	12.99	1.26

Building 3-A continued on next page.

Building 3-A, *continued*

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	MTBE mg/Kg	Depth to Floor of Excavation ft.	Thickness Affected Soil ft.
80S-100E	05/13/03	28.41	12.00	69 [3]	**500**	ND	ND	8.8	28	n/a	12.59	1.66
80S-120E	05/15/03	32.42	8.20	1.4 [3]	90	**1.6**	ND	3.3	2.8	n/a	8.58	0.00
100S-80E	05/22/03	29.06	10.78	ND	ND	ND	ND	ND	ND	n/a	11.94	0.00
100S-100E	05/13/03	32.65	8.65	ND	ND	0.087	ND	0.091	0.052	n/a	8.35	5.90

Building 6 (Northern Half)

Floor slab elevation	*42.00 ft.*
Mean elevation: floor of remedial excavation	*32.82 ft.*
Lowest elevation of top of clean soil below affected zone in subsurface	*28.26 ft.*
Mean elevation: bottom of affected soil	*29.98 ft*
Mean depth: floor slab to bottom of remedial excavation	*9.18 ft*
Mean depth to bottom of affected zone in subsurface	*12.02 ft*
Mean thickness of affected soil remaining in situ	*2.84 ft*

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	MTBE mg/Kg	Depth to Floor of Excavation ft.	Thickness Affected Soil ft.
0S-140E	05/14/03	31.29	10.35	140 [3]	90 [4]	ND	ND	2.3	1.1	n/a	10.71	3.03
0S-180E	05/12/03	33.99	8.51	37 [3]	110 [4]	ND	ND	1.6	1.4	n/a	8.01	5.73
0S-200E	05/06/03	33.95	8.96	2.9 [3]	5.9	0.036	ND	0.13	ND	ND	8.05	5.69
0S-220E	05/06/03	34.20	8.75	2.5 [3]	9.6	**0.21**	ND	0.68	0.058	ND	7.80	5.94

Building 6 continued on next page.

Building 6, *continued*

Sample ID	Date Sampled	Elevation MSL ft.	Depth BGS ft.	TPHd (diesel) mg/Kg	TPHg (gasoline) mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl-benzene mg/Kg	Total Xylenes mg/Kg	MTBE mg/Kg	Depth to Floor of Excavation ft.	Thickness Affected Soil ft.
20S-140E (Deep)	05/27/03	30.45	11.65	70 [3]	**2,000**	**7.8**	ND	38	87	n/a	11.55	2.19
20S-160E (Deep)	05/13/03	28.26	13.50	ND	ND	ND	ND	ND	ND	n/a	13.74	0.00
20S-180E(A)	05/27/03	33.26	8.93	2.8 [3]	ND	ND	ND	ND	0.02	n/a	8.74	5.00
20S-200E	05/07/03	35.44	7.50	2.9	ND	ND	ND	ND	ND	ND	6.56	7.18
20S-220E	05/09/03	34.48	8.50	1.7	ND	ND	ND	ND	ND	n/a	7.52	6.22
35S-200E	05/09/03	34.45	8.46	ND	ND	ND	ND	ND	ND	n/a	7.55	0.00
40S-140E	05/21/03	30.21	11.39	ND	ND	ND	ND	ND	ND	n/a	11.79	0.00
40S-160E	05/21/03	35.05	6.50	3.7 [3]	ND	ND	ND	0.0097	0.018	n/a	6.95	6.79
40S-180E	05/06/03	33.99	8.16	ND	ND	ND	ND	ND	ND	ND	8.01	0.00
40S-200E	05/07/03	36.40	6.50	ND	ND	ND	ND	ND	ND	ND	5.60	0.00
50S-180E	05/06/03	33.47	8.51	ND	ND	ND	ND	ND	ND	ND	8.53	0.00
60S-140E	05/21/03	30.21	11.13	ND	ND	ND	ND	ND	ND	ND	11.79	0.00
70S-135E	05/20/03	28.81	12.15	ND	ND	ND	ND	0.012	ND	n/a	13.19	0.55

Notes:

(1) ND = Not Detected above the Method Detection Limit (MDL).
(2) n/a = Not analyzed
(3) The laboratory reports that the detected hydrocarbon does not match its Diesel standard.
(4) The laboratory reports that the detected hydrocarbon does not match its Gasoline standard.
(5) Concentrations in **bold** script exceed the San Francisco Bay Area RWQCB's limits for human health risk used to establish residential RBSLs for chemicals in fine-grained soils at sites where groundwater is not a source of drinking water.

TABLE II -10

REPRESENTATIVE CHEMICALS OF CONCERN REMAINING IN POST-REMEDIAL SOIL

Building No.	**Benzene** mg/Kg	**Toluene** mg/Kg	**Ethyl-benzene** mg/Kg	**Total Xylene Isomers** mg/Kg	**MTBE** mg/Kg	**Naphtha-lene** mg/Kg
1	**0.28** [2]	0.64	2.2	9.6	0.0025 [1]	0.17 [1]
2-A (North)	0.022	0.028	0.22	0.22	0.0025 [1]	0.17 [1]
3-A	0.013	0.025	0.50	0.68	0.0025 [1]	0.17 [1]
6 (North)	0.016	0.0025	0.076	0.054	0.0025 [1]	0.17 [1]

Notes:

1) When no concentration of a COC was detected, representative concentration was set as one-half of the MDL (Method Detection Limit).

2) Concentration in **bold** script exceeds the San Francisco Bay Area RWQCB's limits for human health risk used to establish residential RBSLs for chemicals in fine-grained soils at sites where groundwater is not a source of drinking water.

TABLE II-11

REPRESENTATIVE CONCENTRATIONS OF CHEMICALS OF CONCERN IN POST-REMEDIAL GROUNDWATER

Constituent	**Concentration** μg/L
Benzene	1,500
Toluene	2,400
Ethylbenzene	730
Xylene (mixed isomers)	3,700
Methyl t-butyl ether	74
Naphthalene	140

Note:

Concentrations in **bold** script exceed the San Francisco Bay Area RWQCB's limits for human health risk used to establish residential RBSLs for chemicals in fine-grained soils at sites where groundwater is not a source of drinking water. None are present in this table.

TABLE II-12

APPLICABLE CHEMICAL, PHYSICAL, TOXICOLOGIC AND CARCINOGENIC PROPERTIES OF CHEMICALS OF CONCERN

Constituent	Molecular Weight (g/mole) MW	Diffusion Coefficients		Log (Koc) (@ 20 - 25 C) log(L/kg)	Henry's Law Constant (@ 20 - 25 C)		Vapor Pressure (@ 20 - 25 C) (mm Hg)	Solubility (@ 20 - 25 C) (mg/L)
		in air (cm2/s) Dair	in water (cm2/s) Dwat		(atm-m3) mol	(unitless)		
Benzene	78.1	8.80E-02	9.80E-06	1.77	5.55E-03	2.29E-01	9.52E+01	1.75E+03
Toluene	92.4	8.50E-02	9.40E-06	2.13	6.30E-03	2.60E-01	3.00E+01	5.15E+02
Ethylbenzene	106.2	7.50E-02	7.80E-06	2.56	7.88E-03	3.25E-01	1.00E+01	1.69E+02
Xylene (mixed isomers)	106.2	7.20E-02	8.50E-06	2.38	7.03E-03	2.90E-01	7.00E+00	1.98E+02
Methyl t-Butyl ether	88.146	7.92E-02	9.41E-05	1.08	5.77E-04	2.38E-02	2.49E+02	4.80E+04
Naphthalene	128.2	5.90E-02	7.50E-06	3.30	4.83E-04	1.99E-02	2.30E-01	3.10E+01

Continued on next page

TABLE II-12

(Continued)

APPLICABLE CHEMICAL, PHYSICAL, TOXICOLOGIC AND CARCINOGENIC

PROPERTIES OF CHEMICALS OFCHEMICALS OF CONCERN

Constituent	Reference Dose (mg/kg/day)		Ref. Conc. (mg/m3)	Slope Factors 1/(mg/kg/day)		Unit Risk Factor 1/(µg/m3)	EPA Weight of Evidence	Is Constituent Carcino-genic?	Maximum Contamination Level MCL (mg/L)	Time-Weighted Av. Workplace Criteria TWA (mg/m3)
	Oral RfD_oral	Dermal RfD_dermal	Inhalation RfC_inhal	Oral SF_oral	Dermal SF_dermal	Inhalation URF_inhal.				
Benzene	3.00E-03	-	5.95E-03	2.90E-02	2.99E-02	8.29E-06	A	TRUE	5.00E-03	3.25E+00
Toluene	2.00E-01	1.60E-01	4.00E-01	-	-	-	D	FALSE	1.00E+00	1.47E+02
Ethylbenzene	1.00E-01	9.70E-02	1.00E+00	-	-	-	D	FALSE	7.00E-01	4.35E+02
Xylene (mixed isomers)	2.00E+00	1.84E+00	7.00E+00	-	-	-	D	FALSE	1.00E+01	4.34E+02
Methyl t-Butyl ether	1.00E-02	8.00E-03	3.00E+00	-	-	-	-	FALSE	-	6.00E+01
Naphthalene	4.00E-01	3.56E-01	1.40E+00	-	-	-	D	FALSE	-	5.00E+01

TABLE II -13

DEPTHS TO GROUNDWATER

Well Number	Date Measured	Casing Elevation	Ground Elevation	Depth Below Top of Well Casing	Depth Below Ground Level	Groundwater Elevation
		ft. MSL	*ft. MSL*	*ft.*	*ft.*	*ft. MSL*
Monitoring Wells in the 40th St. Right-of-Way:						
LF-1		38.95	n/a			
	08/07/93			9.40	n/a [1]	29.55
	08/20/93			10.00		28.95
LF-2		40.25	n/a			
	08/07/93			7.97	n/a	32.28
	08/20/93			8.29	n/a	31.96
LF-3		39.35	n/a			
	08/07/93			8.90	n/a	30.45
	08/20/93			9.18	n/a	30.17
WCEW-1		39.04	n/a			
	06/02/98			7.24	n/a	31.80
	03/13/98			5.92	n/a	33.12
	12/05/97			6.00	n/a	33.04
	09/26/97			8.06	n/a	30.98
Monitoring Wells on the Andante Project Site:						
SJC MW-T1		46.99	43.51			
	04/14/03			6.69	3.21	40.30
	04/16/03			6.84	3.36	40.15
	04/21/03			8.14	4.66	38.85
SJC MW-T2		43.26	41.54			
	04/14/03			2.83	1.11	40.43
	04/16/03			3.42	1.70	39.84
	04/21/03			4.22	2.50	39.04
SJC MW-T2A		43.99	41.52			
	04/14/03			7.49	5.02	36.50
	04/16/03			7.52	5.05	36.47
	04/21/03			7.00	4.53	36.99

Well Number	Date Measured	Casing Elevation	Ground Elevation	Depth Below Top of Well Casing	Depth Below Ground Level	Groundwater Elevation
		ft. MSL	*ft. MSL*	*ft.*	*ft.*	*ft. MSL*
SJC MW-T3		46.01	42.50			
	04/14/03			7.77	4.26	38.24
	04/16/03			7.89	4.38	38.12
	04/21/03			8.12	4.61	37.89
SJC MW-T4		41.01	39.73			
	04/14/03			3.32	2.04	37.69
	04/16/03			3.54	2.26	37.47
	04/21/03			5.14	3.86	35.87
SJC MW-T4A		42.70	39.69			
	04/14/03			8.81	5.80	33.89
	04/16/03			8.10	5.09	34.60
	04/21/03			8.00	4.99	34.70
SJC MW-T5		41.79	39.64			
	04/14/03			2.33	0.18	39.46
	04/11/02			3.52	1.37	38.27
	04/21/03			5.22	3.07	36.57
SJC MW-T5A		42.30	39.52			
	04/14/03			4.20	1.42	38.10
	04/16/03			6.62	3.84	35.68
	04/21/03			7.56	4.78	34.74
SJC MW-T6		44.02	40.73			
	04/14/03			5.28	1.99	38.74
	04/16/03			5.99	2.70	38.03
	04/21/03			7.07	3.78	36.95
SJC MW-T7		44.10	40.55			
	04/14/03			5.86	2.31	38.24
	04/16/03			6.24	2.69	37.86
	04/21/03			6.86	3.31	37.24

Note: n/a = Data is not available.

TABLE II -14

MEAN DEPTHS TO GROUNDWATER BENEATH BUILDINGS

Building No.	**Top of Slab Elevation** *ft. MSL*	**Mean Groundwater Elevation** *ft. MSL*	**Mean Depth to Groundwater** *ft.*	**Soil Column Thickness** *ft.*
1	40.00	33.57	6.43	1.43
2-A North	39.05	32.39	6.66	1.66
3-A	41.00	33.69	7.31	2.31
6	42.00	36.13	5.87	0.87

TABLE II -15

KEY BUILDING DIMENSIONS

Building No.	Portion of Building	Length East to West *ft.*	Length North to South *ft.*	Plan Area *ft.* ^{2}	Foundation Perimeter *ft.* ^{2}	Ground Floor Floor to Ceiling *ft.*	Ground Floor Interior Volume *ft.* ^{3}	Ground Floor Volume/Area Ratio	Ground Floor Slab Thickness *in.*	Impermeable Barrier
1	Complete Building	126	43	5,418	338	12.0	65,016	12.0	5	Liquid Boot® 60 mil
2-A (North)	Northern-most Commercial Unit	66	40	2,640	212	10.0	26,400	10.0	5	Liquid Boot® 60 mil
3-A	Northern-most Type A Res. Unit	45	18	705	126	8.5	5,993	8.5	5	Liquid Boot® 60 mil
6 (North)	Northern Half	120	81	9,720	402	8.0	77,760	8.0	5	Visqueen ™ 10 mil. with sealed joints

TABLE II -16

KEY BUILDING-SPECIFIC MODELING PARAMETERS

Building No.	Portion of Building	Use of First Floor	Indoor Exposure Environment Classification	Outdoor Exposure Environment Classification	Depth to Groundwater *ft.*	Depth to Top of Contam. Soil *ft.*	Depth to Bottom of Contam. Soil *ft.*
1	Complete Building	Restaurant	Commercial	Residential	6.43	8.91	12.12
2-A (North)	Northern-most Commercial Unit	Commercial	Commercial	Residential	6.66	9.62	11.65
3-A	Northern-most Type A Res. Unit	Residential	Residential	Residential	7.31	11.39	13.16
6 (North)	Northern Half	Automobile Parking	Commercial	Residential	5.87	9.18	12.02

TABLE II - 17

BUILDING-SPECIFIC HEALTH RISK ANALYSIS RESULTS

Building	Outdoor Exposure Environment Classification	Indoor Exposure Environment Classification	Cumulative COC Carcinogenic Risk			Toxic Hazard Index		
			Outdoor Air	Indoor Air	Target Risk	Outdoor Air	Indoor Air	Target Index
1	Residential	Commercial	4.0×10^{-9}	**7.4×10^{-8}**	*1.0×10^{-6}*	1.9×10^{-4}	**4.3×10^{-3}**	*2.0×10^{-1}*
2A	Residential	Commercial	4.0×10^{-9}	**8.8×10^{-8}**	*1.0×10^{-6}*	1.9×10^{-4}	**5.1×10^{-3}**	*2.0×10^{-1}*
3A	Residential	Residential	3.9×10^{-9}	**4.3×10^{-7}**	*1.0×10^{-6}*	1.9×10^{-4}	**2.1×10^{-2}**	*2.0×10^{-1}*
6	Residential	Commercial	4.0×10^{-9}	**1.1×10^{-7}**	*1.0×10^{-6}*	2.0×10^{-4}	**6.5×10^{-3}**	*2.0×10^{-1}*

Note: Critical Exposure Pathway Cumulative COC Risk and Hazard Index are in **bold** font.

TABLE II - 18

SENSITIVITY OF CARCINOGENIC RISK AND HAZARD INDEX TO VARYING DEPTHS TO GROUNDWATER

Building	Cumulative COC Carcinogenic Risk - Indoor Air			Toxic Hazard Index Indoor Air		
	Mean GW Elevation	High GW	Low GW	Mean GW Elevation	High GW	Low GW
1	7.4×10^{-8}	**8.9×10^{-8}**	7.1×10^{-8}	4.3×10^{-3}	**5.2×10^{-3}**	4.1×10^{-3}
2A	8.8×10^{-8}	**1.0×10^{-7}**	8.5×10^{-8}	5.1×10^{-3}	**5.9×10^{-3}**	4.9×10^{-3}
3A	4.3 x 10 -7	**4.5×10^{-7}**	4.1×10^{-7}	2.1×10^{-2}	**2.2×10^{-2}**	2.0×10^{-2}
6	1.1×10^{-7}	**1.5×10^{-7}**	1.1×10^{-7}	6.5×10^{-3}	**8.8×10^{-3}**	6.3×10^{-3}

Notes:

1. Highest Cumulative COC Risks and Hazard Index are in **bold** font.
2. Target Risk 1.0×10^{-6}
3. Hazard Index Limit 2.0×10^{-1}

SJC

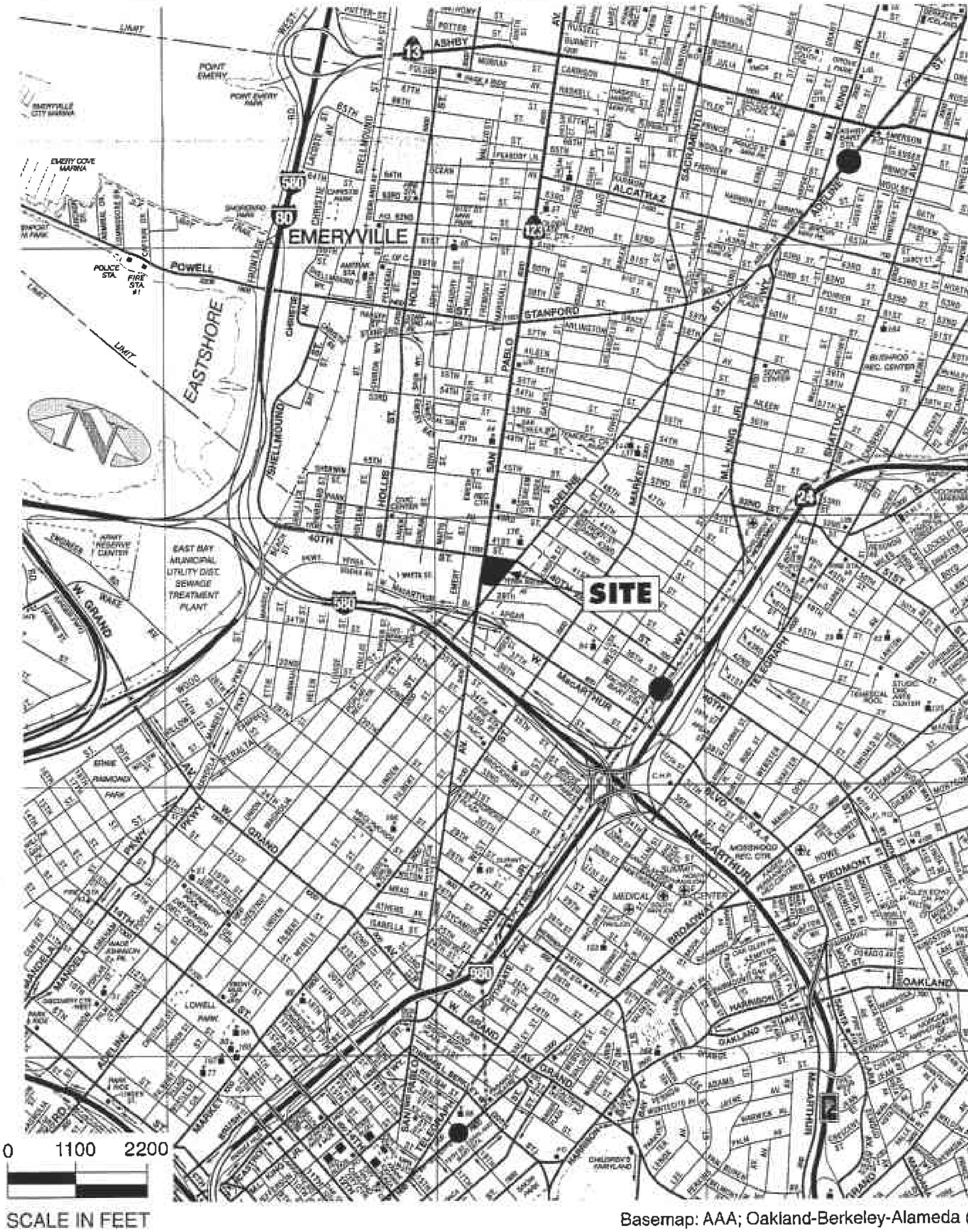
TABLE II - 19

HIGH WATER LEVEL CARCINOGENIC RISK AND HAZARD INDEX FOR RESIDENTIAL OCCUPANCY OF ALL BUILDINGS

Building	Cumulative COC Carcinogenic Risk - Indoor Air	Toxic Hazard Index Indoor Air
1	3.7×10^{-7}	1.8×10^{-2}
2A	4.2×10^{-7}	2.0×10^{-2}
3A	4.5×10^{-7}	2.2×10^{-2}
6	6.3×10^{-7}	3.1×10^{-2}

Notes:

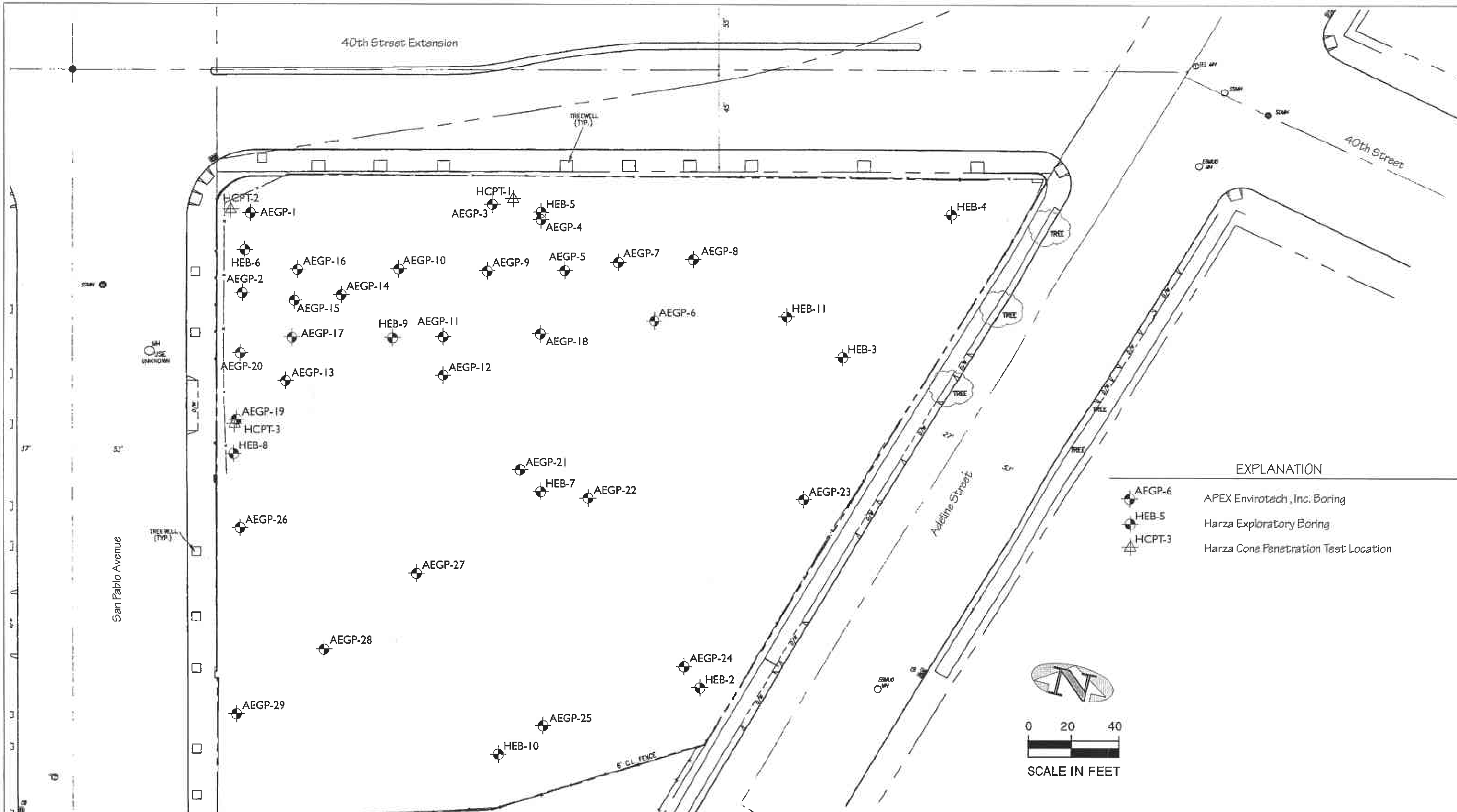
1. All results are for high groundwater conditions
2. Target Risk 1.0×10^{-6}
3. Hazard Index Limit 2.0×10^{-1}



Basemap: AAA; Oakland-Berkeley-Alameda (12/02)

SITE LOCATION
Andante Project - 3992 San Pablo Avenue
Emeryville, California

FIG II-1	**The San Joaquin Company Inc.**	Project Number: 9401.205	
		Drawn by: GNM	Date: 10/27/03



SITE PLAN PRIOR TO CONSTRUCTION

Andante Project - 3992 San Pablo Avenue

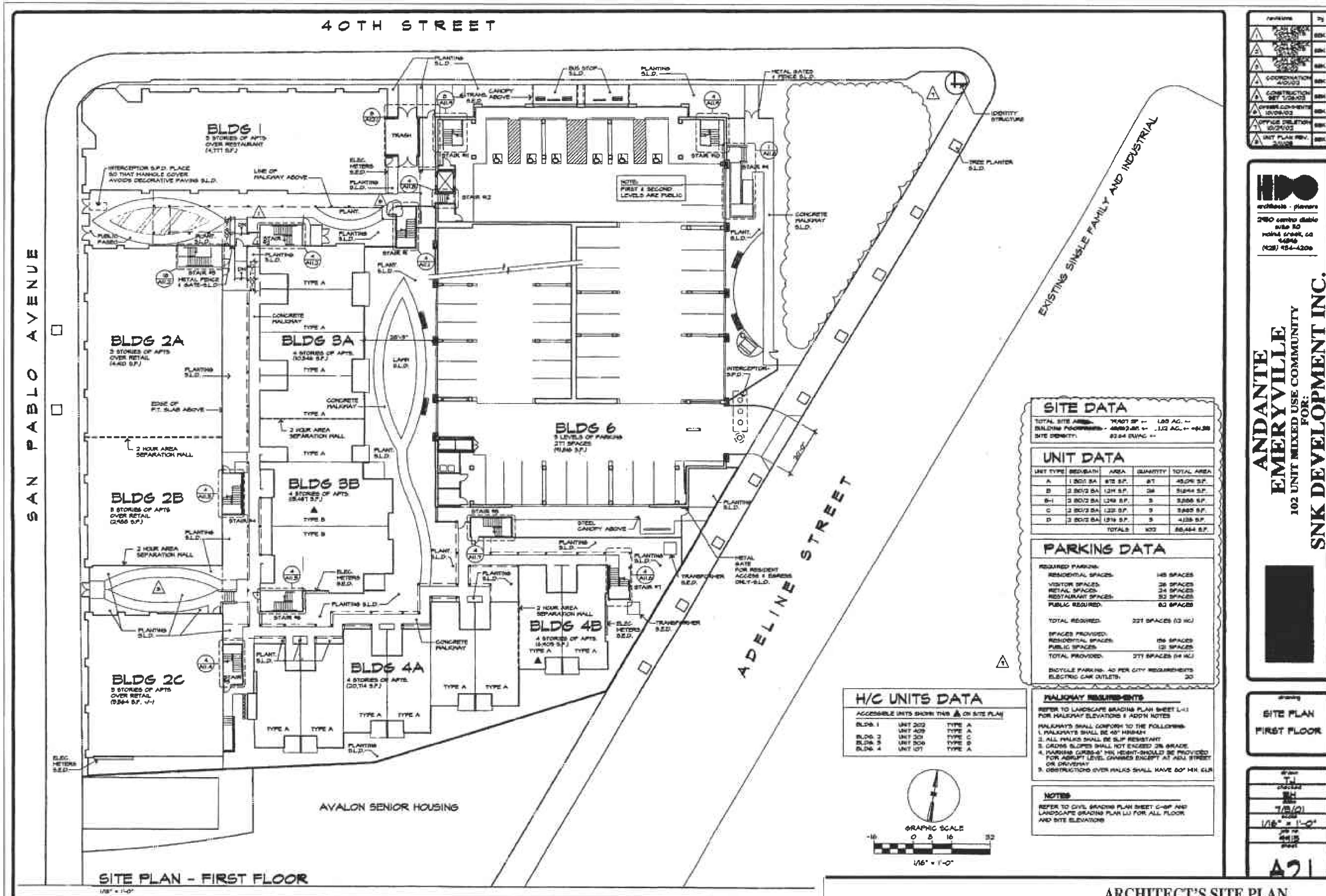
Emeryville, California

FIG II- 2

The San Joaquin Company Inc.

Project Number: 9401.205

Drawn by: GNM | Date: 10/27/03



0 20 40

SCALE IN FEET

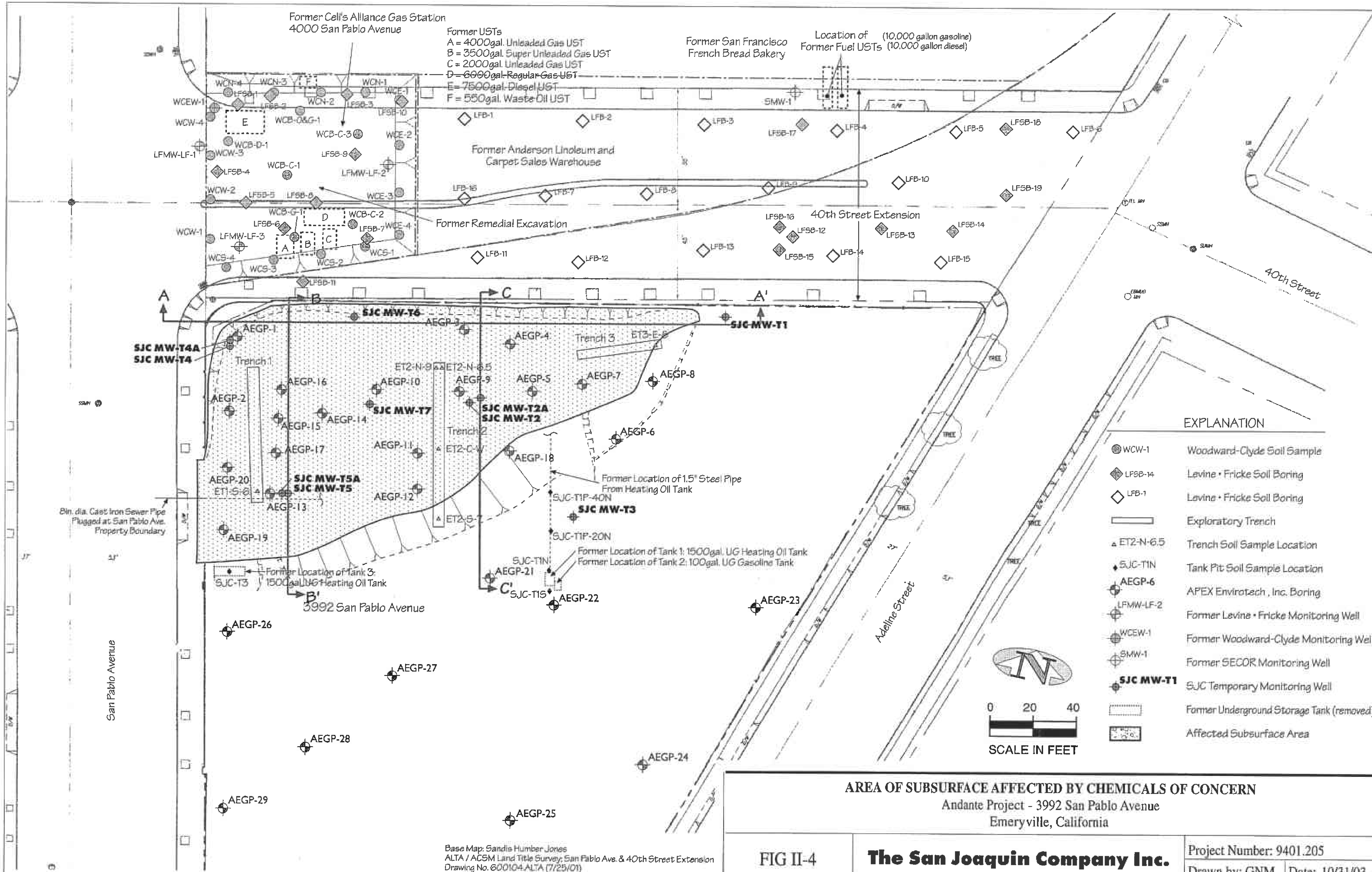
Base Map: HDO Architects, Planners
Site Plan, 1s Floor - Andante Emeryville, 102 Unit Mixed Use Community
Job No. 9915 • Drawing No. Sheet A2.1 of 67 (rev.2/11/03)

ARCHITECT'S SITE PLAN
Andante Project - 3992 San Pablo Avenue
Emeryville, California

FIG II-3

The San Joaquin Company Inc.

Project Number: 9401.205
Drawn by: GNM
Date: 10/27/03



AREA OF SUBSURFACE AFFECTED BY CHEMICALS OF CONCERN

Andante Project - 3992 San Pablo Avenue

Emeryville, California

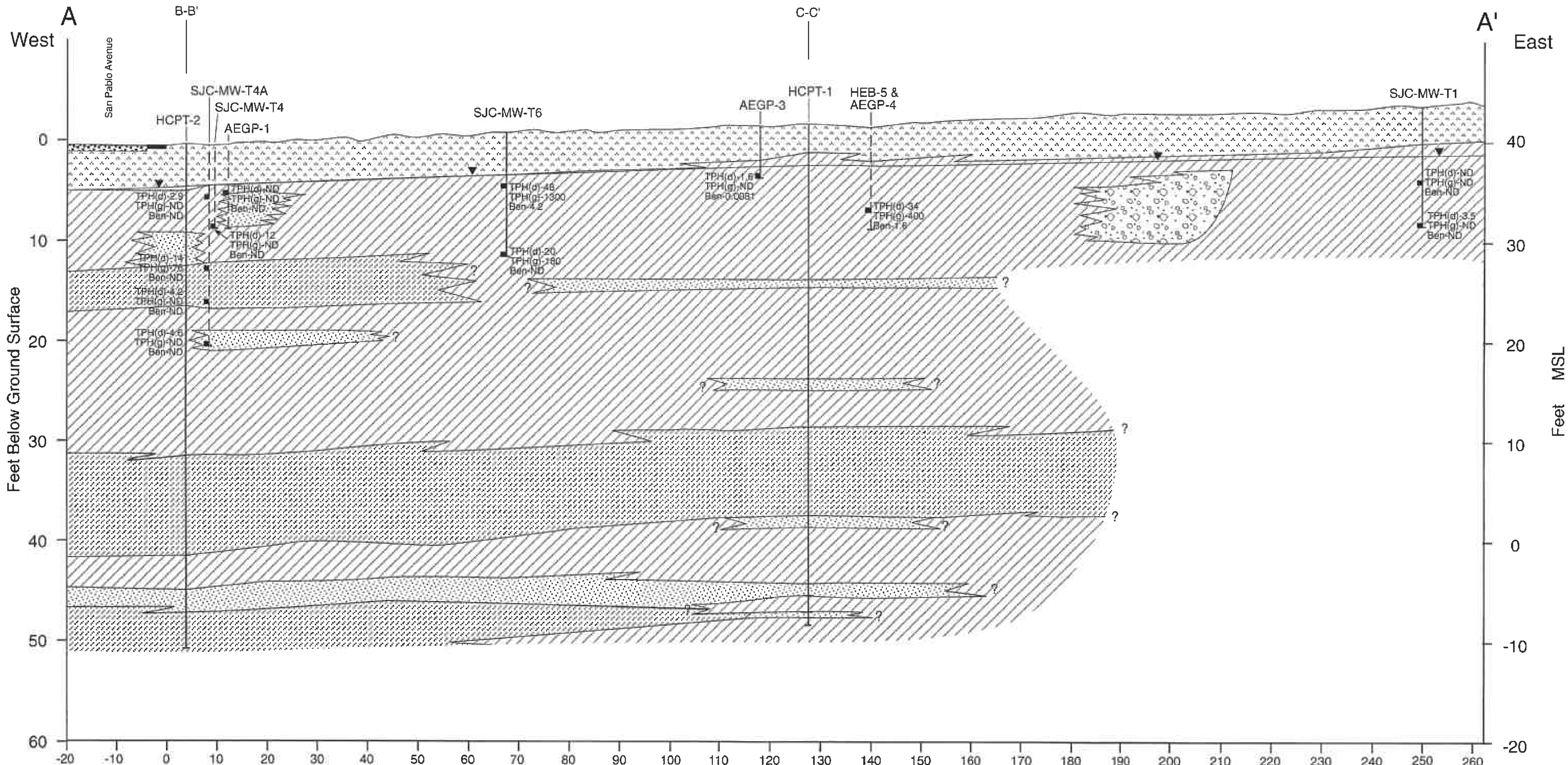
FIG II-4

The San Joaquin Company Inc.

Project Number: 9401.205

Drawn by: GNM

Date: 10/31/03



FILL - mixture of loose Silty Sand and Gravel, with soft Silty Clay and Clay

Sandy Silt and Clayey Silt, with some Silty Clay

Sands, Silty Sands, Silts and some Gravel, with some Clayey Silt

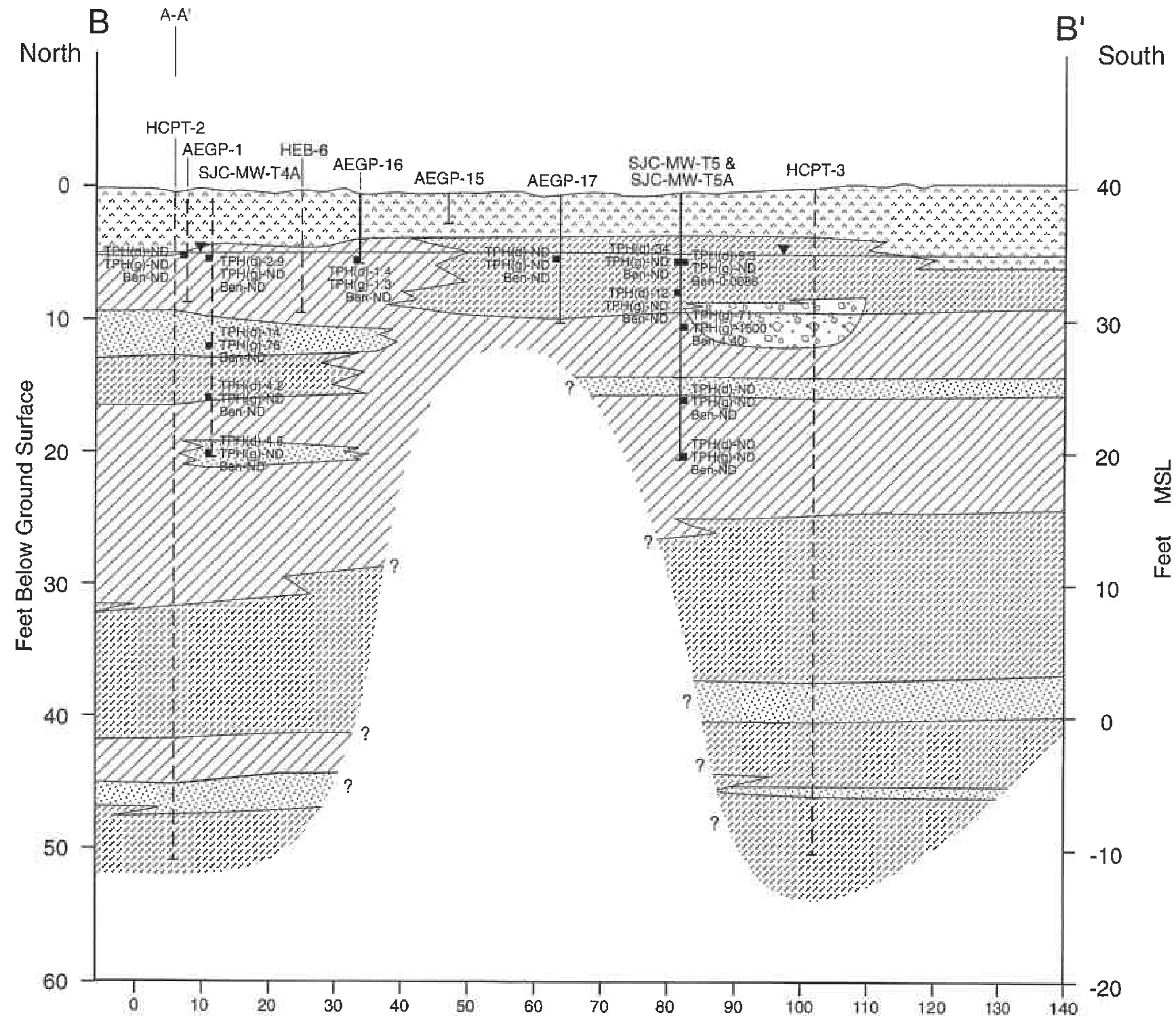
Clay and Silty Clay

Sand and Gravel stream bed deposits

AEGP-3	APEX Envirotech, Inc Boring (existing)
HCPT-1	Harza Cone Penetration Test (existing)
HEB-5	Harza Exploratory Boring (existing)
SJC-MW-T1	San Joaquin Co. Inc Temporary Groundwater Monitoring Well
▼	Water Table (4/21/03)
TPH(d)-150 TPH(g)-150 Ben-ND	Soil Sample Analysis Results (mg/kg)

HYDROSTRATIGRAPHIC CROSS SECTION A-A' PRIOR TO EXCAVATION
Andante Project - 3992 San Pablo Avenue
Emeryville, California

FIG II-5	**The San Joaquin Company Inc.**	Project Number: 9401.205
		Drawn by: GNM — Date: 10/29/03



FILL - mixture of loose Silty Sand and Gravel, with soft Silty Clay and Clay

Sandy Silt and Clayey Silt, with some Silty Clay

Sands, Silty Sands, Silts and some Gravel, with some Clayey Silt

Clay and Silty Clay

Sand and Gravel stream bed deposits

AEGP-1 APEX Envirotech, Inc Boring (existing)

HCPT-3 Harza Cone Penetration Test (existing)

HEB-6 Harza Exploratory Boring (existing)

SJC-MW-T5 San Joaquin Co. Inc Temporary Groundwater Monitoring Well

▼ Water Table (4/21/03)

TPH(d)-150 TPH(g)-150 Ben-ND Soil Sample Analysis Results (mg/kg)

HYDROSTRATIGRAPHIC CROSS SECTION B-B' PRIOR TO EXCAVATION

Andante Project - 3992 San Pablo Avenue

Emeryville, California

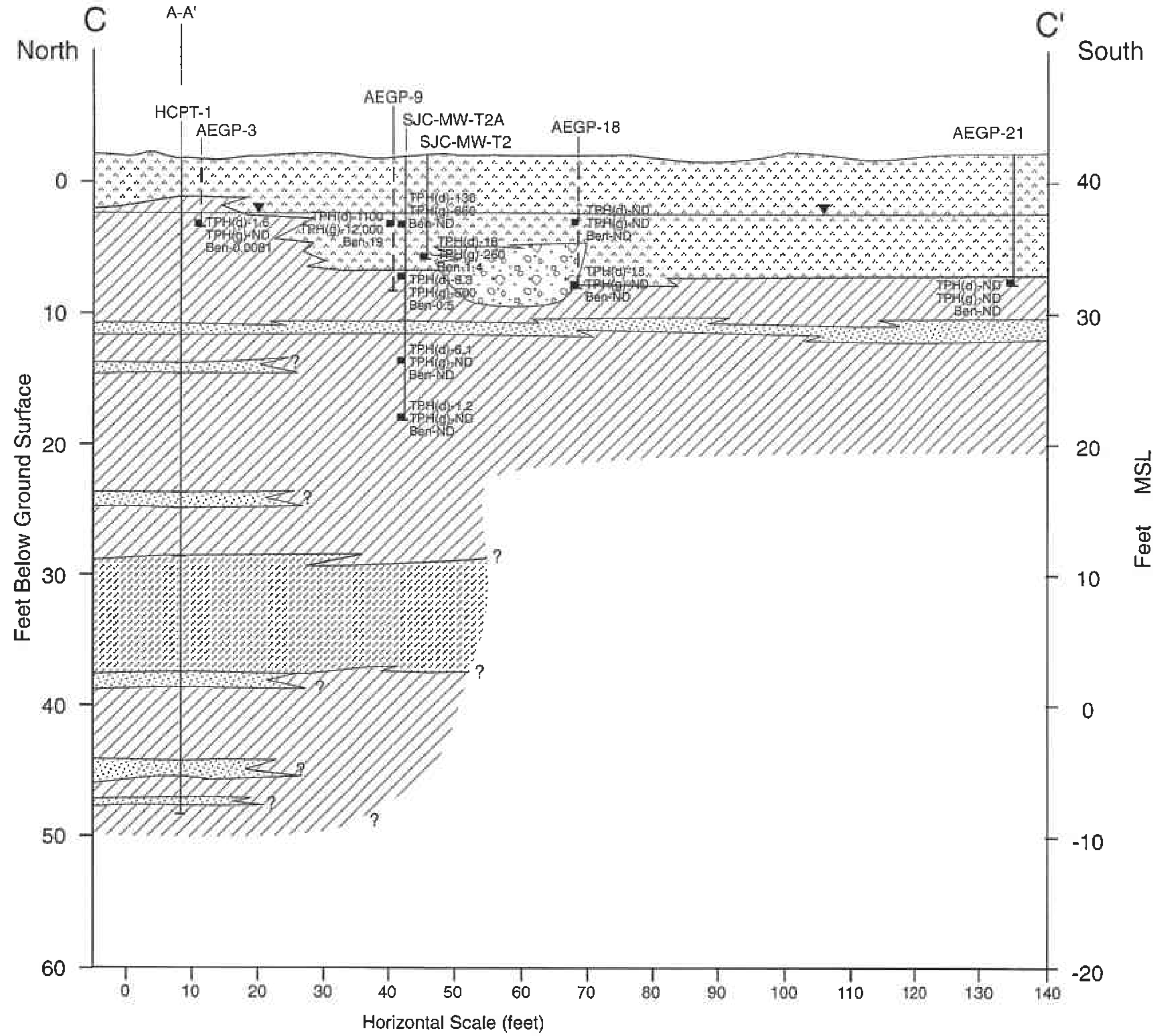
FIG II-6

The San Joaquin Company Inc.

Project Number: 9401.205

Drawn by: GNM

Date: 10/29/03



FILL - mixture of loose Silty Sand and Gravel, with soft Silty Clay and Clay

Sandy Silt and Clayey Silt, with some Silty Clay

Sands, Silty Sands, Silts and some Gravel, with some Clayey Silt

Clay and Silty Clay

Sand and Gravel stream bed deposits

AEGP-3 APEX Envirotech, Inc Boring (existing)

HCPT-1 Harza Cone Penetration Test (existing)

SJC-MW-T2 San Joaquin Co. Inc Temporary Groundwater Monitoring Well

▼ Water Table (4/21/03)

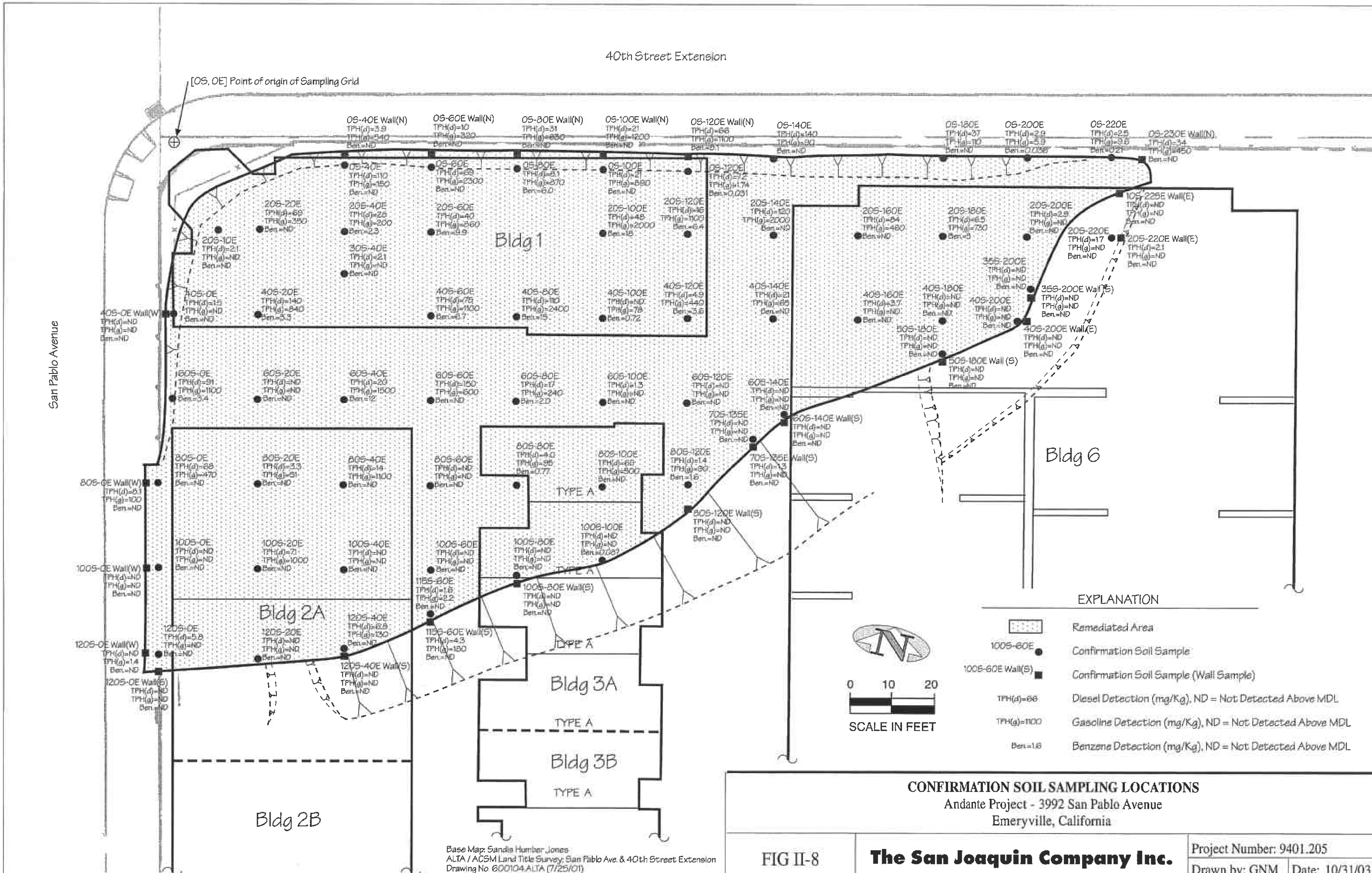
TPH(d)-150 TPH(g)-150 Ben-ND Soil Sample Analysis Results (mg/kg)

HYDROSTRATIGRAPHIC CROSS SECTION C-C' PRIOR TO EXCAVATION

Andante Project - 3992 San Pablo Avenue

Emeryville, California

FIG II-7	**The San Joaquin Company Inc.**	Project Number: 9401.205
		Drawn by: GNM Date: 10/29/03

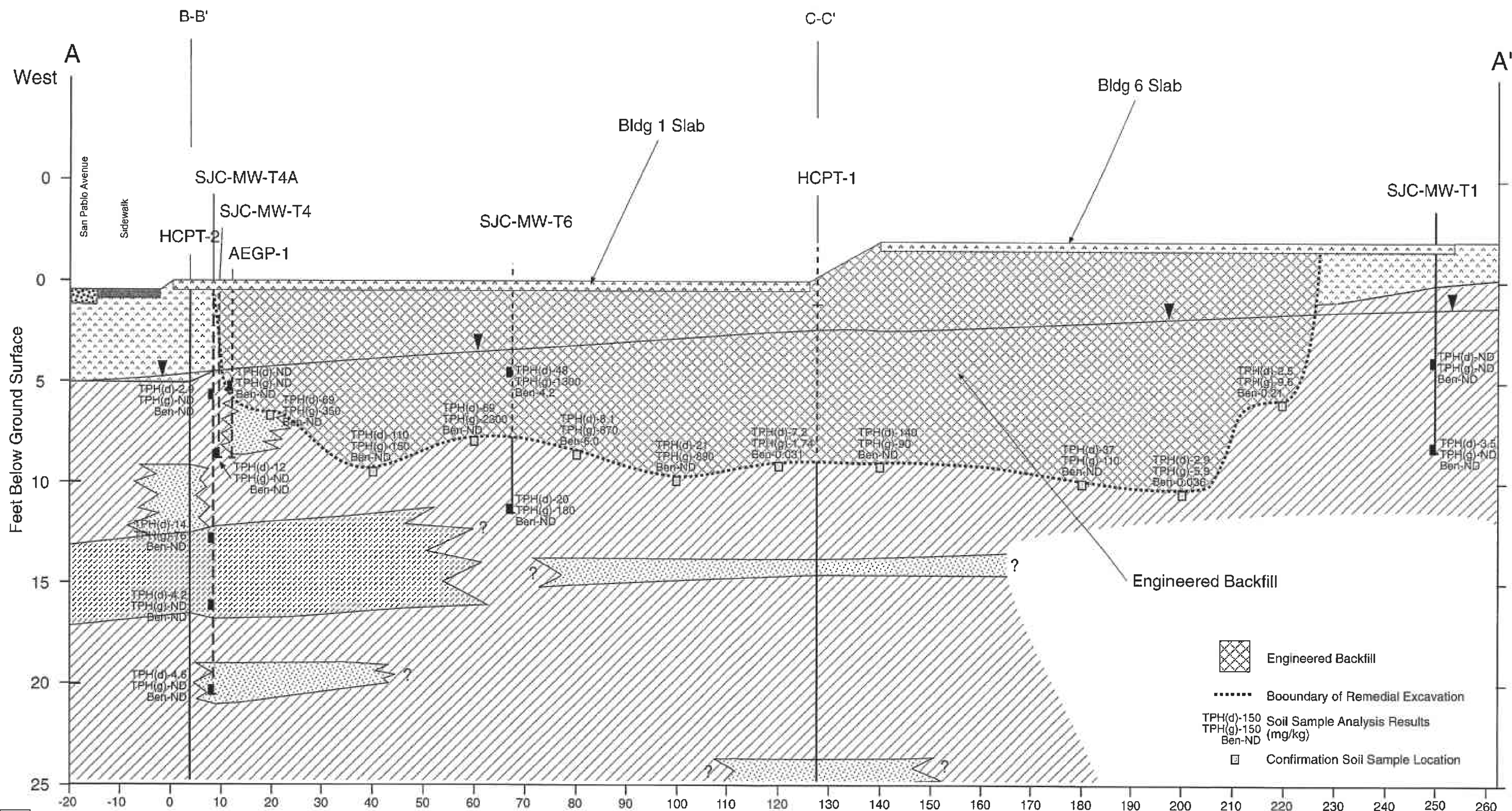


CONFIRMATION SOIL SAMPLING LOCATIONS

Andante Project - 3992 San Pablo Avenue

Emeryville, California

FIG II-8	The San Joaquin Company Inc.	Project Number: 9401.205	
		Drawn by: GNM	Date: 10/31/03



FILL - mixture of loose Silty Sand and Gravel, with soft Silty Clay and Clay

Sandy Silt and Clayey Silt, with some Silty Clay

Sands, Silty Sands, Silts and some Gravel, with some Clayey Silt

Clay and Silty Clay

Sand and Gravel stream bed deposits

AEGP-3	APEX Envirotech, Inc Boring (existing)
HCPT-1	Harza Cone Penetration Test (existing)
HEB-5	Harza Exploratory Boring (existing)
SJC-MW-T1	San Joaquin Co. Inc Temporary Groundwater Monitoring Well
▼	Water Table (4/21/03)

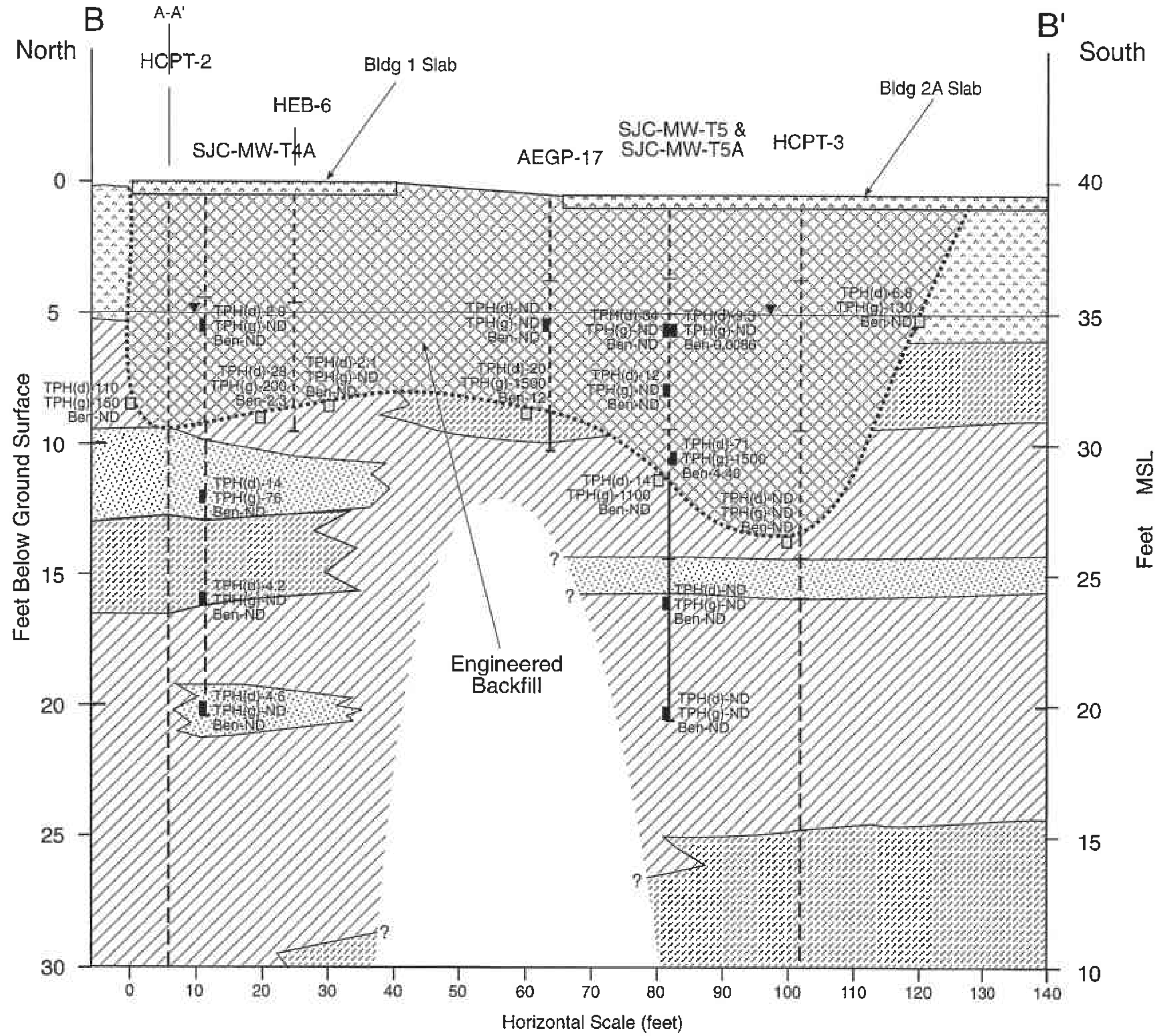
HYDROSTRATIGRAPHIC CROSS SECTION A-A' THROUGH BACKFILLED REMEDIAL EXCAVATION

Andante Project - 3992 San Pablo Avenue
Emeryville, California

FIG II-9

The San Joaquin Company Inc.

Project Number: 9401.205
Drawn by: GNM | Date: 10/28/03



AEGP-1	APEX Envirotech, Inc Boring (existing)
HCPT-3	Harza Cone Penetration Test (existing)
HEB-6	Harza Exploratory Boring (existing)
SJC-MW-T5	San Joaquin Co. Inc Temporary Groundwater Monitoring Well
▼	Water Table (4/21/03)

Engineered Backfill

Booundary of Remedial Excavation

TPH(d)-150 TPH(g)-150 Ben-ND — Soil Sample Analysis Results (mg/kg)

Confirmation Soil Sample Location

FILL - mixture of loose Silty Sand and Gravel, with soft Silty Clay and Clay

Sandy Silt and Clayey Silt, with some Silty Clay

Sands, Silty Sands, Silts and some Gravel, with some Clayey Silt

Clay and Silty Clay

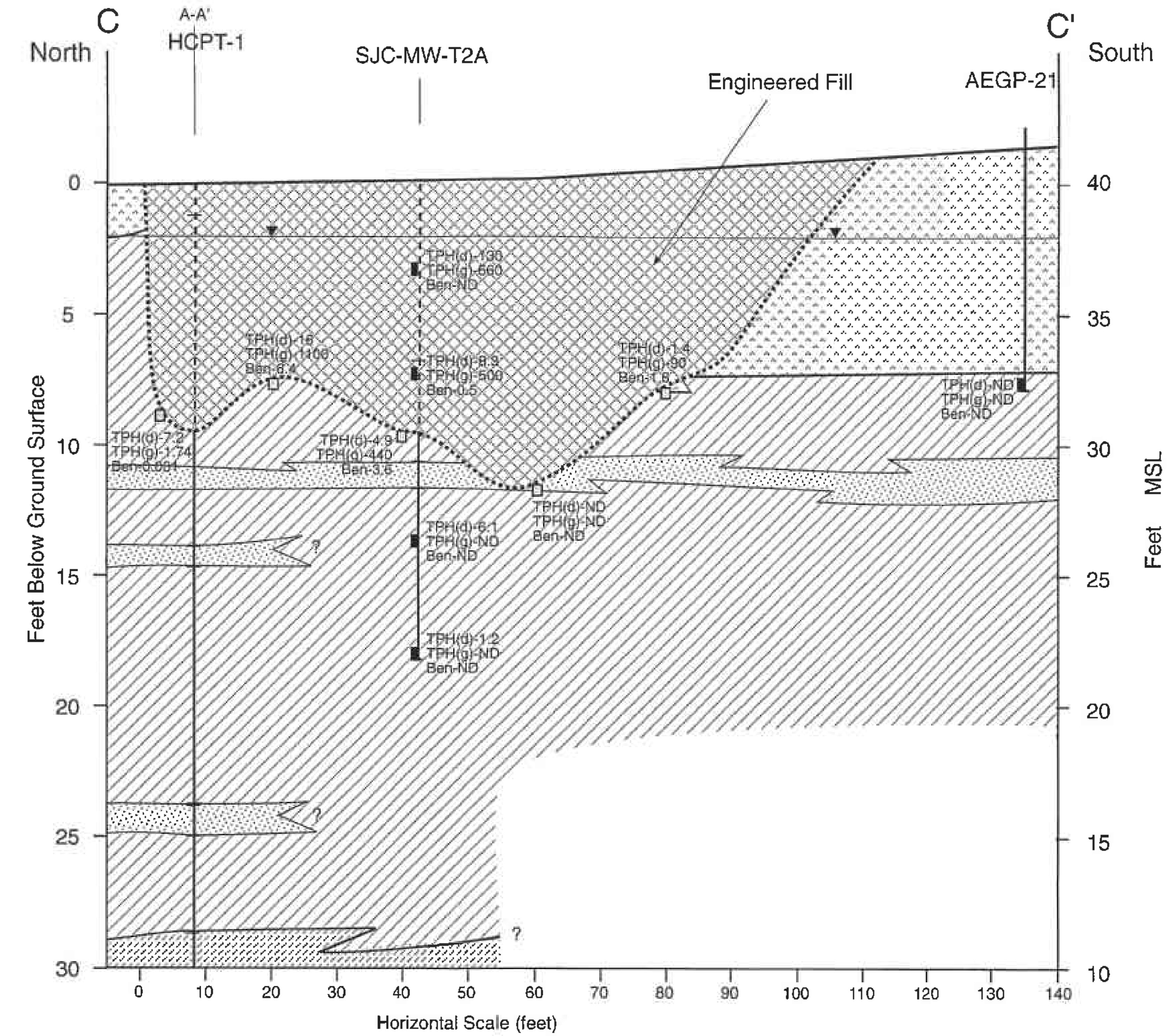
Sand and Gravel stream bed deposits

HYDROSTRATIGRAPHIC CROSS SECTION B-B' THROUGH BACKFILLED REMEDIAL EXCAVATION

Andante Project - 3992 San Pablo Avenue

Emeryville, California

FIG II-10 | **The San Joaquin Company Inc.** | Project Number: 9401.205 | Drawn by: GNM | Date: 10/28/03



Engineered Backfill

Booundary of Remedial Excavation

TPH(d)-150 TPH(g)-150 Ben-ND — Soil Sample Analysis Results (mg/kg)

Confirmation Soil Sample Location

FILL - mixture of loose Silty Sand and Gravel, with soft Silty Clay and Clay

Sandy Silt and Clayey Silt, with some Silty Clay

Sands, Silty Sands, Silts and some Gravel, with some Clayey Silt

Clay and Silty Clay

Sand and Gravel stream bed deposits

AEGP-3 APEX Envirotech, Inc Boring (existing)

HCPT-1 Harza Cone Penetration Test (existing)

SJC-MW-T2 San Joaquin Co. Inc Temporary Groundwater Monitoring Well

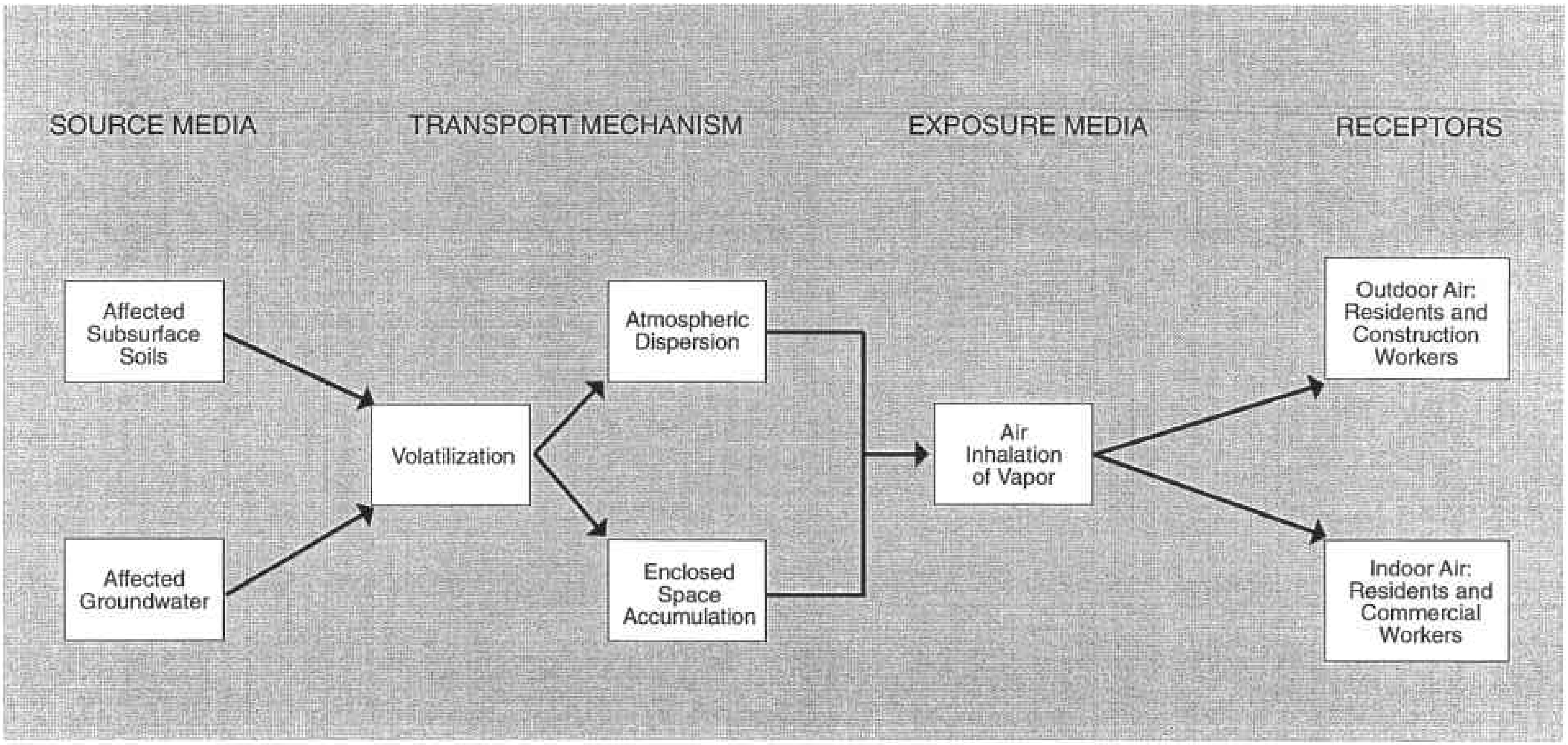
Water Table (4/21/03)

HYDROSTRATIGRAPHIC CROSS SECTION C-C' THROUGH BACK-FILLED REMEDIAL EXCAVATION

Andante Project - 3992 San Pablo Avenue

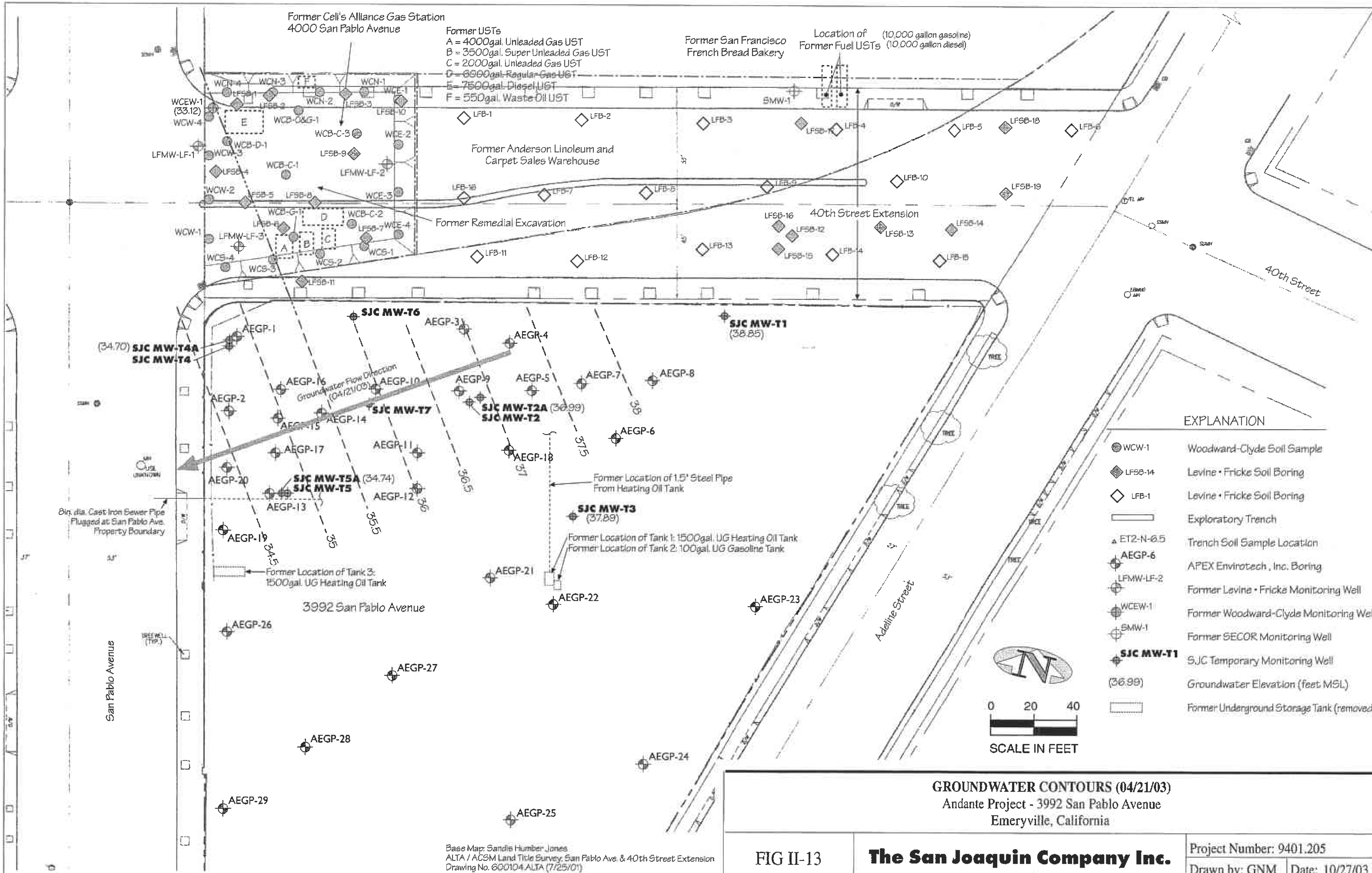
Emeryville, California

FIG II-11	**The San Joaquin Company Inc.**	Project Number: 9401.205
		Drawn by: GNM Date: 10/28/03

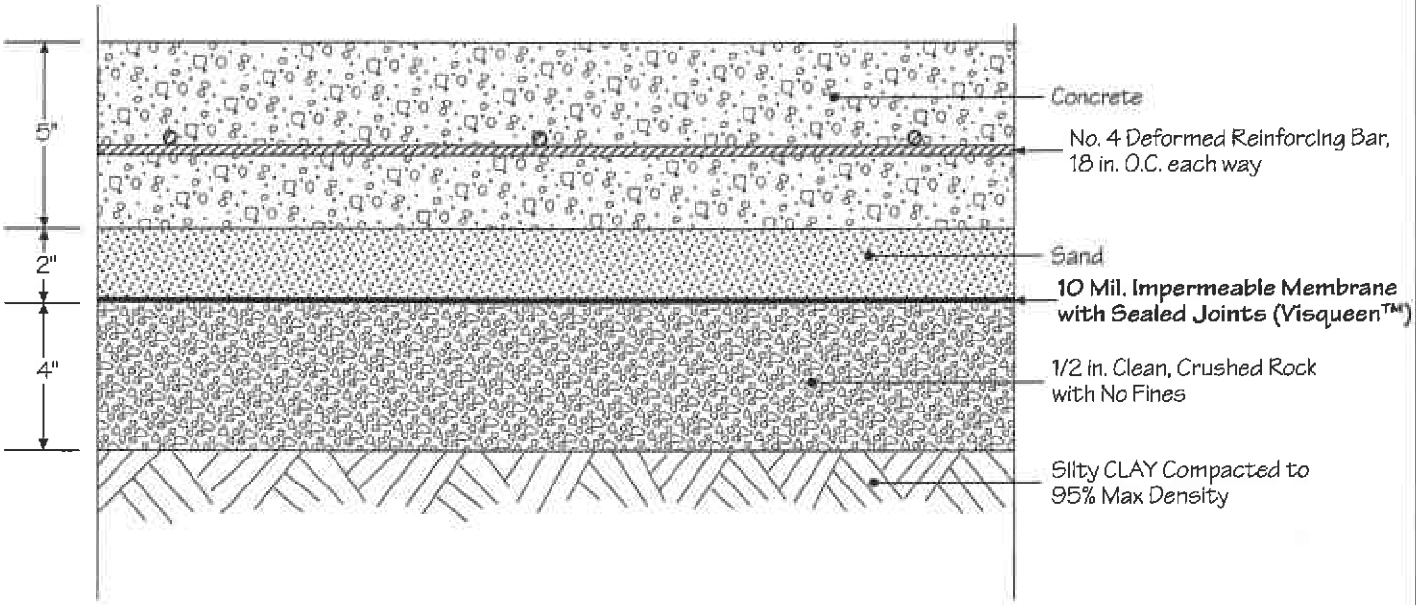


EXPOSURE PATHWAYS FOR HUMAN HEALTH RISK ASSESSMENTS
Andante Project - 3992 San Pablo Avenue
Emeryville, California

FIG II-12	**The San Joaquin Company Inc.**	Project Number: 9401.205 Drawn by: GNM Date: 10/27/03



Former Celi's Alliance Gas Station
4000 San Pablo Avenue
Former USTs
A = 4000gal. Unleaded Gas UST
B = 3500gal. Super Unleaded Gas UST
C = 2000gal. Unleaded Gas UST
D = 6900gal. Regular Gas UST
E = 7500gal. Diesel UST
F = 550gal. Waste Oil UST
Former San Francisco French Bread Bakery
Location of Former Fuel USTs
(10,000 gallon gasoline)
(10,000 gallon diesel)
Former Anderson Linoleum and Carpet Sales Warehouse
Former Remedial Excavation
40th Street Extension
40th Street
Adeline Street
San Pablo Avenue
3992 San Pablo Avenue
Groundwater Flow Direction (04/21/03)
(34.70) SJC MW-T4A
SJC MW-T4
SJC MW-T6
SJC MW-T1 (38.85)
SJC MW-T7
SJC MW-T2A (36.99)
SJC MW-T2
SJC MW-T5A (34.74)
SJC MW-T5
SJC MW-T3 (37.89)
WCEW-1 (33.12)
8in. dia. Cast Iron Sewer Pipe Plugged at San Pablo Ave. Property Boundary
Former Location of Tank 3: 1500gal. UG Heating Oil Tank
Former Location of 1.5" Steel Pipe From Heating Oil Tank
Former Location of Tank 1: 1500gal. UG Heating Oil Tank
Former Location of Tank 2: 100gal. UG Gasoline Tank
EXPLANATION
WCW-1 Woodward-Clyde Soil Sample
LFSB-14 Levine • Fricke Soil Boring
LFB-1 Levine • Fricke Soil Boring
Exploratory Trench
ET2-N-6.5 Trench Soil Sample Location
AEGP-6 APEX Envirotech, Inc. Boring
LFMW-LF-2 Former Levine • Fricke Monitoring Well
WCEW-1 Former Woodward-Clyde Monitoring Well
SMW-1 Former SECOR Monitoring Well
SJC MW-T1 SJC Temporary Monitoring Well
(36.99) Groundwater Elevation (feet MSL)
Former Underground Storage Tank (removed)
0 20 40
SCALE IN FEET
Base Map: Sandis Humber Jones
ALTA / ACSM Land Title Survey, San Pablo Ave. & 40th Street Extension
Drawing No. 600104.ALTA (7/25/01)
GROUNDWATER CONTOURS (04/21/03)
Andante Project - 3992 San Pablo Avenue
Emeryville, California
FIG II-13
The San Joaquin Company Inc.
Project Number: 9401.205
Drawn by: GNM
Date: 10/27/03

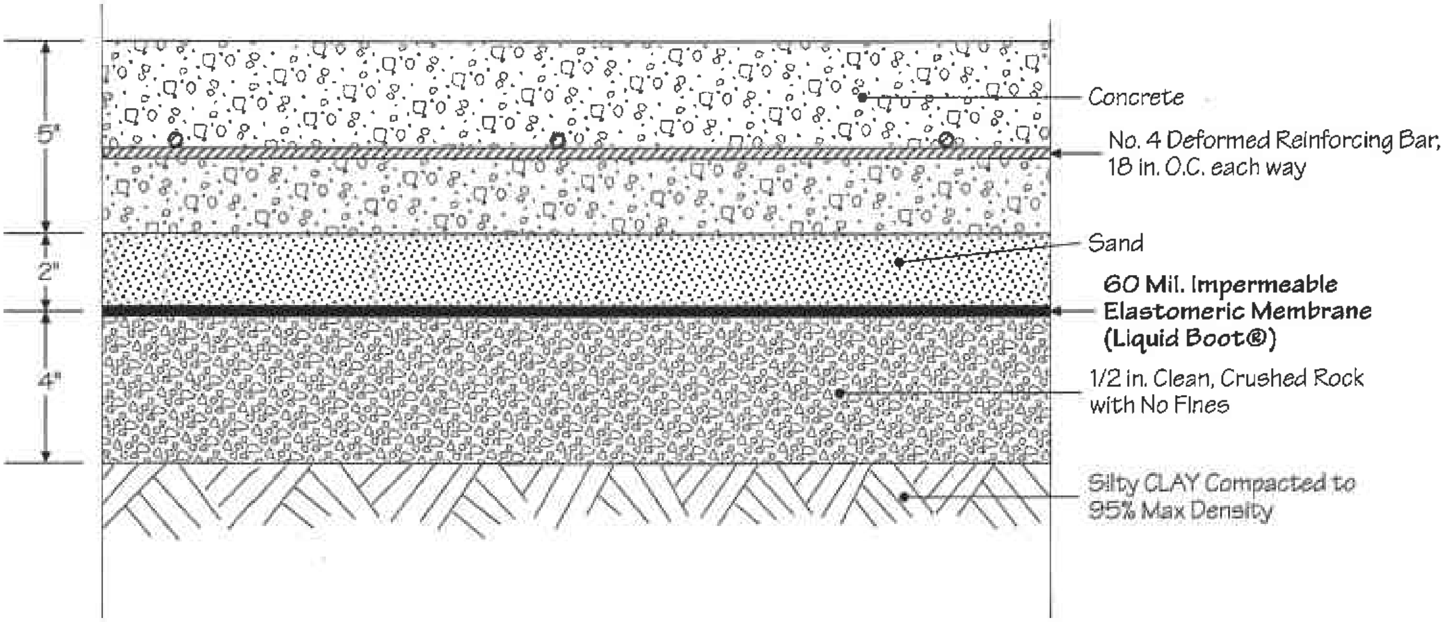


FLOOR SLAB WITH VISQUEEN™ MEMBRANE

Andante Project - 3992 San Pablo Avenue

Emeryville, California

FIG II-14	**The San Joaquin Company Inc.**	Project Number: 9401.205	
		Drawn by: GNM	Date: 10/27/03



FLOOR SLAB WITH LIQUID BOOT® MEMBRANE

Andante Project - 3992 San Pablo Avenue

Emeryville, California

FIG II-15	**The San Joaquin Company Inc.**	Project Number: 9401.205	
		Drawn by: GNM	Date: 10/27/03

APPENDIX II-A

Risk-based Site Evaluation Process

Source: Groundwater Services, Inc.

SJC

Overview of Risk Management Steps

Effective risk management at chemical release sites involves: i) identification of applicable risk factors on a site-specific basis; and ii) development and implementation of appropriate protective measures in the timeframe necessary to prevent unsafe conditions. Key elements of the risk-based site evaluation process include:

- ***Exposure Pathway Screening:*** Identify potential mechanisms for exposure of human or ecological receptors on a site-specific basis.
- ***Risk-Based Cleanup Objectives:*** For each complete exposure pathway, evaluate potential for exposure in excess of safe limits based on tiered evaluation of soil and groundwater cleanup limits.
- ***Remedy Selection:*** Develop risk-based exposure control strategy based on the nature and timing of the potential impact.
- ***Compliance Monitoring:*** If needed, conduct final compliance monitoring to confirm satisfactory remedy completion prior to formal case closure.

Further discussion of these process steps and relevant risk-based modeling tools is provided below.

Exposure Pathway Screening

The risk-based evaluation addresses the potential for constituent transport from the affected media source zone to a point of contact with a human or ecological receptor via various *exposure pathways*. For most remediation sites, the primary exposure pathways of human health concern are i) groundwater ingestion, ii) soil-to-groundwater release, and iii) soil ingestion, vapor inhalation, and dermal contact. Additional exposure pathways may apply based on site conditions and land use (e.g., surface water impacts, ecological exposures). To pose a risk, three components of each exposure pathway must be present: an affected source medium, a mechanism for constituent transport, and a receptor. In practical terms, exposure pathways may therefore be screened from further consideration based on the presence and mobility of the constituents of concern and the proximity of receptors to the source zone. For example, for an affected groundwater plume in a stable or diminishing condition, no potential exists for impacts on water supply wells located outside the current plume area.

Pathways determined to be potentially complete should be retained for site-specific evaluation. However, if the preliminary screening analysis shows no complete exposure pathways, no further evaluation is required.

- ***Applicable Data Evaluation Tools:*** The RBCA Tool Kit is organized to facilitate pathway screening via the "Exposure Pathway Identification" input screen. The user identifies affected source media and actual and/or potential receptors from among a matrix of possible options. Based on these selections, the complete exposure pathways may be viewed on the Exposure Flowchart output screen. In addition, ASTM standard E-1943, "Standard Guide for Remediation by Natural Attenuation (RNA)," outlines practical data evaluation methods for analysis of groundwater plume stability, including historical data plots, estimation of bulk attenuation rates, and modeling methods. The *GSI Natural Attenuation Tool Kit* developed for use with the ASTM RNA Standard, is also available from GSI (*http://www.gsi.net.com*).

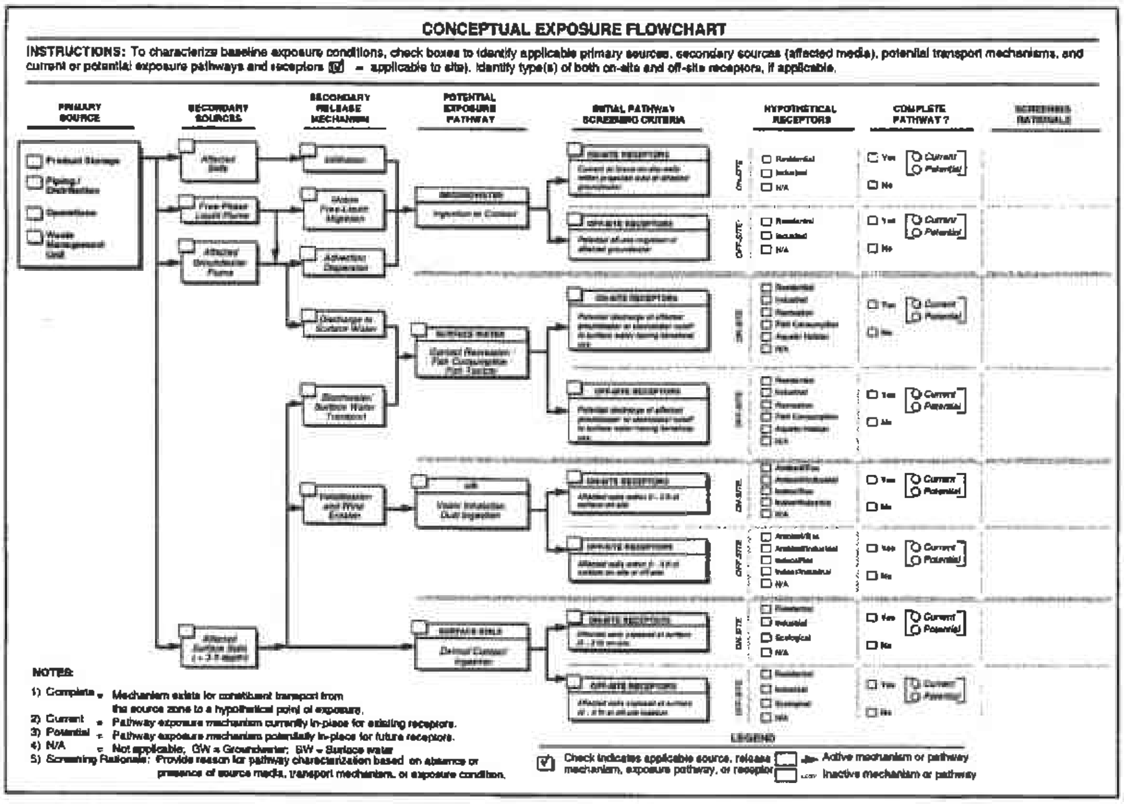


FIGURE A.1. CONCEPTUAL EXPOSURE FLOWCHART

Risk-Based Cleanup Objectives

The RBCA process employs a tiered approach to derivation of risk-based soil and groundwater cleanup goals, with each tier serving to refine the risk analysis based upon additional site data and more sophisticated fate and transport modeling methods. For example, Tiers 1 and 2 of the site evaluation process are amenable to use of simple analytical models to estimate risk-based concentration limits, while more complex and costly numerical modeling methods are reserved for Tier 3 evaluations. In each case, risk-based concentration limits are derived for relevant exposure pathways, receptors, and constituents of concern (COCs) and compared to measured source media concentrations. Source media exceeding these target levels will require either further investigation or remedial action in the timeframe necessary to control exposure. Summary information regarding principal calculation steps is provided below.

i) ***Media-Specific Cleanup Standards:*** For a given exposure pathway and COC, the risk-based standard represents a concentration in the affected source medium (soil or groundwater) that is protective of a human or ecological receptor located at a relevant point of exposure (POE). For example, for the human health soil-to-air exposure pathway, the cleanup standard is the mean concentration in the affected surface soil zone that will prevent unsafe human exposures via soil vapor or particulate release to air. The ASTM RBCA Standard and other regulatory programs distinguish between two types of risk-based cleanup standards: i) the Risk-Based Screening Level (RBSL), a *generic* target level utilized under Tier 1, and ii) a Site-Specific Target Level (SSTL), a *site-specific* target level utilized under Tier 2 or Tier 3. Under the RBCA process, Tier 1 RBSLs are based on an assumed exposure in immediate proximity to the source. If source media COC concentrations exceed Tier 1 RBSLs, the relevant exposure pathways and COCs may be further evaluated under Tier 2 or Tier 3 to calculate SSTLs, which would address actual site-specific exposure conditions , and where the POE may be located at some distance away from the source. For each complete exposure pathway, cleanup standards for the source medium can be back-calculated from safe exposure levels at the POE using the following general expressions:

Tier 1: $RBSL = RBEL \times NAF_{CM}$

Tier 2: $SSTL = RBSL \times NAF_{LT}$

where

RBEL = Risk-based *exposure* limit for direct intake of exposure medium (e.g. air concentration limit for inhalation).

NAF_{CM} = Natural attenuation factor defining natural reduction in constituent concentrations during cross-media (CM) transport (e.g., soil to air volatilization).

NAF_{LT} = Natural attenuation factor defining natural reduction in constituent concentrations during lateral transport (LT) (e.g., via dispersion during lateral migration in air).

RBSL or SSTL values must be developed for each complete exposure pathway and COC. For exposure pathways with multiple POEs (e.g., ambient vapor inhalation by on-site worker and by off-site resident), separate SSTLs must be developed for each POE using the appropriate RBEL value. In general, the RBEL value does not vary among Tiers 1, 2, and 3. Rather, the cleanup standard value is refined at each successive tier by improving the NAF estimations, based upon more complete site information and more sophisticated data evaluation and/or modeling methods. Determination of applicable RBEL and NAF values is addressed below.

ii) ***Risk-Based Exposure Limits:*** The RBEL represents the constituent concentration exposed to the receptor that does not exceed target risk limits, based on applicable regulatory criteria. The RBEL applies at the POE, i.e., the likely point of constituent intake or contact by a human or ecological receptor. For each complete exposure pathway and COC, the applicable RBEL must be matched to each relevant POE based on the type of exposure medium (air, water, soil) and the type of receptor (resident, commercial/industrial worker, etc.). For certain exposure media, human health-based exposure limits are specified under applicable regulations, such as Maximum Contaminant Levels (MCLs) for drinking water ingestion or Permissible Exposure Limits (PELs) for industrial air exposure. In the absence of such standards, human health RBELs can be derived for each constituent and exposure medium (air, water, soil) using the following general expressions:

Carcinogens: $$RBEL = \frac{TR}{E \cdot SF}$$

Non-carcinogens: $$RBEL = \frac{THQ \cdot RfD}{E}$$

where

E = effective exposure rate for specified pathway, based on applicable exposure factors (e.g., daily intake rate in mg/day per kg body weight),

TR = target risk limit for carcinogenic effects of individual constituents (dimensionless),

SF = slope factor for carcinogenic effects of COC $(mg/kg\text{-}day)^{-1}$,

THQ = target hazard quotient for non-carcinogenic effects of individual constituents (dimensionless), and

RfD = reference dose for non-carcinogenic effect of COC (mg/kg-day).

SJC

Applicable target risk limits (TR, THQ) for health protection can be matched to levels specified by the environmental regulatory authority. Toxicological parameters for each COC can be determined from published references, such as the U.S. EPA Integrated Risk Information System (IRIS). Exposure rates correspond to the chronic rate of contact or intake of the affected exposure medium (air, water, soil) by the receptor under anticipated land use conditions. As a conservative measure, these rates can be estimated based on standard exposure factors published by the regulatory authority or other source (e.g., American Industrial Health Council) for the anticipated land use at the site (e.g., residential, commercial, etc.).

Quantitative measures for derivation of RBELs for ecological receptors are not well defined. However, if the pathway screening evaluation indicates a reasonable potential for ecological exposure (e.g., surface water/aquatic species), applicable RBELs may be based on published standards or ecological screening criteria (e.g., surface water quality standard for aquatic life protection, ecological screening limits for terrestrial species, etc.). The U.S. EPA and various state agencies maintain databases of ecological screening levels for various types of receptors. However, given the highly conservative nature of these concentration limits, use of these values as ecological RBELs is appropriate only for preliminary screening-level analyses.

iii) ***Applicable Exposure Factors:*** For each complete pathway, *exposure factors* must be defined characterizing the potential duration, frequency, and rate of contact of the receptor with affected media at the POE. Depending upon the degree of conservatism desired, exposure activities can be characterized on the basis of either i) *most likely exposure* (MLE) factors, representing average exposure rates, or ii) *reasonable maximum exposure* (RME) factors, corresponding to the highest rate of exposure that could reasonably be expected to occur (i.e., upper 95% value). Standard RME and MLE exposure factors for various exposure pathways, under both residential and non-residential land use scenarios, are listed on Table A.1.

To select appropriate exposure factors, the user must first define the type of receptor anticipated under current and future land use (i.e., residential vs. commercial/industrial) and then evaluate the applicability of the standard factors to site-specific conditions. The likelihood that such exposure will occur and the degree of conservatism desired should be considered in selecting among MLE and RME values. A Tier 2 evaluation may use both MLE and RME values, in order to estimate the potential range of risks associated with exposure to the site. Modification of these standard values may be justified under certain conditions (e.g., frequency of dermal contact with soils in cold weather climates). For detailed information regarding derivation and application of these exposure factors, see U.S. EPA (1997; 1992a; 1991) and American Industrial Health Council (1994).

iv) ***Natural Attenuation Factor:*** For each complete exposure pathway, the NAF represents the cumulative effect of various partitioning, dilution, and attenuation factors acting to reduce constituent concentrations during transport from source to receptor (see Figure A.2). These NAF components may involve both cross-media transfer factors (NAF_{CM}, such as soil-to-air volatilization or soil-to-groundwater leaching) and lateral transport factors (NAF_{LT}, such as air dispersion or groundwater advection-dispersion; see Appendix B). For exposure pathways with multiple POEs, separate NAF_{LT} values must be derived for each POE location (e.g., ambient vapor inhalation by on-site worker and off-site resident; or groundwater ingestion at both hypothetical and actual wells). For a given site and exposure pathway, the NAF value may vary among evaluation of Tiers 1, 2, and 3, based on use of improved site data and evaluation methods.

For each complete exposure pathway and COC, the applicable NAF values can be derived based on either: i) the actual measured concentration ratio between the source medium and the POE or

TABLE A.1 STANDARD EXPOSURE FACTORS FOR TIER 1 AND TIER 2 EVALUATIONS

EXPOSURE PATHWAY		Contact Rate (CR)	Exposure Frequency (EF)	Exposure Duration (ED)	Body Weight (BW)	Surface Contact Area (SA)	Soil Adherence Factor (AF)	Dermal Adsorption Factor (DA)	EXPOSURE RATE (E): Equation	Value for Carcinogens	Value for Non-carcinogens
RESIDENTIAL LAND USE											
Ingestion of potable water	MLE:	1.4 L/day	350 days/yr	8 years	70 kg	—	—	—	$\frac{CR \cdot EF \cdot ED}{BW \cdot AT}$	0.0022 L/kg-day	0.019 L/kg-day
	RME:	2 L/day	350 days/yr	30 years	70 kg	—	—	—		0.0012 L/kg-day	0.027 L/kg-day
Ingestion of soil and dust	MLE:	25 mg/day	350 days/yr	8 years	70 kg	—	—	—	$\frac{CR \cdot EF \cdot ED}{BW \cdot AT}$	0.039 mg/kg-day	0.34 mg/kg-day
	RME:	100 mg/day	350 days/yr	30 years	70 kg	—	—	—		0.59 mg/kg-day	1.4 mg/kg-day
Inhalation of volatiles	MLE:	—	350 days/yr	8 years	—	—	—	—	$\frac{EF \cdot ED}{AT}$	40 days/yr	350 days/yr
	RME:	—	350 days/yr	30 years	—	—	—	—		150 days/yr	350 days/yr
Dermal contact with soils	MLE:	—	40 days/yr	9 years	70 kg	5000 cm^2	0.2 mg/cm^2-day	Organics: 0.04* Metals: 0.001*	$\frac{EF \cdot ED \cdot SA \cdot AF \cdot DA}{BW \cdot AT}$	0.008 mg/kg-day**	0.063 mg/kg-day**
	RME:	—	350 days/yr	30 years	70 kg	5800 cm^2	1.0 mg/cm^2-day	Organics: 0.04* Metals: 0.001*		1.4 mg/kg-day**	3.2 mg/kg-day**
COMMERCIAL / INDUSTRIAL LAND USE											
Ingestion of potable water	MLE:	1 L/day	250 days/yr	4 years	70 kg	—	—	—	$\frac{CR \cdot EF \cdot ED}{BW \cdot AT}$	0.00056 L/kg-day	0.0098 L/kg-day
	RME:	1 L/day	250 days/yr	25 years	70 kg	—	—	—		0.0035 L/kg-day	0.0098 L/kg-day
Ingestion of soil and dust	MLE:	50 mg/day	250 days/yr	4 years	70 kg	—	—	—	$\frac{CR \cdot EF \cdot ED}{BW \cdot AT}$	0.028 mg/kg-day	0.49 mg/kg-day
	RME:	50 mg/day	250 days/yr	25 years	70 kg	—	—	—		0.17 mg/kg-day	0.49 mg/kg-day
Inhalation of volatiles	MLE:	—	250 days/yr	4 years	—	—	—	—	$\frac{EF \cdot ED}{AT}$	14 days/yr	250 days/yr
	RME:	—	250 days/yr	25 years	—	—	—	—		89 days/yr	250 days/yr
Dermal contact with soils	MLE:	—	40 days/yr	4 years	70 kg	5000 cm^2	0.2 mg/cm^2-day	Organics: 0.04* Metals: 0.001*	$\frac{EF \cdot ED \cdot SA \cdot AF \cdot DA}{BW \cdot AT}$	0.0036 mg/kg-day**	0.063 mg/kg-day**
	RME:	—	250 days/yr	25 years	70 kg	5800 cm^2	1.0 mg/cm^2-day	Organics: 0.04* Metals: 0.001*		1.4 mg/kg-day**	2.3 mg/kg-day**

NOTES:

1) Exposure factors shown above are matched to published U.S. EPA guidelines, when available (U.S. EPA, 1997, 1992a, 1991a). If no EPA value available, other peer-reviewed reference applied (American Industrial Health Council, 1994).

2) MLE = Most Likely Exposure; corresponding to mean exposure rate for exposed population (American Industrial Health Council, 1994; U.S. EPA, 1992a).

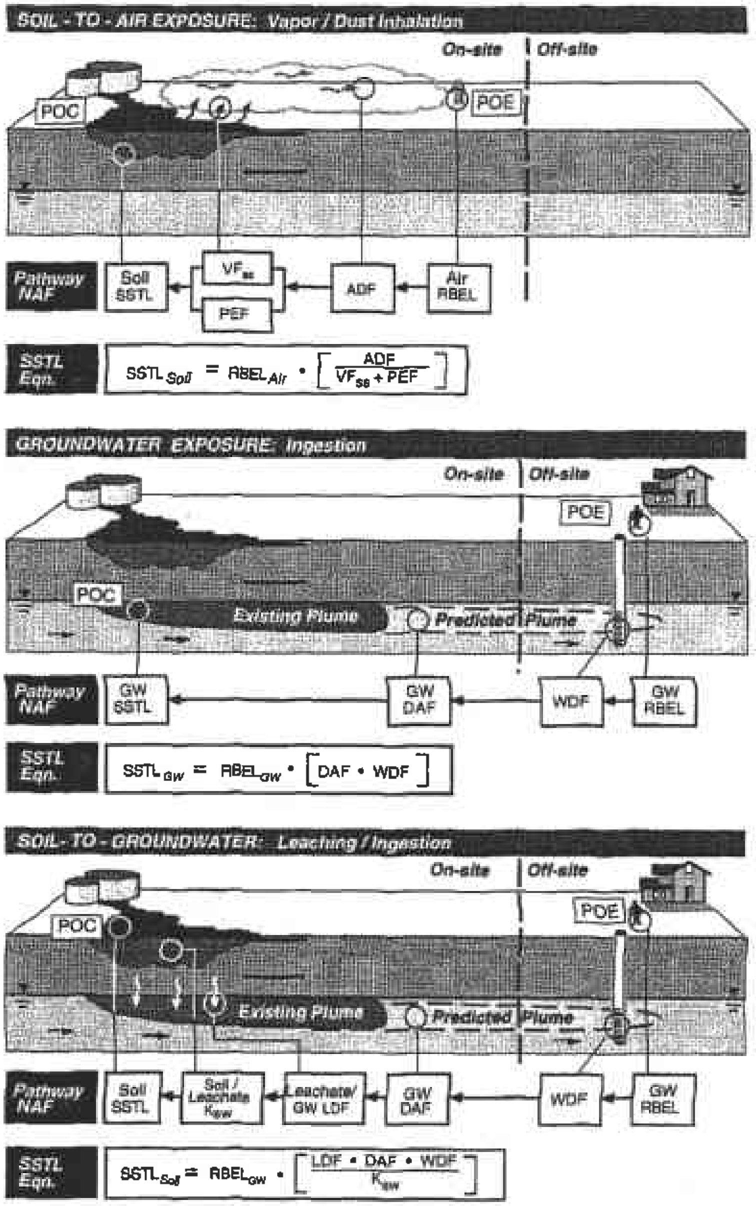
3) RME = Reasonable Maximum Exposure; corresponding to upper 95% exposure rate for exposed population (American Industrial Health Council, 1994; U.S. EPA, 1997, 1992a, 1991a).

4) AT = Averaging Time. For carcinogens, AT = 70 yrs x 365 days/yr. For non-carcinogens, AT = ED x 365 days/yr.

5) * = Default value. Use chemical-specific data if available. Values shown represent mid- to upper-range values per U.S. EPA, 1992b; Howard et al., 1991.

6) ** = Calculations of dermal contact with soils or sediments are based on organic default values. Contact rates for soil ingestion and dermal contact shown above are based upon adult receptor.

ii) fate-and-transport modeling analyses predicting this concentration ratio. For purpose of simplicity and accuracy, direct field measurements represent the preferred method of NAF estimation, whenever feasible. However, due to temporal variability and sampling difficulties, some of these factors can prove difficult to quantify via direct field measurements (e.g., soil volatilization or leaching factors). In this case, modeling analyses, based on appropriate site-specific data and conservative assumptions, provide a convenient method of estimation. NAF_{LT} for groundwater may be referred to as a groundwater dilution attenuation factor (DAF). DAFs are amenable to direct measurement via wells spaced along the centerline of the plume. In all cases, time-series groundwater monitoring data should be evaluated to establish the stability condition of the affected groundwater plume. Stable or diminishing plumes pose no risk to downgradient receptors located outside the plume area (i.e., DAF = infinite). Consequently, groundwater modeling analyses are necessary only for plumes for which available data either are insufficient to establish the stability condition or indicate an expanding plume.



NOTES:

SSTL	=	Site-Specific Target Level: i.e., allowable COC concentration in source medium.
RBEL	=	Risk-Based Exposure Limit, i.e., allowable COC concentration in exposure medium at point of exposure.
COC	=	Constituent of Concern
GW	=	Groundwater
POC	=	Point of Compliance
POE	=	Point of Exposure

Natural Attenuation Factors:

NAF	=	Natural Attenuation Factor.
VF_{ss}	=	Volatilization Factor for surface soils (mg/m^3 - air) / (mg/kg-soil).
PEF	=	Particulate Emission Factor for surface soils (g/cm^2 - s).
ADF	=	Air Dispersion Factor (mg/m^3 - air at POC) / (mg/m^3 - air at POE).
DAF	=	Groundwater Dilution-Attenuation Factor (mg/L - GW at POC) / (mg/L - GW at POE).
WDF	=	Well Dilution Factor (mg/L - well discharge) / (mg/L - plume edge).
LDF	=	Leachate - Groundwater Dilution Factor (cm^3/yr - GW) / (cm^3/yr - Leachate).
K_{sw}	=	Soil - Water Partition Factor (mg/L-water) / (mg/kg-soil).

FIGURE A.2. BACK-CALCULATION OF SSTL VALUES FOR SOIL AND GROUNDWATER *vi)* ***Risk Reduction Requirements:*** The SSTL represents an action level for affected media in the source zone. Source media containing COC concentrations in excess of applicable SSTLs will require further assessment or remediation to control exposure via the relevant exposure pathway(s). If the SSTLs were estimated on the basis of limited site-specific data or highly conservative assumptions, the appropriate response may be further site assessment and re-evaluation of appropriate target levels. For those pathways for which the results of the site-specific evaluation are reliable, appropriate remedies and exposure control measures must be selected and implemented, as discussed in Remedy Selection below.

- ***Applicable Data Evaluation Tools:*** Derivation of SSTL values involves calculation of NAF values for each complete exposure pathway and relevant constituents of concern. Analytical models which can be used for estimation of steady-state NAF values for various air, soil, and groundwater exposure pathways under Tiers 1 and 2 are incorporated in the RBCA Tool Kit. As noted above, it is advisable to evaluate SSTLs for both *actual* and *potential* POE locations in order to support remedy selection. In addition to steady-state models, the Transient Domenico Worksheet can be used to provide important information regarding the timing and duration of potential groundwater impacts.

Remedy Selection

For each exposure pathway determined to pose a health/environmental concern, a cost-effective remedy must be selected and implemented to achieve necessary risk reduction in the appropriate timeframe. This step of the site evaluation process involves development of an overall *exposure control strategy* and selection of optimal remediation technologies to implement this strategy.

The goal of risk-based site management is to minimize risk by preventing exposure to harmful levels of site constituents. Risk reduction can be achieved by addressing any component of the exposure pathway: i) removing or treating the source, ii) interrupting contaminant transport mechanisms, or iii) controlling activities at the point of exposure. The remedial action plan may consist of one or more exposure control strategies, including:

i) ***Removal/Treatment Action:*** Removal or treatment of affected source media (i.e., affected soils, groundwater, etc.) to reduce COC concentrations to levels less than or equal to applicable SSTLs (e.g., via excavation, soil venting, pump-and-treat, etc.).

ii) ***Containment Measures:*** Long-term engineering controls to prevent migration of harmful concentrations of COCs from the source to the POE (e.g., surface cover/capping, barrier walls, soil stabilization, hydraulic containment, etc.).

iii) ***Natural Attenuation Monitoring:*** Periodic sampling and analysis to confirm stabilization or reduction of affected media concentrations via natural attenuation processes.

iv) ***Institutional Controls:*** Legal or administrative measures to control the nature and frequency of human activity at the POE (e.g., deed notice, alternative water supply, etc.).

The appropriate exposure control strategy for a given site will depend on the nature of the risk reduction requirements. For example, as shown on Figure A.4, engineered remedies (such as removal/ treatment or containment strategies) are appropriate for response to current or anticipated impacts on actual receptors. If risk reduction is required only for protection of potential future receptors (e.g., hypothetical water well users), groundwater remediation by natural attenuation may be employed to confirm plume stabilization or reduction. No response action is required if constituent concentrations do not exceed SSTL values for either actual or potential receptors. The estimated *time to impact* determined in the risk-based site evaluation is also a key consideration in the remedy selection process. For example, if source media concentrations presently exceed an applicable SSTL value but the corresponding RBEL is not likely to be exceeded at the POE for an extended time period, additional time may be available for re-evaluation of potential exposure conditions based on site-specific monitoring program.

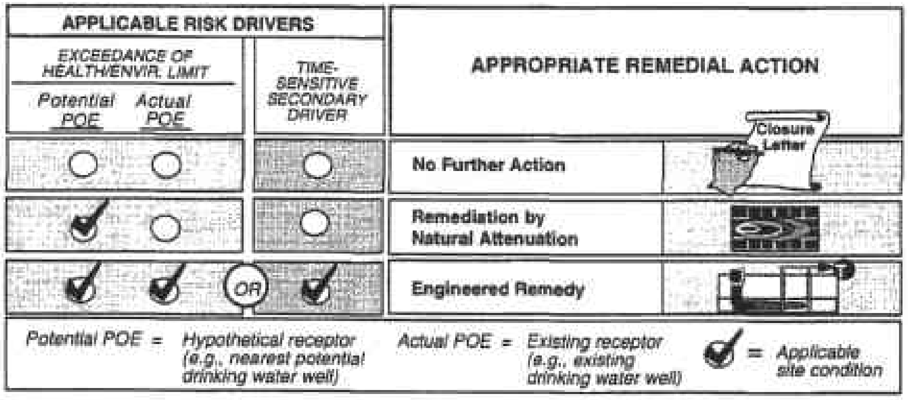


FIGURE A.4. POTENTIAL RISK-BASED REMEDY SELECTION CRITERIA

Compliance Monitoring Program Design

Under many regulatory programs, a final compliance monitoring period is required to confirm satisfactory completion of the remedy. Compliance monitoring (or *verification sampling*) typically involves sampling of one or more locations on an established schedule to identify either i) an exceedance of an applicable concentration limit or ii) a change of condition (e.g., change of land use, failure of engineering control) that might invalidate the basis for the remedy selection. If, upon completion of the monitoring period, compliance with applicable concentration limits is demonstrated, no further action is required.

- ***Applicable Data Evaluation Tools:*** To confirm compliance with applicable cleanup standards, compliance monitoring *action levels* for the groundwater exposure pathway can be derived using the same models used for SSTL calculation. Under this approach, groundwater compliance monitoring locations are selected between the source location (point of compliance) and the point of exposure (POE). By adjusting the distance variable on Transient Domenico Worksheet in the RBCA Tool Kit, the NAF value can be calculated for constituent transport from each monitoring point to the POE. The action level can be calculated as the arithmetic product of the NAF times the applicable RBEL for each constituent. If action levels are exceeded during the compliance monitoring period, further evaluation may be required to ensure adequate protection of downgradient receptors.

Model Selection Guidelines

Under the risk-based site evaluation process outlined above, fate-and-transport models are used to derive SSTL values based on estimation of the pathway-specific natural attenuation factor (NAF). Whenever feasible, direct field measurements represent the preferred method of NAF estimation. However, if the exposure pathway is not amenable to direct NAF measurement (e.g., volatilization factors, leachate factors, etc.) or if time-series analyses show the contaminant zone to be expanding over time, modeling analyses, based on appropriate site-specific data and conservative assumptions, can provide a convenient method of estimating future exposure levels.

The "best" model for a given site will be the simplest model providing a reliable and reasonably conservative prediction of potential exposure. Under the ASTM RBCA process, relatively simple analytical modeling tools are applied under Tiers 1 and 2, followed by more sophisticated modeling methods, if warranted, under Tier 3. The choice between simple and complex modeling methods should be dictated by the adequacy of the site database and the relative degree of error likely to be introduced by the model itself. In addition, the cost of upgrading to a more complex Tier 3 site evaluation must be warranted by the potential reduction in site remediation costs or the complex nature of the anticipated exposure condition. General guidelines for application of various types of fate-and-transport models under Tiers 1,2, and 3 are summarized below.

Model Dimensions: For each of the exposure pathways addressed in the RBCA standard, fate-and-transport models are available to estimate NAF values based on either a one-, two-, or three-dimensional analysis of contaminant transport. In reality, all contaminant transport occurs in three dimensions; however, one-dimensional (1-D) or two-dimensional (2-D) modeling tools may be employed for purpose of conservatism and simplicity. One-dimensional models, which ignore lateral and vertical dispersion effects, may significantly overestimate exposure levels and underestimate the pathway NAF. For this purpose, 2-D fate-and-transport models are commonly employed for Tier 1 and Tier 2 analyses, as presented in Appendix X3 of the ASTM RBCA Standard (*PS 104, 1998*[a])and included in the RBCA Tool Kit. Three-dimensional transport models may provide a more accurate and less conservative NAF estimate under a Tier 3 evaluation, but must be supported by three-dimensional characterization of key transport parameters (e.g., hydraulic conductivity, etc.). While three-dimensional models are not included in the RBCA Tool Kit, NAF values calculated by these models may be entered directly into the software in order to calculate baseline risks and cleanup standards.

Steady-State vs. Transient Analyses: Steady-state fate-and-transport models, which assume a constant source concentration and constant flow conditions over time, provide a conservative (lowerbound) NAF estimate corresponding to maximum chronic exposure conditions. In reality, following termination of the release, source concentrations in soil and groundwater are likely to diminish over time, resulting in time-variable exposure concentrations at the POE. For purpose of simplicity and conservatism, steady-state, constant-source models, providing a lowerbound NAF value, are commonly employed under Tiers 1 and 2. However, to support risk management decisions, these constant-source models can be run in a transient mode to predict the *time to impact*, i.e., the time required for the exposure concentration to exceed the RBEL at the POE. Under Tier 3, fully transient models, simulating both time-variable source concentrations and transport phenomena, can be used to characterize both the timing and *duration* of the RBEL exceedance. Again, these more sophisticated Tier 3 analyses should be based on sufficient site-specific data to support reliable modeling results.

Probabilistic vs. Deterministic Models: Under Tiers 1 and 2, exposure concentrations and NAF values are characterized on the basis of *deterministic* models which provide a unique output value for each unique set of input values. Uncertainty in the modeling analysis is addressed by means of a *sensitivity study*, i.e., by varying key input values to evaluate their potential impact on the model output. Under Tier 3, *probabilistic* modeling may be employed as a more sophisticated approach to management of model uncertainty. In probabilistic modeling, for each key input parameter, the user provides a probability distribution corresponding to the range and type of distribution observed for the parameter at the site. The model then completes the fate-and-transport calculation for the full range of these input values, effectively conducting multiple random model sensitivity studies. The model result is not a unique value but a probability distribution defining the possible range of results (e.g., exposure concentration, NAF value) for the specified site conditions. The probabilistic analysis provides the user with relatively sophisticated information regarding possible exposure conditions (e.g., for a given SSTL value, what is the probability that the RBEL will be exceeded at any future time?) However, to support reliable results, this Tier 3 modeling method will typically require significant additional site characterization data relative to Tier 1 or Tier 2 deterministic analyses.

RBCA Tool Kit for Chemical Releases

The RBCA Tool Kit has been developed expressly for use with the Tier 1 and Tier 2 site evaluation procedures outlined in the ASTM RBCA Standard (PS 104, 1998a).Based upon site-specific data supplied by the user, the RBCA Tool Kit combines fate-and-transport modeling and risk characterization functions to compute: exposure concentrations, average daily intake, baseline risk levels, and risk-based media cleanup standards

Key features of the RBCA Tool Kit relevant to SSTL calculations and risk-based remedy selection are outlined below.

MODEL CALCULATION FUNCTIONS

Using a system of ten analytical models linked to internal libraries of standard exposure factors and chemical/toxicological data for over 90 compounds, the RBCA Tool Kit can calculate either baseline risk levels or cleanup standards for each complete exposure pathway identified by the user. Key calculation steps are as follows:

Exposure Concentrations: Based on representative concentrations of constituents of concern (COCs) present in the affected source media, maximum steady-state concentrations likely to occur at the point of exposure (POE) are calculated using the steady-state analytical fate-and-transport models identified in Appendix X3 of ASTM PS 104. To perform these calculations, the system evaluates cross-media partitioning (e.g., volatilization from soil to air) and lateral transport from the source to the POE (e.g., contaminant transport via air or groundwater flow). The source media and optional exposure pathways included in the software are as follows:

SOURCE MEDIA	EXPOSURE PATHWAYS
Surface Soils	Inhalation of Vapor and Particulates Dermal Contact with Soil Ingestion of Soil and Dust Leaching to Groundwater
Subsurface Soils	Inhalation of Vapor Leaching to Groundwater
Groundwater	Ingestion of Potable Water Inhalation of Vapor Discharge to Surface Water - Ingestion/Dermal Contact via Swimming - Ingestion via Fish Consumption - Aquatic Life Protection

Average Daily Intake: Based upon the exposure factors selected by the user, the average daily chemical intake for each receptor along each selected pathway is calculated in accordance with EPA guidelines (see Connor et al., 1997). These values are used in baseline risk calculations for each complete pathway.

Baseline Risk Characterization: Human health risks associated with exposure to COCs are calculated by the software on the basis of average daily intake rates and the corresponding toxicological parameters for carcinogenic and non-carcinogenic effects. For each complete pathway, the system output provides both individual and additive constituent results for carcinogens and non-carcinogens.

Media Cleanup Values: The RBCA Tool Kit has the ability to i) compare the site data to Tier 1 Risk-Based Screening Levels (RBSLs), computed using the default parameter values as listed in ASTM PS 104, or ii) calculate Tier 2 Site-Specific Target Levels (SSTLs) based on user-supplied site information. For each source medium (i.e., affected soil and groundwater), the software reports target concentrations for all complete pathways and identifies the applicable (i.e., minimum) value for source remediation. The equations used by the RBCA Tool Kit to calculate RBSLs and SSTLs are presented in Table A.2.

TABLE A.2 RBSL AND SSTL EQUATIONS USED IN THE RBCA TOOL KIT

GROUNDWATER EXPOSURE PATHWAY	
Groundwater Ingestion	
Carcinogens: $RBSL_{GW} = \frac{TR \cdot BW \cdot AT_C}{SFo \cdot EF \cdot ED \cdot IR_w}$ Non-Carcinogens: $RBSL_{GW} = \frac{THQ \cdot RfDo \cdot BW \cdot AT_n}{EF \cdot ED \cdot IR_w}$	$SSTL_{GW} = RBSL_{GW} \cdot DAF$
Soil Leaching to Groundwater → Groundwater Ingestion	
Carcinogens: $RBSL_S = \frac{TR \cdot BW \cdot AT_C}{SFo \cdot EF \cdot ED \cdot IR_w \cdot LF}$ Non-Carc.: $RBSL_S = \frac{THQ \cdot RfDo \cdot BW \cdot AT_n}{EF \cdot ED \cdot IR_w \cdot LF}$	$SSTL_s = RBSL_s \cdot DAF$
SOIL EXPOSURE PATHWAY	
Surface Soil Ingestion, Inhalation, and Dermal Contact	
Carcinogens: $RBSL_{SS} = \frac{TR \cdot BW \cdot AT_C}{EF \cdot ED \cdot [(SFo \cdot IR_s) + (URF \cdot 1000 \cdot BW \cdot (VF_{ss} + VF_p)) + (SFd \cdot SA \cdot M \cdot RAF_d)]}$ Non-Carc.: $RBSL_{SS} = \frac{THQ \cdot BW \cdot AT_n}{EF \cdot ED \cdot \left[\left(\frac{IR_s}{RfDo}\right) + \left(\frac{BW \cdot (VF_{ss} + VF_p)}{RfC}\right) + \left(\frac{SA \cdot M \cdot RAF_d}{RfDd}\right)\right]}$	$SSTL_{ss} = RBSL_{ss}$ *(No lateral transport; receptor at source.)*
OUTDOOR AIR EXPOSURE PATHWAY	
Subsurface Soil Volatilization to Ambient Air	
Carcinogens: $RBSL_S = \frac{TR \cdot AT_C}{EF \cdot ED \cdot URF \cdot 1000 \cdot VF_{samb}}$ Non-Carcinogens: $RBSL_S = \frac{THQ \cdot RfC \cdot AT_n}{EF \cdot ED \cdot VF_{samb}}$	$SSTL_s = RBSL_s \cdot ADF$
Groundwater Volatilization to Ambient Air	
Carcinogens: $RBSL_{GW} = \frac{TR \cdot AT_C}{EF \cdot ED \cdot URF \cdot 1000 \cdot VF_{wamb}}$ Non-Carcinogens: $RBSL_{GW} = \frac{THQ \cdot RfC \cdot AT_n}{EF \cdot ED \cdot VF_{wamb}}$	$SSTL_{GW} = RBSL_{GW} \cdot ADF$

Continued

TABLE A.2 RBSL AND SSTL EQUATIONS USED IN THE RBCA TOOL KIT **Continued**

INDOOR AIR EXPOSURE PATHWAY

Subsurface Soil Volatilization to Enclosed Space

Carcinogens: $$RBSL_S = \frac{TR \cdot AT_C}{EF \cdot ED \cdot URF \cdot 1000 \cdot VF_{sesp}}$$

Non-Carcinogens: $$RBSL_S = \frac{THQ \cdot RfC \cdot AT_n}{EF \cdot ED \cdot VF_{sesp}}$$

$SSTL_{GW} = RBSL_{GW}$

(No lateral transport; receptor at source.)

Groundwater Volatilization to Enclosed Space

Carcinogens: $$RBSL_{GW} = \frac{TR \cdot AT_C}{EF \cdot ED \cdot URF \cdot 1000 \cdot VF_{wesp}}$$

Non-Carcinogens: $$RBSL_{GW} = \frac{THQ \cdot RfC \cdot AT_n}{EF \cdot ED \cdot VF_{wesp}}$$

$SSTL_{GW} = RBSL_{GW}$

(No lateral transport; receptor at source.)

SURFACE WATER EXPOSURE PATHWAY

Groundwater Discharge to Surface Water → Swimming and Fish Consumption

RBSL not applicable.

(Receptor located away from source.)

Carcinogens: $$SSTL_{GW} = \frac{TR \cdot BW \cdot AT_C \cdot DAF \cdot DF_{gw-sw}}{ED \cdot \left[(SFo \cdot EV \cdot ET \cdot IR_{sw}) + (SFd \cdot EV \cdot SA_{sw} \cdot Z) + (SFo \cdot IR_{fish} \cdot FI_{fish} \cdot BCF)\right]}$$

Non-Carc.: $$SSTL_{GW} = \frac{THQ \cdot BW \cdot AT_n \cdot DAF \cdot DF_{gw-sw}}{ED \cdot \left[\left(\frac{EV \cdot ET \cdot IR_{sw}}{RfDo}\right) + \left(\frac{EV \cdot SA_{sw} \cdot Z}{RfDd}\right) + \left(\frac{IR_{fish} \cdot FI_{fish} \cdot BCF}{RfDo}\right)\right]}$$

Soil Leaching to Groundwater → Groundwater Discharge to Surface Water → Swimming and Fish Consumption

RBSL not applicable.

(Receptor located away from source.)

Carcinogens: $$SSTL_S = \frac{TR \cdot BW \cdot AT_C \cdot DAF \cdot DF_{gw-sw}}{ED \cdot \left[(SFo \cdot EV \cdot ET \cdot IR_{sw}) + (SFd \cdot EV \cdot SA_{sw} \cdot Z) + (SFo \cdot IR_{fish} \cdot FI_{fish} \cdot BCF)\right] \cdot LF}$$

Non-Carc.: $$SSTL_S = \frac{THQ \cdot BW \cdot AT_n \cdot DAF \cdot DF_{gw-sw}}{ED \cdot \left[\left(\frac{EV \cdot ET \cdot IR_{sw}}{RfDo}\right) + \left(\frac{EV \cdot SA_{sw} \cdot Z}{RfDd}\right) + \left(\frac{IR_{fish} \cdot FI_{fish} \cdot BCF}{RfDo}\right)\right] \cdot LF}$$

Groundwater Discharge to Surface Water → Aquatic Life Protection

RBSL not applicable.

(Receptor located away from source.)

Carcinogens: $$SSTL_{GW} = AQL \cdot DAF \cdot DF_{gw-sw}$$

Non-Carcinogens: $$SSTL_{GW} = AQL \cdot DAF \cdot DF_{gw-sw}$$

Soil Leaching to Groundwater → Groundwater Discharge to Surface Water → Aquatic Life Protection

RBSL not applicable.

(Receptor located away from source.)

Carcinogens: $$SSTL_S = \frac{AQL \cdot DAF \cdot DF_{gw-sw}}{LF}$$

Non-Carcinogens: $$SSTL_S = \frac{AQL \cdot DAF \cdot DF_{gw-sw}}{LF}$$

Continued

TABLE A.2 RBSL AND SSTL EQUATIONS USED IN THE RBCA TOOL KIT *Continued*

PARAMETER DEFINITIONS

ADF	Lateral air dispersion factor (unitless)
AQL	Aquatic protection criteria (mg/L)
AT_c	Averaging time - carcinogens (yr)
AT_n	Averaging time - non-carcinogens (yr)
BCF	Bioconcentration factor (mg/kg-fish)/(mg/L-wat)
BW	Body weight (kg)
DAF	Lateral groundwater dilution-attenuation factor (unitless)
$DF_{gw\text{-}sw}$	Groundwater to surface water dilution factor (unitless)
ED	Exposure duration (yr)
EF	Exposure frequency (d/yr)
ET	Exposure time (hr/event)
EV	Event frequency (events/yr)
FI_{fish}	Fraction of ingested fish from affected surface water (unitless)
IR_{fish}	Rate of fish consumption (kg/yr)
IR_s	Soil ingestion rate (kg/d)
IR_{sw}	Water ingestion rate while swimming (L/hr)
IR_w	Water ingestion rate (L/d)
LF	Soil-to-GW leaching factor (mg/L-wat)/(mg/kg-soil)
M	Soil-to-skin adherence factor ($mg/cm^2/d$)
RAF_d	Relative absorption factor for soil dermal contact (unitless)
$RBSL_{GW}$	Risk-based screening level for groundwater (mg/L)
$RBSL_S$	Risk-based screening level for soil (mg/kg)
$RBSL_{SS}$	Risk-based screening level for surface soil (mg/kg)
RfC	Reference concentration (mg/m^3)
RfDd	Chronic dermal reference dose (mg/kg/d)
RfDo	Chronic oral reference dose (mg/kg/d)
SA	Skin surface area for soil dermal contact (cm^2)
SA_{sw}	Skin surface area for swimming dermal contact (cm^2)
SFd	Dermal slope factor $(mg/kg/d)^{-1}$
SFo	Oral slope factor $(mg/kg/d)^{-1}$
$SSTL_{GW}$	Site-specific target level for groundwater (mg/L)
$SSTL_s$	Site-specific target level for soil (mg/kg)
$SSTL_{ss}$	Site-specific target level for surface soil (mg/kg)
THQ	Target hazard quotient
TR	Target risk
URF	Unit risk factor $(\mu g/m^3)^{-1}$
VF_p	Particulate emission factor (mg/m^3-air)/(mg/kg-soil)
VF_{samb}	Subsurface soil to ambient air volatilization factor (mg/m^3-air)/(mg/kg-soil)
VF_{sesp}	Subsurface soil to enclosed space volatilization factor (mg/m^3-air)/(mg/kg-soil)
VF_{ss}	Surface soil to ambint air volatilization factor (mg/m^3-air)/(mg/kg-soil)
VF_{wamb}	GW to ambient air volatilization factor (mg/m^3-air)/(mg/L-wat)
VF_{wesp}	GW to enclosed space volatilization factor (mg/m^3-air)/(mg/L-wat)
Z	Water to skin dermal absorption factor (cm/event)

RISK-BASED DECISION SUPPORT FEATURES

The RBCA Tool Kit includes several features designed to support key steps of the risk-based site evaluation process, including the following:

Step-by-Step Evaluation Process: From the Main Screen of the graphical user interface, the user is guided through all the necessary steps for completing the Tier 1 or Tier 2 evaluation process. On subsequent screens the interface leads the user through exposure pathway identification, model selection, site-specific parameter input, and output review. All output screens may be printed in a report-quality format.

Analysis of Actual and Potential POEs: Multiple off-site exposure points are allowed for the groundwater and outdoor air pathways. This enables the user to evaluate risks at both actual (e.g. an actual nearby well) and potential (e.g., a hypothetical well at the property boundary) POEs. Whether site risks affect an actual or potential POE adds a qualitative dimension to the risk calculations which may be an important factor in remedy selection at some sites.

Transient Groundwater Modeling Analyses: An optional Transient Domenico Worksheet is provided to allow the user to estimate the time required for site constituents to impact off-site groundwater POEs. Groundwater risk levels and cleanup standards calculated by the software are based on steady-state concentrations. However, the time to reach steady-state concentrations at off-site POEs may be very long for some constituents. Thus, the time required to exceed a concentration limit at a POE may be an important factor in remedy selection as near-term impacts may require a significantly different response than longer-term impacts (e.g., an engineered response vs. natural attenuation).

Summary

The RBCA Tool Kit for Chemical Releases provides a system of simple analytical fate-and-transport models that can be used for comprehensive risk-based evaluation of potential soil, air, groundwater, and surface water exposure pathways. However, as with all predictive modeling efforts, reliable results require proper characterization of site-specific input parameters. In all cases, model predictions must be shown to be consistent with the actual constituent distributions observed at the site. Use of the Tier 1 and Tier 2 calculation methods outlined in the ASTM RBCA Standard (PS 104, 1998) and incorporated in the RBCA Tool Kit can significantly reduce the time and effort required for evaluation of risk reduction requirements and selection of appropriate exposure control methods. However, proper scientific and/or engineering expertise is required both for characterization of input parameters and assessment of model results.

APPENDIX II-B

Fate and Transport Modeling Methods

Source: Groundwater Services, Inc.

The RBCA Tool Kit contains a series of fate and transport models for predicting COC concentrations at points of exposure (POEs) located downwind or downgradient of source areas for air or groundwater exposure pathways, respectively. Under Tiers 1 and 2, relatively simple analytical models are to be employed for these calculations. The RBCA Tool Kit is consistent with Appendix X3 of ASTM PS-104, although selected algorithms and default parameters have been updated to reflect advances in evaluation methods.

The idealized schematic shown on Figure B.1 illustrates the steps included in the RBCA Tool Kit for predicting transport of contaminants from the source zone to the POE for air and groundwater exposure pathways. Each element in Figure B.1 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). 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.

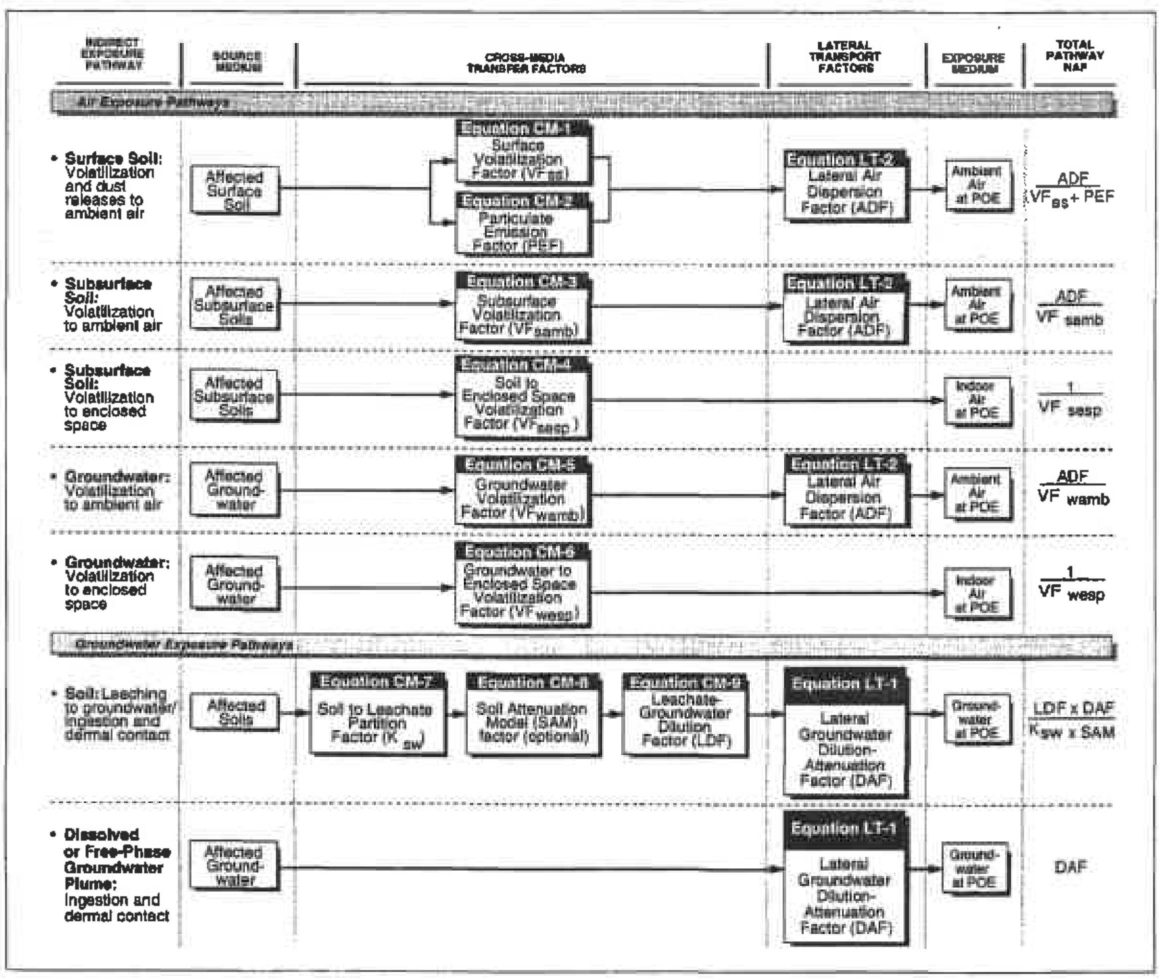


FIGURE B.1. NAF CALCULATION SCHEMATIC FOR INDIRECT EXPOSURE PATHWAYS

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 Tool Kit are presented in Figure B.2. Detailed discussion of each of these cross-media factors is provided below.

- ***VF_{SS}: Surface Soil Volatilization Factor (Equation CM-1)***

  The surface volatilization factor is the steady-state ratio of the predicted 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 B.2). Equation CM-1a typically controls for low-volatility compounds, as it assumes there is an infinite source of chemical in the surface soils and uses a volatilization rate based primarily on chemical properties. Equation CM-1b, which typically controls for volatile organic compounds (VOCs), is based on a mass balance approach. In this equation, a finite amount of chemical 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 chemicals 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.

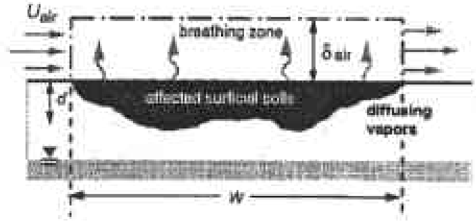
  Key assumptions used in this model and their effect on the SSTL calculation are as follows:

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 predicted concentration of chemicals in particulates in the ambient air breathing zone to the source concentration of chemical 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.

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:

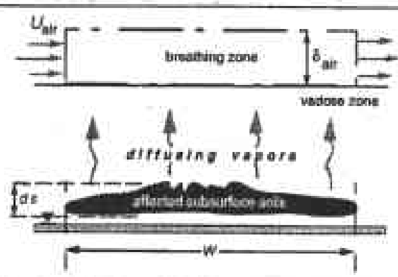
$$VF_{ss}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{W\rho_s d}{U_{air}\delta_{air}\tau}\times10^3$$

whichever is less

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

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

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



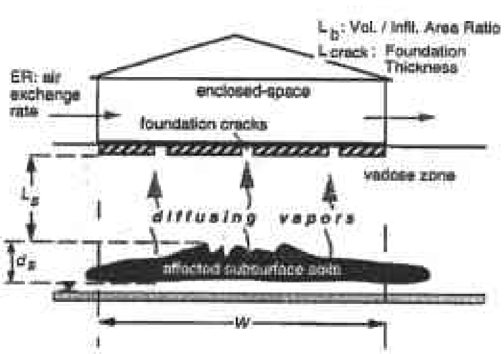
CM-3a:

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

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:

For $Q_s=0$:

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

For $Q_s>0$:

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

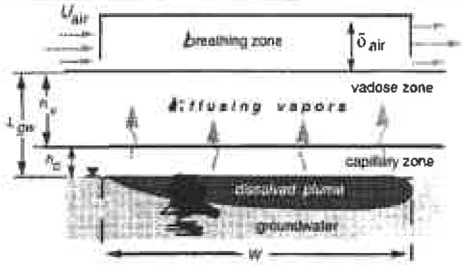
or CM-4b: $$VF_{sesp}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{\rho_s d_s}{L_B ER\tau}\,x\times10^3$$

whichever is less

FIGURE B.2. CROSS-MEDIA TRANSFER FACTORS IN THE RBCA TOOL KIT   ***Continued***

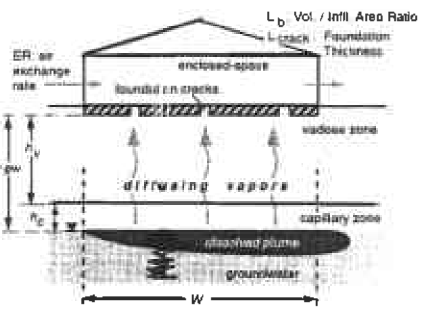
Continued

Equation CM-5: Groundwater Volatilization Factor (VFwamb)



$$VF_{wamb}\left[\frac{(mg/m^3-air)}{(mg/L-H_2O)}\right]=\frac{H}{1+\left[\frac{U_{air}\,\delta_{air}\,L_{GW}}{D_{ws}^{eff}\,W}\right]}\times 10^3$$

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



For $Q_s=0$:

$$VF_{wesp}\left[\frac{(mg/m^3-air)}{(mg/L-H_2O)}\right]=\frac{H\left[\frac{D_{ws}^{eff}/L_{GW}}{ER\,L_B}\right]}{1+\left[\frac{D_{ws}^{eff}/L_{GW}}{ER\,L_B}\right]+\left[\frac{D_{ws}^{eff}/L_{GW}}{\left(D_{crack}^{eff}/L_{crack}\right)\cdot\eta}\right]}\times 10^3$$

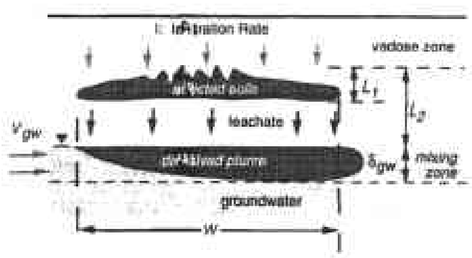
For $Q_s>0$:

$$VF_{wesp}\left[\frac{(mg/m^3-air)}{(mg/L-H_2O)}\right]=\frac{H\left[\frac{D_{ws}^{eff}/L_{GW}}{ER\,L_B}\right]e^{\xi}}{e^{\xi}+\left[\frac{D_{ws}^{eff}/L_{GW}}{ER\,L_B}\right]+\left[\frac{D_{ws}^{eff}/L_{GW}}{Q_s/A_b}\right]\left[e^{\xi}-1\right]}\times 10^3$$

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

Equation CM-8: Optional Soil Attenuation Model (SAM) Factor

Equation CM-9: Leachate-Groundwater Dilution Factor (LDF)



CM-7: $$K_{sw}\left[\frac{(mg/L-H_2O)}{(mg/kg-soil)}\right]=\frac{\rho_s}{\theta_{ws}+k_s\rho_s+H\theta_{as}}$$

CM-8: $$SAM\,[dimensionless]=\frac{L_1}{L_2}$$

CM-9: $$LDF\,[dimensionless]=1+\frac{V_{gw}\,\delta_{gw}}{I\cdot W}$$

Effective Diffusion Coefficients

Effective diffusivity in vadose zone soils:

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

Effective diffusivity through foundation cracks:

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

Effective diffusivity above the water table:

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

Effective diffusivity in the capillary zone:

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

Convective Air Flow Through Foundation Cracks

$$\xi=\frac{Q_s/A_b}{\left(D_{crack}^{eff}/L_{crack}\right)\cdot\eta}$$

$$Q_s=\frac{2\pi\,\Delta p\,k_v\,X_{crack}}{\mu_{air}\ln\left[\frac{2\,Z_{crack}\,X_{crack}}{A_b\,\eta}\right]}$$

FIGURE B.2. CROSS-MEDIA TRANSFER FACTORS IN THE RBCA TOOL KIT **Continued**

SJC

Continued

Definitions for Cross-Media Transfer Equations

A_b	Area of building foundation (cm2)
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_c	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 = foc . koc (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)
L_1	Thickness of affected soils (cm)
L_2	Distance from top of affected soils to top of water-bearing unit = $L_{GW} - L_S$ (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)
X_{crack}	Enclosed space foundation perimeter (cm)
Z_{crack}	Depth to base of enclosed space foundation (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^3-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 B.2. CROSS-MEDIA TRANSFER FACTORS IN THE RBCA TOOL KIT

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, VFsamb, corresponds to the lesser result of two calculation methods (termed CM-3a and CM-3b on Figure B.2). Equation CM-3a, which corresponds to the expression given in Appendix X3 of ASTM PS-104, 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 Tool Kit. 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 predicted concentration of a chemical constituent in indoor air 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 20 exchanges per day (commercial) or 12 exchanges per day (residential). 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 predicted concentration of a chemical 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 vapors in the breathing zone is estimated using a box model, as described for Equation CM-1 above.

- ***SAM: Optional Soil Attenuation Model (SAM) factor (Equation CM-8)***
  An optional factor based on the Soil Attenuation Model (see Connor *et al.*, 1997) may be applied to incorporate depth effects by accounting for the sorption of constituents from the leachate onto clean soils underlying the affected soil zone. The presence of clean intervening soils reduces constituent concentrations ultimately delivered to the underlying groundwater. In deeper groundwater systems, wherein a significant thickness of unaffected soils underlies the affected soil zone, neglecting the sorptive capacity of the intervening soils can prove overly conservative. Note that SAM corresponds to movement of *dissolved* constituents through porous media and does not apply to cases involving downward migration of mobile NAPL materials.

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

KEY ASSUMPTIONS: SAM	EFFECT ON CLEANUP STANDARD
• **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-9)***
  The LDF factor accounts for dilution of chemical constituents as leachate from the overlying affected soil zone mixes with groundwater in the underlying water-bearing unit. As indicated on Figure B.1, the leachate dilution factor (LDF) divided by the soil-leachate partition factor (K_{sw}) represents the steady-state ratio between the concentration of a constituent in the groundwater zone and the source concentration in the overlying affected soil. To estimate the leachate dilution factor, a simple box model is used to estimate dilution within a mixing zone in the water-bearing unit directly beneath the affected soil mass (see Equation CM-9, Figure B.2). 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 PS-104, Appendix X3. 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.	⇩

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 B.1). 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 Tool Kit. Equations for the steady-state analytical transport models incorporated in the RBCA Tool Kit are shown on Figure B.3. 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.

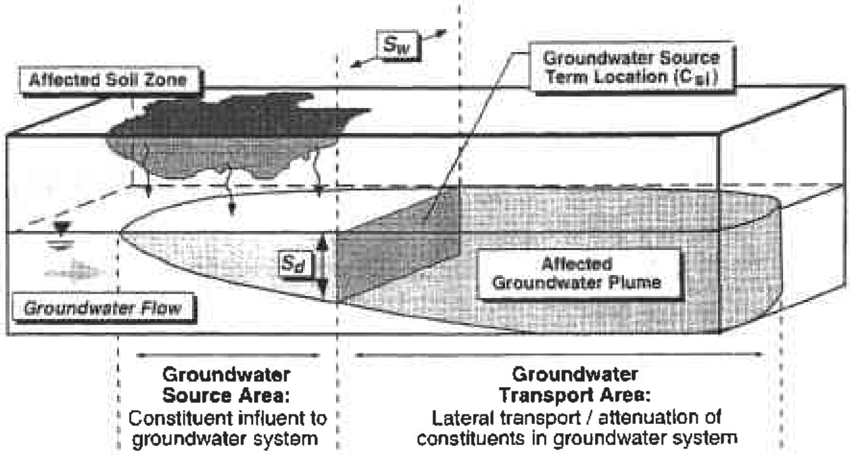
- ***DAF: Lateral Groundwater Dilution Attenuation Factor (Equation LT-1)***
  To account for attenuation of affected groundwater concentrations between the source and POE, the Domenico analytical solute transport model has been incorporated into the RBCA Tool Kit. This model uses a partially or completely penetrating vertical plane source, perpendicular to groundwater flow, to simulate the release of constituents from the mixing zone to the migrating groundwater (see Figure B.3). 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 Tool Kit, 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 Tool Kit, 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 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. These values should correspond to the maximum COC concentrations measured at the plume "core" unless sufficient data are available to describe a representative maximum based on 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. 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. Selection of dispersion coefficients can prove problematic, given the impracticability of direct site measurements. Two dispersivity relationships are incorporated in the RBCA Tool Kit: i) the method employed in ASTM E-1739 (1995) and ii) the Xu and Eckstien (1995) dispersivity model. These relationships allow the user to estimate 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. The RBCA Tool Kit 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 (f_{oc}) 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 steady-state conditions.

  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 Tool Kit, the user may elect to use a version of the Domenico solute transport model incorporating first-order decay (see Equation LT-1a on Figure B.3). Considerable care must be exercised in the selection of a first-order decay coefficient for each COC in order to



SELECTION OF GROUNDWATER MODEL INPUT PARAMETERS

For use of Domenico groundwater solute transport model, select source term location, dimensions, and concentration as follows:

1) Groundwater Source Term Location

The source term corresponds to a vertical source plane, normal to the direction of groundwater flow, located at the downgradient limit of the area serving as the principal source of constituent release to groundwater (e.g., affected unsaturated zone soils, NAPL plume, spill area, etc.). If the point of maximum plume concentration is significantly displaced from the initial suspected point of release, this plume "core" should be used as the source point for the groundwater ingestion pathway. However, the downgradient edge of the affected soil zone should be retained as the source location for the soil-to-groundwater leaching pathway. Distances to downgradient points of exposure (POEs) should then be measured from the applicable source location along the principal direction of groundwater flow.

2) Groundwater Source Term Width, S_W

The width of the source term should be matched to the following dimensions:

i) for groundwater ingestion, the measured groundwater plume width, (as defined by RBSL), perpendicular to the principal direction of groundwater flow at the designated source term location.

ii) for soil-to-groundwater impacts, the maximum width of the affected soil zone (as defined by RBSL), perpendicular to the principal groundwater flow direction.

3) Groundwater Source Term Thickness, S_d

The thickness of the source term should be determined by one of the following methods:

i) measure the vertical extent of the affected groundwater plume at the designated source term location, based on depth-specific groundwater sampling and testing; or

ii) for unconfined water-bearing unit, estimate mixing zone depth at the source location based on the observed magnitude of water table fluctuation.

4) Groundwater Source Term Concentration, C_{si}

To calculate baseline risk levels, the user must also provide a groundwater source concentration C_{si} for each constituent of concern (COC). The vertical plane source acts as a constant source term, applying these input concentrations to all groundwater flowing through the source location. For input to the Domenico model, the source concentration of each COC may be matched to the average concentration (i.e., either mean or 95% UCL) measured across the plume width at the source location.

FIGURE B.3. DEFINITION OF DOMENICO MODEL SOURCE TERM avoid significantly over-predicting or under-predicting actual biodecay rates. An optional method for preliminary selection of decay coefficients is as follows:

Literature Values: Various published references are available regarding decay half-life values for hydrolysis and biodegradation. The chemical/toxicological database in the RBCA Tool Kit includes minimum published decay rate coefficients (representing maximum decay half-lives) for each chemical, and the user may select to use these or enter other values. These first-order decay coefficients are provided for informational purposes and may used for preliminary analyses. Note, however, that the use of minimum published decay rates will not necessarily ensure conservative modeling results (i.e., predict worst-case exposure concentrations and more stringent cleanup standards).

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 simulate solute 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 estimate biodegradation effects on organic plume concentrations at the POE, without the difficulty associated with selection of a site-specific, first-order decay rate. Note, however, that this method is not valid for modeling the sequential degradation of chlorinated compounds.

For this purpose, the RBCA Tool Kit includes a version of the Domenico solute transport model incorporating an electron acceptor superposition algorithm (see Equation LT-1b on Figure B.4), as employed in the BIOSCREEN model (Newell et al., 1996). 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 in Figure B.5 and discussed in further detail below.

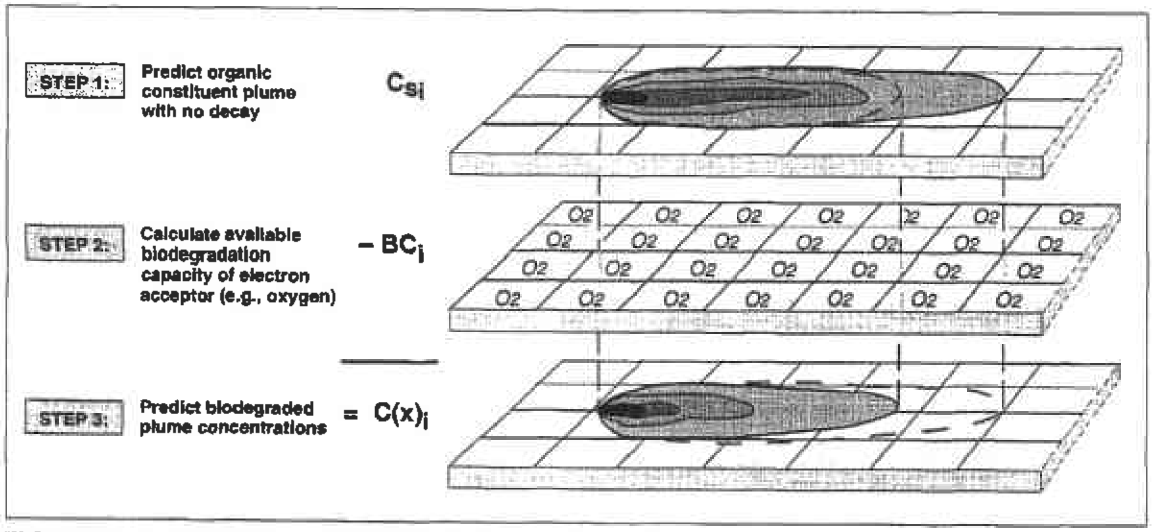


FIGURE B.5. ELECTRON ACCEPTOR SUPERPOSITION METHOD

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 relating to the degradation of BTEX present in shallow groundwater systems, as reported in the research literature, are summarized on Table B.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.	⇩
• **Vertical Dispersion**: Assumes one-directional (downward) vertical dispersion.	⇩
• **Infinite Aquifer Thickness**: Neglects boundary effects on vertical dispersion.	⇧
• **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**: First-order of decay rate may be specified by user per site data.	⇧

- ***ADF: Lateral Air Dispersion Factor (Equation LT-2)***
The RBCA Tool Kit 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 B.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 B.1, 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 Tool Kit, 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 B.2. 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 B.2). 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 in the RBCA Tool Kit.

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 Tool Kit, 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 B.6. Corresponding horizontal and vertical dispersion coefficients for each class are provided on Figure B.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 DeVaull et al., 1994).

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 Tool Kit 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. Note that, even when these average dispersion coefficients are employed, the exposure concentrations predicted by the RBCA Tool Kit 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.	⇩

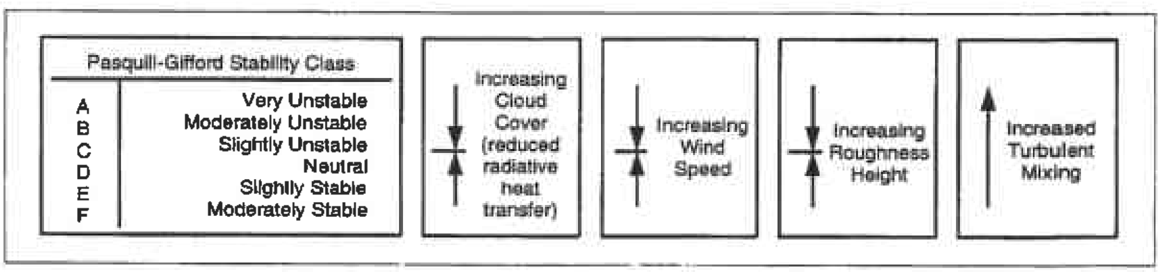


FIGURE B.6. STABILITY CLASSIFICATION FOR AIR TRANSPORT MODELING
SOURCE: DEVAULL ET AL, 1994

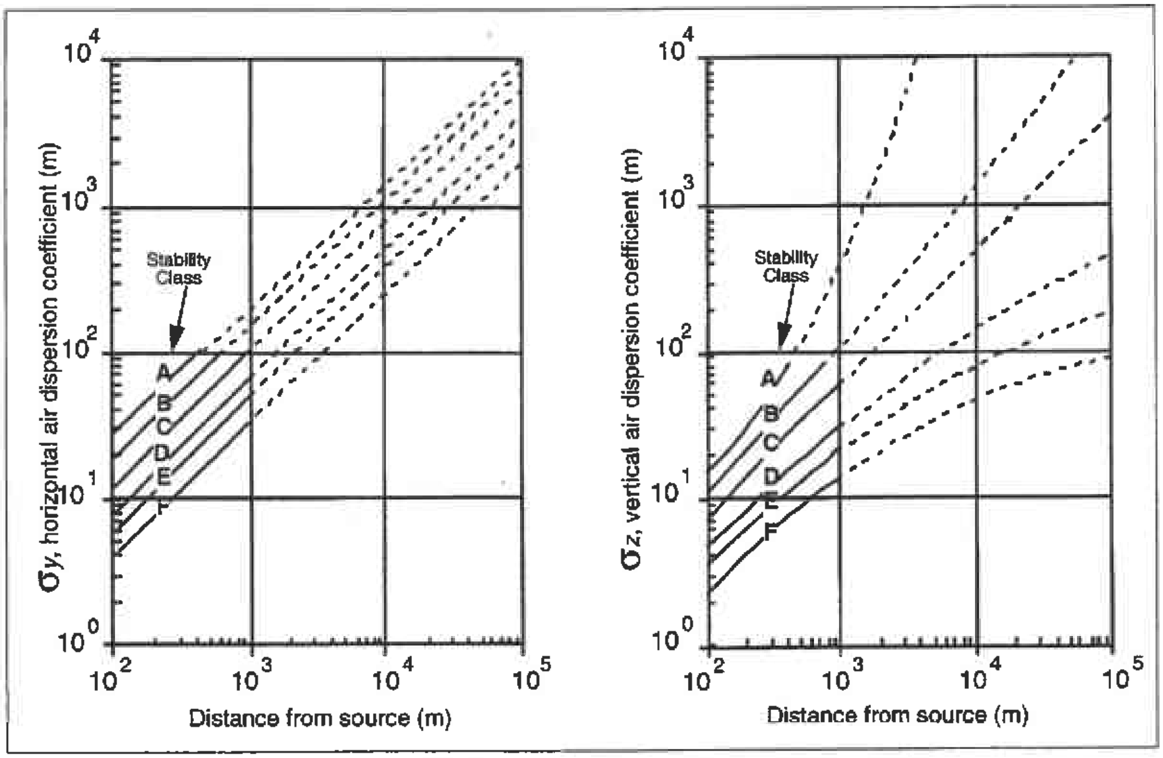


FIGURE B.7. DISPERSION COEFFICIENTS FOR AIR STABILITY CLASSIFICATIONS
SOURCE: EPA, 1988

APPENDIX II-C

Permeability Tests

SJC

PERMEABILITY (CONSTANT HEAD METHOD)

PROJECT NO. 1470.002 DATE 5-19-03 TESTED BY K

BORING NO. Fill SAMPLE DEPTH

SOIL SAMPLE Blk silty CLAY, some sand (CL)

Relative Compaction

90 % DD 111 pcf

WC 13 %

Remolding Data

	Wet Soil and Mold (pounds)		417.1
	Mold (pounds)		210.0
d=2.5	Wet Soil (pounds)	.45657	207.1
L=1.35	Multiplication Factor (ft³)	.003835	
	Wet Density (pcf)	119.06	

Container No. X²	GRAMS
Weight of Container + Wet Soil	79.3
Weight of Container + Dry Soil	70.1
Weight of Water, W_w	
Weight of Container	21.0
Weight of Dry Soil, W_s	

Dry Density, pcf	100.3

Water Content,	18.7

Elapsed Time	Output (g)	cm³/sec	A.P.C	k
120 sec	0.88	.00733	7.7×10^{-5}	5.64×10^{-7}
"	0.72	.00600	"	4.62×10^{-7}
"	1.04	.00867	"	6.68×10^{-7}

Applied Pressure 20 psi

Permeability Constant (k) 5.65×10^{-7} cm/sec

FUGRO

ASTM D1557

COMPACTION CURVE

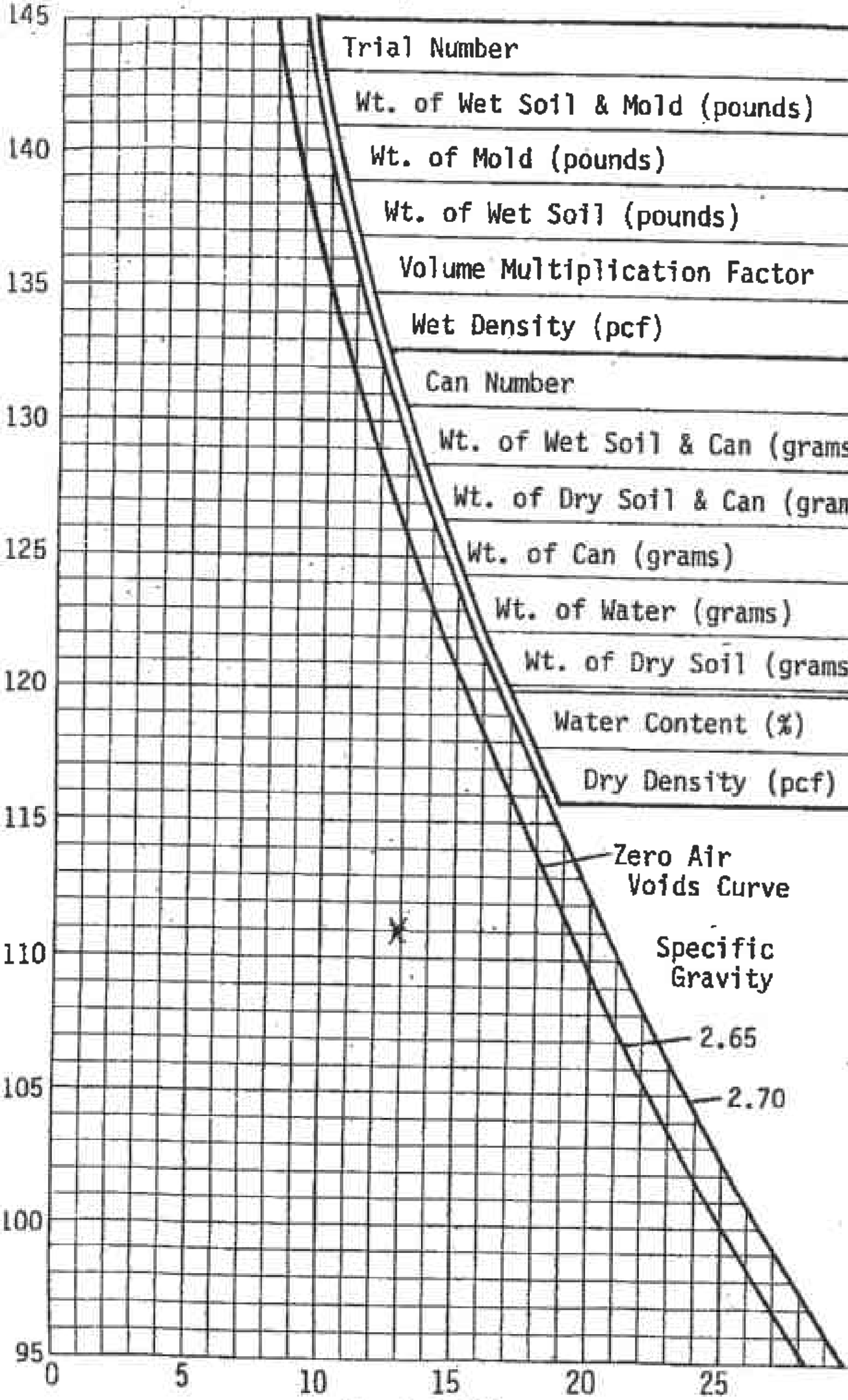
PROJECT NO. 1470.002 PROJECT NAME Andante

SAMPLE NO. 2 SOURCE OF MATERIAL (Fill)

DESCRIPTION Dark Brown Silty CLAY (CL), some sand

DATE 5/19/03

TESTED BY JC



Trial Number	0%				
Wt. of Wet Soil & Mold (pounds)	13.56				
Wt. of Mold (pounds)	9.39				
Wt. of Wet Soil (pounds)	4.17				
Volume Multiplication Factor	30				
Wet Density (pcf)	125.1				
Can Number	RR				
Wt. of Wet Soil & Can (grams)	824				
Wt. of Dry Soil & Can (grams)	735				
Wt. of Can (grams)	38.7				
Wt. of Water (grams)					
Wt. of Dry Soil (grams)					
Water Content (%)	12.8				
Dry Density (pcf)	110.9				

90% WET @ %		95% WET @ %
MAXIMUM DRY DENSITY (pcf)	est	111
OPTIMUM WATER CONTENT (%)	est	13

ASTM D 1557-91 METHOD (Check One)			
Method A	4-Inch Mold/No. 4 Sieve		
Method B	4-Inch Mold/⅜-Inch Sieve	✓	
Method C	6-Inch Mold/¾-Inch Sieve		
Total Wt.	+¾" <5%	+⅜" ~0%	+#4
g.	g.	g.	g.
100%	%	%	%

FUGRO

CC-1

PERMEABILITY (CONSTANT HEAD METHOD)

PROJECT NO. 1470.002 DATE 5-20-03 TESTED BY K

BORING NO. Insitu SAMPLE DEPTH

SOIL SAMPLE Blk silty CLAY (CH)

Relative Compaction 90 % DD 112 pcf

WC 13 %

Remolding Data

Wet Soil and Mold (pounds)		395.1
Mold (pounds)		210.0
Wet Soil (pounds)	0.40807	185.1
Multiplication Factor	.003409	
Wet Density (pcf)	119.7	

d=2.5
L=1.2

Container No. X	GRAMS
Weight of Container + Wet Soil	79.5
Weight of Container + Dry Soil	70.4
Weight of Water, W_w	
Weight of Container	21.0
Weight of Dry Soil, W_s	

Dry Density, pcf	101.1

Water Content,	18.4

Elapsed Time	Output (g)	cm³/sec	A.P.C	k
1200 sec	0.53	4.417×10^{-4}	3.91×10^{-5}	1.73×10^{-8}

Applied Pressure 35 psi

Permeability Constant (k) 1.73×10^{-8} cm/sec

FUGRO

- ASTM D1557

COMPACTION CURVE

PROJECT NO. 1470.002 PROJECT NAME Arlante

SAMPLE NO. 1 SOURCE OF MATERIAL In Situ

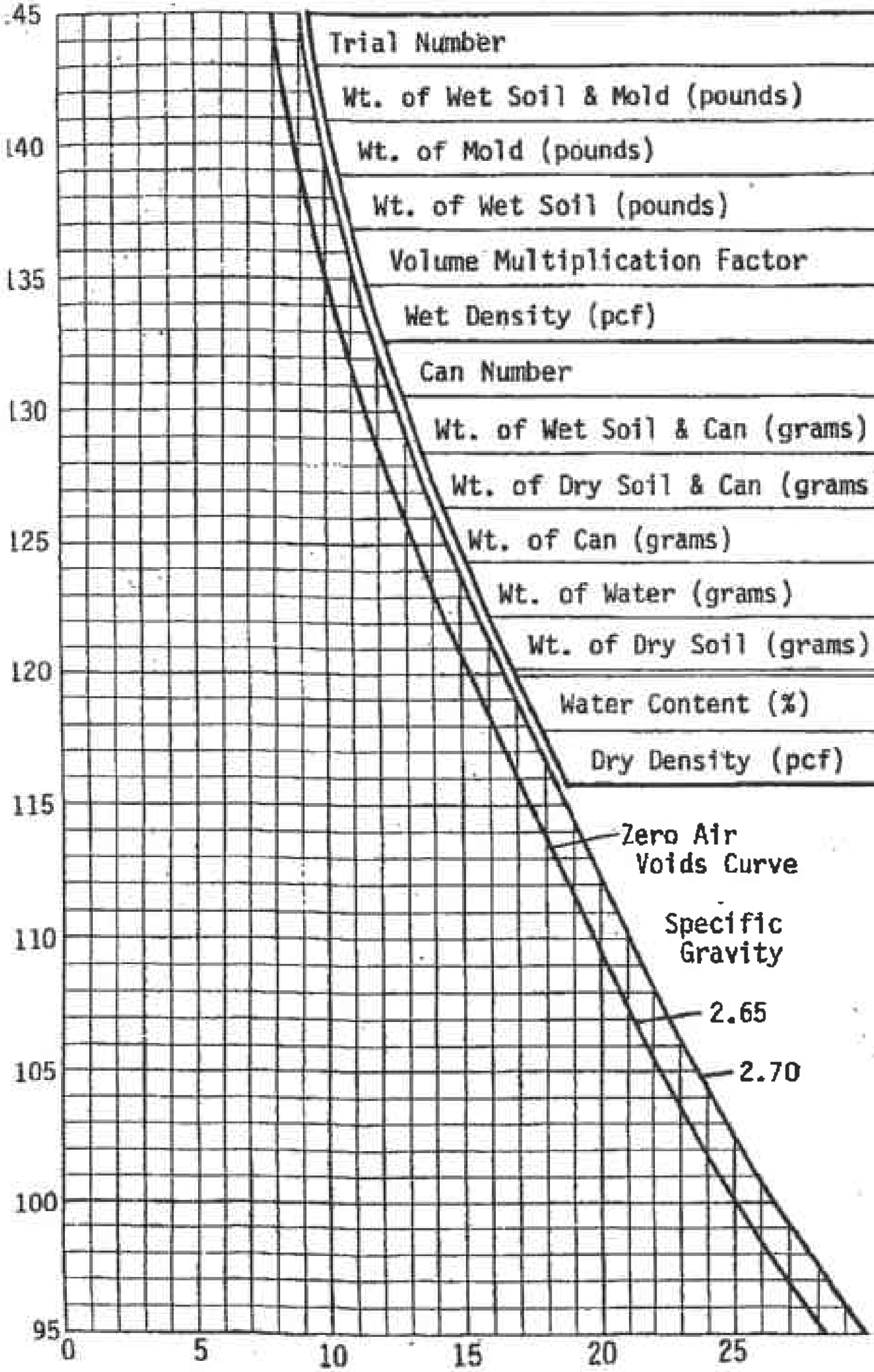
DESCRIPTION Blk silty clay (CL-CH)

DATE 5/19/03

TESTED BY JC

J.C

Trial Number	2 ?					
Wt. of Wet Soil & Mold (pounds)	13.62					
Wt. of Mold (pounds)	9.39					
Wt. of Wet Soil (pounds)	4.23					
Volume Multiplication Factor	30					
Wet Density (pcf)	126.9					
Can Number	PQR					
Wt. of Wet Soil & Can (grams)	817					
Wt. of Dry Soil & Can (grams)	726.3					
Wt. of Can (grams)	38.7					
Wt. of Water (grams)						
Wt. of Dry Soil (grams)						
Water Content (%)	13.2					
Dry Density (pcf)	112.1					



90% WET	@ %	95% WET	@ %
MAXIMUM DRY DENSITY (pcf)	est.	112	
OPTIMUM WATER CONTENT (%)	est.	13	

ASTM D 1557-91 METHOD (Check One)			
Method A	4-Inch Mold/No. 4 Sieve		
Method B	4-Inch Mold/⅜-Inch Sieve		
Method C	6-Inch Mold/¾-Inch Sieve		
Total Wt.	+¾" ≤5%	+⅜" <20%	+#4
g.	g.	g.	g.
100%	%	%	%

FUGRO

CC-1

APPENDIX II-D

Health Risk Assessment Building 1

RBCA Tool Kit for Chemical Releases, Version 1.3a

Main Screen

RBCA Tool Kit for Chemical Releases
Version 1.3a © 2000

1. Project Information

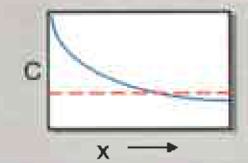
Site Name: SNK Andante Bld. 1
Location: 3992 San Pablo Ave. Emeryville
Compl. By: Dai Watkins
Date: 30-Aug-03 Job ID: 9401.205

2. Which Type of RBCA Analysis?

○ **Tier 1**

Generic Values
On-Site
Exposure

◉ **Tier 2**



Site-Specific Values
On- or Off-Site Exposure

3. Calculation Options

Affects which input data are required

☑ ***Baseline Risks (Forward mode)***

☐ ***RBCA Cleanup Standards (Backward mode)***

4. RBCA Evaluation Process

Prepare Input Data

Data Complete? (■= yes, ■= no)

- Exposure Pathways
- Constituents of Concern (COCs)
- Transport Models
- Soil Parameters
- GW Parameters
- Air Parameters

Review Output

- Exposure Flowchart
- COC Chem. Parameters
- Input Data Summary
- User-Spec. COC Data...
- Transient Domenico Analysis...
- Baseline Risks...
- Cleanup Standards...

5. Commands and Options

New Site	Load Data...	Save Data As...	Quit
Print Sheet	Set Units	Custom Chem. Data...	Help

RBCA Tool Kit for Chemical Releases, Version 1.3a

Exposure Pathway Identification

Site Name: SNK Andante Bld. 1
Location: 3992 San Pablo Ave. Emeryville
Compl. By: Dai Watkins
Job ID: 9401.205 Date: 30-Aug-03

1. Groundwater Exposure

Groundwater Ingestion/ Surface Water Impact

Receptor	None	None	None
Type:	On-site	Off-site1	Off-site2

Source Media

Distance to GW receptors

	0	0	0	(ft)
☐ Affected Groundwater	On-site	Off-site1	Off-site2	
☐ Affected Soil Leaching to Groundwater	0	0	0	(ft)

GW Discharge to Surface Water Exposure

☐ Swimming
☐ Fish Consumption
☐ Aquatic Life Protection

Enter ALP Criteria

2. Surface Soil Exposure

Direct Ingestion and Dermal Contact

Receptor	None	No off-site receptors
Type:	On-site	

Construction Worker ☐

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation

Receptor	Res.	None	None	
Type:	On-site	Off-site1	Off-site2	
	0	0	0	(ft)

Construction worker ☑

☑ Affected Soils--Volatilization to Ambient Outdoor Air
☑ Affected Groundwater--Volatilization to Ambient Outdoor Air
☐ Affected Surface Soils--Particulates to Ambient Outdoor Air

Volatilization to Indoor Air Inhalation

Receptor	Com.	No off-site receptors
Type:	On-site	

☑ Affected Soils--Volatilization to Enclosed Space
☑ Affected Groundwater--Volatilization to Enclosed Space

4. Commands and Options

Main Screen | Print Sheet | Set Units | Help

Exposure Factors & Target Risks | Exposure Flowchart

Building 1

RBCA Tool Kit for Chemical Releases, Version 1.3a

Exposure Factors and Target Risk Limits

Site Name: SNK Andante Bld. 1
Location: 3992 San Pablo Ave. Emeryville
Compl. By: Dai Watkins
Job ID: 9401.205 — Date: 30-Aug-03

1. Exposure Parameters

	Age Adjustment?	Residential Adult	Residential (Age 0-6)	Residential (Age 0-16)	Commercial Chronic	Commercial Construc.
Averaging time, carcinogens (yr)		70				
Averaging time, non-carcinogens (yr)		30			25	1
Body weight (kg)		70	15	35	70	
Exposure duration (yr)		30	6	16	25	1
Exposure frequency (days/yr)		350			250	180
Dermal exposure frequency (days/yr)		350			250	
Skin surface area, soil contact (cm^2)	☑	5800		2023	5800	5800
Soil dermal adherence factor ($mg/cm^2/day$)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☑	100	200		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☑	0.05	0.5			
Skin surface area, swimming (cm^2)	☑	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				

2. Risk Goal Calculation Options

○ Individual Constituent Risk Goals Only

◉ Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcins.)	1.0E-6	1.0E-6
Target Risk (Class C carcinogens)	1.0E-6	
Target Hazard Quotient	2.0E-1	
Target Hazard Index		2.0E-1

4. Commands and Options

Return to Exposure Pathways

Use Default Values

Print Sheet

Help

Building 1

RBCA Tool Kit for Chemical Releases, Version 1.3a

Site Name: SNK Andante Bld. 1 Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville Date: 30-Aug-03
Compl. By: Dai Watkins

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

☐ Apply Raoult's Law ?

Selected COCs	*Representative COC Concentration* ?			
COC Select: Add/Insert, Delete — *Sort List:* Top, Bottom, MoveUp, MoveDown ?	**Groundwater Source Zone** (Enter Directly / Enter Site Data)		**Soil Source Zone** (Enter Directly / Enter Site Data)	
	(mg/L)	note	*(mg/kg)*	note
Benzene	1.5E+0		2.8E-1	
Toluene	2.4E+0		6.4E-1	
Ethylbenzene	7.3E-1		2.2E+0	
Xylene (mixed isomers)	3.7E+0		9.6E+0	
Methyl t-Butyl ether	7.4E-2		2.5E-3	
Naphthalene	1.4E-1		1.7E-1	

RBCA Tool Kit for Chemical Releases, Version 1.3a

Transport Modeling Options

Site Name: SNK Andante Bld. 1 | Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville | Date: 30-Aug-03
Compl. By: Dai Watkins

1. Vertical Transport, Surface Soil Column

Outdoor Air Volatilization Factors

- ○ Surface soil volatilization model only
- ◉ Combination surface soil/Johnson & Ettinger models
  - Thickness of surface soil zone: 1.43 (ft)
- ○ User-specified VF from other model [Enter VF Values]

Indoor Air Volatilization Factors

- ◉ Johnson & Ettinger model
- ○ User-specified VF from other model [Enter VF Values]

Soil-to-Groundwater Leaching Factor

- ○ ASTM Model
  - ☐ Apply Soil Attenuation Model (SAM)
  - ☐ Allow first-order biodecay [Enter Decay Rates]
- ○ User-specified LF from other model [Enter LF Values]

2. Lateral Air Dispersion Factor

Wind

- ○ 3-D Gaussian dispersion model
- ○ User-Specified ADF

	Off-site 1	Off-site 2	
	1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor

Calculate DAF using Domenico Model

- ○ Domenico equation with dispersion only (no biodegradation)
- ○ Domenico equation first-order decay [Enter Decay Rates]
- ○ Modified Domenico equation using electron acceptor superposition [Enter Site Data]
  - [Enter Directly] Biodegradation Capacity: NC (mg/L)

— or —

User-Specified DAF Values

- ○ DAF values from other model or site data [Enter DAF Values]

4. Commands and Options

[Main Screen] [Print Sheet] [Help]

RBCA Tool Kit for Chemical Releases, Version 1.3a

Site-Specific Soil Parameters

Site Name: SNK Andante Bld. 1	Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville	Date: 30-Aug-03
Compl. By: Dai Watkins	

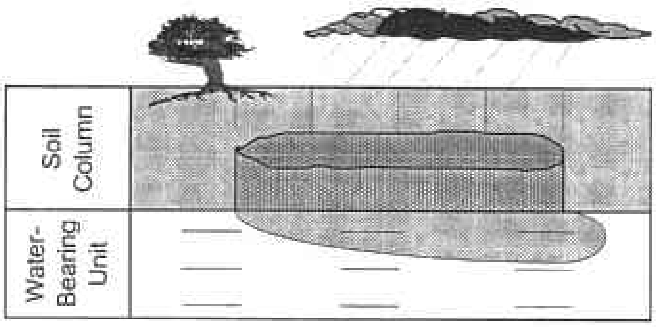
1. Soil Source Zone Characteristics

Hydrogeology

	General Case	Construction	
Depth to water-bearing unit	6.43		(ft)
Capillary zone thickness	5		(ft)
Soil column thickness	1.43		(ft)

Affected Soil Zone

	General Case	Construction	
Depth to top of affected soils	6.43		(ft)
Depth to base of affected soils	6.43		(ft)
Affected soil area	5418	5418	(ft^2)
Length of affected soil parallel to assumed wind direction	235	235	(ft)



2. Surface Soil Column

	Vadose Zone	Capillary Fringe	
Total porosity	0.3412		(-)
Volumetric water content	0.275	0.3312	(-)
Volumetric air content	0.0662	0.01	(-)
Dry bulk density	1.7		(kg/L)
Vertical hydraulic conductivity	5.7E-7		(cm/s)
Vapor permeability	1.1E-16		(ft^2)
Capillary zone thickness	5.0E+0		(ft)

or Calculate

NA

or

Partitioning Parameters

Fraction organic carbon	0.02	(-)
Soil/water pH	6.8	(-)

3. Commands and Options

Main Screen | Use Default Values | Print Sheet

Set Units | Help

Building 1

RBCA Tool Kit for Chemical Releases, Version 1.3a

Site-Specific Air Parameters

Site Name: SNK Andante Bld. 1	Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville	Date: 30-Aug-03
Compl. By: Dai Watkins	

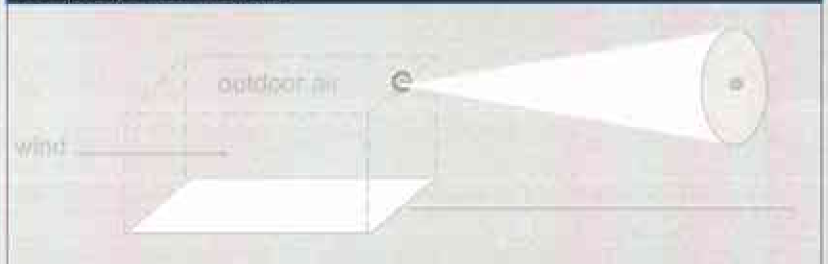
1. Outdoor Air Pathway

Dispersion in Air

	Off-site 1	Off-site 2	
Distance to offsite air receptor			(ft)
or NA			
Horizontal dispersivity			(ft)
Vertical dispersivity			(ft)

Air Source Zone

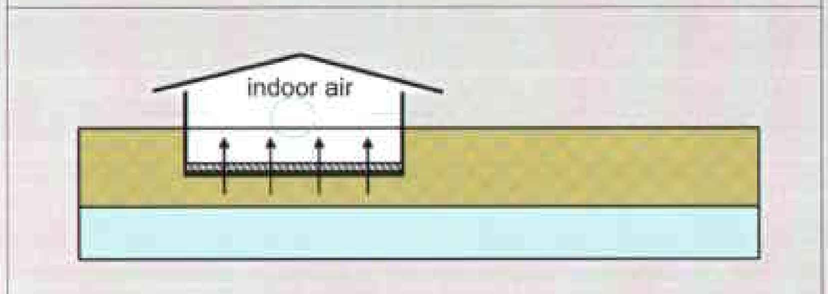
Air mixing zone height	6.56	(ft)
Ambient air velocity in mixing zone	10.56	(ft/s)
Areal particulate emission flux		(g/cm^2/s)



2. Indoor Air Pathway

Building Parameters

	Residential	Commercial	
Building volume/area ratio		12	(ft)
Foundation area		5418	(ft^2)
Foundation perimeter		338	(ft)
Building air exchange rate		1.4E-3	(1/s)
Depth to bottom of foundation slab		0.42	(ft)
Convective air flow through cracks		2.2E-7	(ft^3/s)
Foundation thickness	0.42		(ft)
Foundation crack fraction	0.001		(-)
Volumetric water content of cracks	0.12		(-)
Volumetric air content of cracks	0.26		(-)
Indoor/Outdoor differential pressure	0.01		(psi)



3. Commands and Options

Main Screen | Use Default Values | Print Sheet | Set Units | Help

Commands and Options	Site Name: SNK Andante Bld. 1	Job ID: 9401.205
Return / Print Sheet / Help	Location: 3992 San Pablo Ave. Emeryville	Date: 30-Aug-03
	Compl. By: Dai Watkins	

Groundwater Source Zone Concentration Calculator

UCL Percentile: 95%

Paste Defaults | Mean Option

Constituent	Detection Limit (mg/L)	No. of Samples	No. of Detects	Estimated Distribution of Data	Max. Conc. (mg/L)	Mean Conc. (mg/L)	UCL on Mean (mg/L)
Benzene	5.0E-4	1	1	-	1.5E+0	1.5E+0	NA
Toluene	5.0E-4	1	1	-	2.4E+0	2.4E+0	NA
Ethylbenzene	5.0E-4	1	1	-	7.3E-1	7.3E-1	NA
Xylene (mixed isomers)	1.0E-4	1	1	-	3.7E+0	3.7E+0	NA
Methyl t-Butyl ether	5.0E-4	1	1	-	7.4E-2	7.4E-2	NA
Naphthalene	1.0E-2	1	1	-	1.4E-1	1.4E-1	NA

RBCA Tool Kit for Chemical Releases, Version 1.3a

Enter Analytical Data from Groundwater Source Zone (up to 50 Data Points)

Analytical Data

	1	2	3	4	5	6	7	8	9	10	11	12	13
ID	1.00E+0												
Date	10-Jun-03												
	(mg/L)	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*
	1.50E+0												
	2.40E+0												
	7.30E-1												
	3.70E+0												
	7.40E-2												
	1.40E-1												

RBCA Tool Kit for Chemical Releases, Version 1.3a

Commands and Options

Return | Print Sheet | Help

Site Name: SNK Andante Bld. 1 — Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville — Date: 30-Aug-03
Compl. By: Dai Watkins

Soil Source Zone Concentration Calculator

UCL Percentile: 95%

Paste Defaults | Mean Option

Constituent	Detection Limit (mg/kg)	No. of Samples	No. of Detects	Estimated Distribution of Data	Max. Conc. (mg/kg)	Mean Conc. (mg/kg)	UCL on Mean (mg/kg)
Benzene	5.0E-3	27	13	Lognormal	1.8E+1	7.9E-2	2.8E-1
Toluene	5.0E-3	27	13	Lognormal	4.3E+1	1.5E-1	6.4E-1
Ethylbenzene	5.0E-3	27	18	Lognormal	4.4E+1	5.6E-1	2.2E+0
Xylene (mixed isomers)	5.0E-3	27	20	Lognormal	2.4E+2	2.1E+0	9.6E+0
Methyl t-Butyl ether	5.0E-3	27	0	Normal	0.0E+0	2.5E-3	2.5E-3
Naphthalene	3.4E-1	27	0	Normal	0.0E+0	1.7E-1	1.7E-1

RBCA Tool Kit for Chemical Releases, Version 1.3a

Enter Analytical Data from
Soil Source Zone
(up to 50 Data Points)

Analytical Data

	1	2	3	4	5	6	7	8	9	10	11	12	13
ID	0S-40E	0S-60E	0S-80E	0S-100E	0S-120E	0S-140E	20S-10E	20S-20E	20S-40E	20S-60E	20S-100E	20S-120E	20S-140E
Date	9-May-03	9-May-03	9-May-03	16-May-03	14-May-03	14-May-03	9-May-03	13-May-03	11-May-03	11-May-03	16-May-03	12-May-03	27-May-03
	(mg/kg)	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
	ND	ND	6.00E+0	ND	3.10E-2	ND	ND	ND	2.30E+0	9.90E+0	1.80E+1	6.40E+0	7.80E+0
	ND	3.70E+1	1.50E+1	2.00E+1	ND	ND	ND	2.00E+0	8.10E+0	3.00E+1	4.30E+1	2.20E+1	ND
	ND	4.40E+1	1.60E+1	1.70E+1	3.70E-2	2.30E+0	ND	6.00E+0	3.90E+0	1.40E+1	3.90E+1	1.90E+1	3.80E+1
	1.30E+1	2.40E+2	7.90E+1	1.00E+2	ND	1.10E+0	ND	3.00E+1	1.90E+1	7.90E+1	1.90E+2	9.30E+1	8.70E+1
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Analytical Data

14	15	16	17	18	19	20	21	22	23	24	25	26
40S-0E	40S-20E	40S-60E	40S-80E	40S-100E	40S-120E	40S-140E	60S-0E	60S-20E	60S-40E	60S-60E	60S-80E	60S-100E
9-May-03	14-May-03	15-May-03	27-May-03	27-May-03	27-May-03	21-May-03	9-May-03	16-May-03	16-May-03	13-May-03	27-May-03	20-May-03
(mg/kg)	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
ND	1.90E+0	6.70E+0	ND	7.20E-1	3.60E+0	ND	3.40E+0	ND	1.20E+1	ND	ND	ND
ND	3.00E+0	1.50E+1	ND	ND	3.70E+0	ND	2.00E+1	ND	1.20E+1	ND	ND	ND
ND	3.50E+0	1.80E+1	ND	1.80E+0	8.40E+0	ND	2.20E+1	ND	2.80E+1	8.00E+0	ND	ND
5.70E-2	1.80E+1	1.10E+2	2.00E-2	8.60E+0	3.90E+1	ND	1.20E+2	ND	1.40E+2	3.70E+1	ND	ND
n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

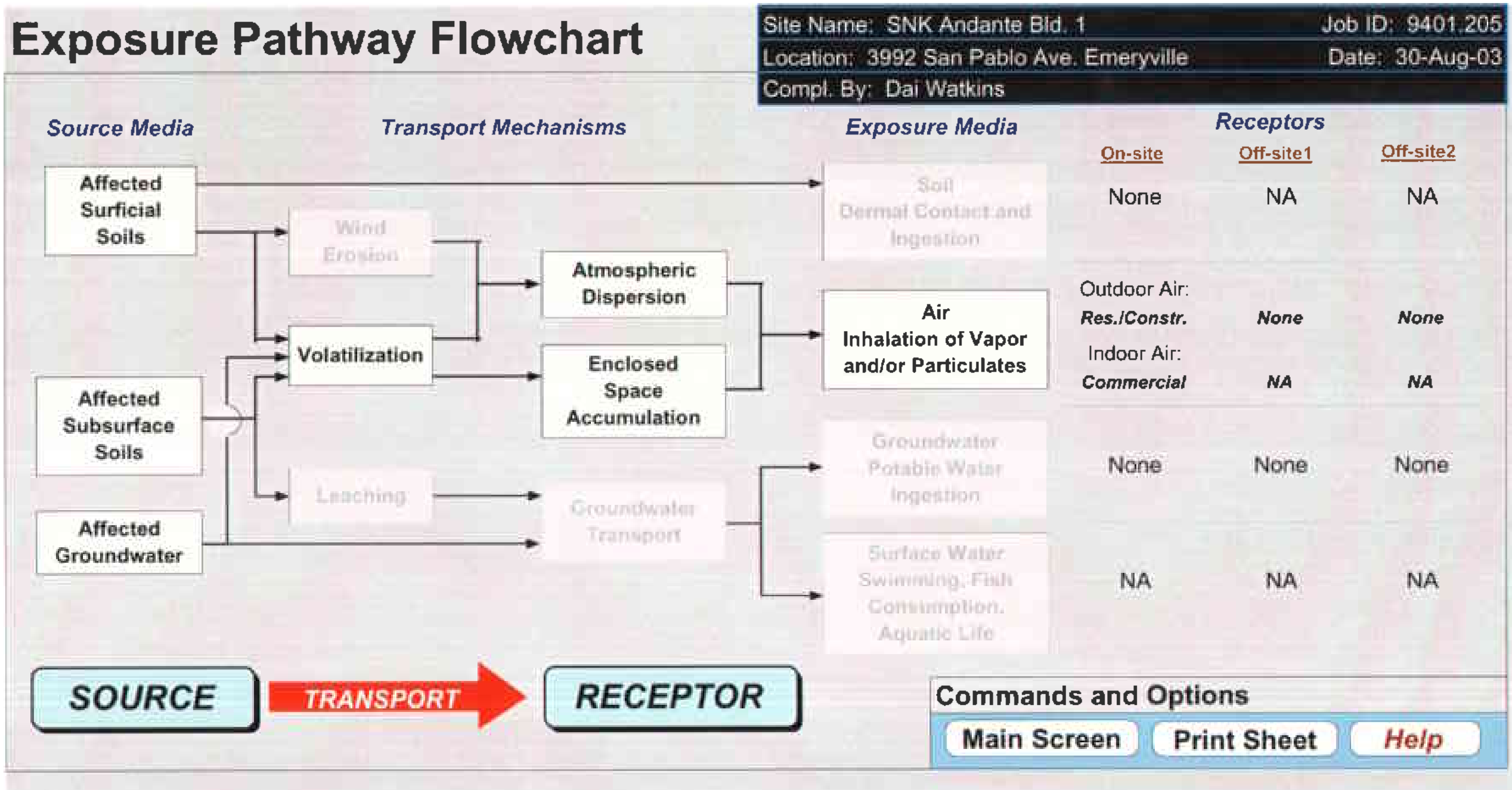
RBCA Tool Kit for Chemical Releases, Version 1.3a

Analytical Data

27	28	29	30	31	32	33	34	35	36	37	38	39
60S-120E												
20-May-03												
(mg/kg)	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
ND												
ND												
ND												
ND												
n/a												
n/a												

Building 1

RBCA Tool Kit for Chemical Releases, Version 1.3a



Building 1

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs | Physical Property Data

Constituent	CAS Number	type	Molecular Weight (g/mole) MW	ref	Diffusion Coefficients In air (cm2/s) Dair	ref	Diffusion Coefficients In water (cm2/s) Dwat	ref	log (Koc) or log(Kd) (@ 20 - 25 C) log(L/kg)	partition	ref	Henry's Law Constant (@ 20 - 25 C) (atm-m3) mol	Henry's Law Constant (unitless)	ref	Vapor Pressure (@ 20 - 25 C) (mm Hg)	ref	Solubility (@ 20 - 25 C) (mg/L)	ref	acid pKa	base pKb	ref
Benzene	71-43-2	A	78.1	PS	8.80E-02	PS	9.80E-06	PS	1.77	Koc	PS	5.55E-03	2.29E-01	PS	9.52E+01	PS	1.75E+03	PS	-	-	-
Toluene	108-88-3	A	92.4	5	8.50E-02	A	9.40E-06	A	2.13	Koc	A	6.30E-03	2.60E-01	A	3.00E+01	4	5.15E+02	29	-	-	-
Ethylbenzene	100-41-4	A	106.2	PS	7.50E-02	PS	7.80E-06	PS	2.56	Koc	PS	7.88E-03	3.25E-01	PS	1.00E+01	PS	1.69E+02	PS	-	-	-
Xylene (mixed isomers)	1330-20-7	A	106.2	5	7.20E-02	A	8.50E-06	A	2.38	Koc	A	7.03E-03	2.90E-01	A	7.00E+00	4	1.98E+02	5	-	-	-
Methyl t-Butyl ether	1634-04-4	O	88.146	5	7.92E-02	6	9.41E-05	7	1.08	Koc	A	5.77E-04	2.38E-02	-	2.49E+02	-	4.80E+04	A	-	-	-
Naphthalene	91-20-3	PAH	128.2	PS	5.90E-02	PS	7.50E-06	PS	3.30	Koc	PS	4.83E-04	1.99E-02	PS	2.30E-01	PS	3.10E+01	PS	-	-	-

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401 205

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs

Toxicity Data

	Reference Dose (mg/kg/day)				Reference Conc. (mg/m3)		Slope Factors 1/(mg/kg/day)				Unit Risk Factor 1/(µg/m3)			
			(mg/kg/day)						1/(mg/kg/day)				EPA Weight	Is
	Oral		Dermal		Inhalation		Oral		Dermal		Inhalation		of	Constituent
Constituent	RfD_oral	ref	RfD_dermal	ref	RfC_inhal	ref	SF_oral	ref	SF_dermal	ref	URF_inhal	ref	Evidence	Carcinogenic ?
Benzene	3.00E-03	R	-	-	5.95E-03	R	2.90E-02	PS	2.99E-02	TX	8.29E-06	PS	A	TRUE
Toluene	2.00E-01	A,R	1.60E-01	TX	4.00E-01	A,R	-	-	-	-	-	-	D	FALSE
Ethylbenzene	1.00E-01	PS	9.70E-02	TX	1.00E+00	PS	-	-	-	-	-	-	D	FALSE
Xylene (mixed isomers)	2.00E+00	A,R	1.84E+00	TX	7.00E+00	A	-	-	-	-	-	-	D	FALSE
Methyl t-Butyl ether	1.00E-02	31	8.00E-03	TX	3.00E+00	R	-	-	-	-	-	-	-	FALSE
Naphthalene	4.00E-01	PS	3.56E-01	TX	1.40E+00	PS	-	-	-	-	-	-	D	FALSE

Site Name: SNK Andante Bld. 1

Site Location: 3992 San Pab

RBCA Tool Kit for Chemical Releases, Version 1.3a

Miscellaneous Chemical Data

	Maximum Contaminant Level		Time-Weighted Average Workplace Criteria		Aquatic Life Prot. Criteria		Biocon-centration Factor
Constituent	MCL (mg/L)	ref	TWA (mg/m3)	ref	AQL (mg/L)	ref	(L-wat/kg-fish)
Benzene	5.00E-03	52 FR 25690	3.25E+00	PS	-	-	12.6
Toluene	1.00E+00	56 FR 3526 (30 Jan 91)	1.47E+02	ACGIH	-	-	70
Ethylbenzene	7.00E-01	56 FR 3526 (30 Jan 91)	4.35E+02	PS	-	-	1
Xylene (mixed isomers)	1.00E+01	56 FR 3526 (30 Jan 91)	4.34E+02	ACGIH	-	-	1
Methyl t-Butyl ether	-	-	6.00E+01	NIOSH	-	-	1
Naphthalene	-	-	5.00E+01	PS	-	-	430

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pab

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs | **Miscellaneous Chemical Data**

Constituent	Dermal Relative Absorp. Factor (unitless)	Water Dermal Permeability Data: Dermal Permeability Coeff. (cm/hr)	Lag time for Dermal Exposure (hr)	Critical Exposure Time (hr)	Relative Contr of Derm Perm Coeff (unitless)	Water/Skin Derm Adsorp Factor (cm/event)	ref	Detection Limits: Groundwater (mg/L)	ref	Soil (mg/kg)	ref	Half Life (First-Order Decay) (days): Saturated	Unsaturated	ref
Benzene	0.5	0.021	0.26	0.63	0.013	7.3E-2	D	0.002	S	0.005	S	720	720	H
Toluene	0.5	0.045	0.32	0.77	0.054	1.6E-1	D	0.002	S	0.005	S	28	28	H
Ethylbenzene	0.5	0.074	0.39	1.3	0.14	2.7E-1	D	0.002	S	0.005	S	228	228	H
Xylene (mixed isomers)	0.5	0.08	0.39	1.4	0.16	2.9E-1	D	0.005	S	0.005	S	360	360	H
Methyl t-Butyl ether	0.5	-	-	-	-	-	-	-	-	-	-	360	180	H
Naphthalene	0.05	0.069	0.53	2.2	0.2	2.7E-1	D	0.01	32	0.01	32	258	258	H

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pab

RBCA SITE ASSESSMENT

Input Parameter Summary

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

Exposure Parameters		Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Construc.
AT_c	Averaging time for carcinogens (yr)	70				
AT_n	Averaging time for non-carcinogens (yr)	30			25	1
BW	Body weight (kg)	70	15	35	70	
ED	Exposure duration (yr)	30	6	16	25	1
τ	Averaging time for vapor flux (yr)	30			25	1
EF	Exposure frequency (days/yr)	350			250	180
EF_D	Exposure frequency for dermal exposure	350			250	
IR_w	Ingestion rate of water (L/day)	2			1	
IR_s	Ingestion rate of soil (mg/day)	100	200		50	100
SA	Skin surface area (dermal) (cm^2)	5800		2023	5800	5800
M	Soil to skin adherence factor	1				
ET_{swim}	Swimming exposure time (hr/event)	3				
EV_{swim}	Swimming event frequency (events/yr)	12	12	12		
IR_{swim}	Water ingestion while swimming (L/hr)	0.05	0.5			
SA_{swim}	Skin surface area for swimming (cm^2)	23000		8100		
IR_{fish}	Ingestion rate of fish (kg/yr)	0.025				
FI_{fish}	Contaminated fish fraction (unitless)	1				

Complete Exposure Pathways and Receptors	On-site	Off-site 1	Off-site 2
Groundwater:			
Groundwater Ingestion	None	None	None
Soil Leaching to Groundwater Ingestion	None	None	None
Applicable Surface Water Exposure Routes:			
Swimming			NA
Fish Consumption			NA
Aquatic Life Protection			NA
Soil:			
Direct Ingestion and Dermal Contact	None		
Outdoor Air:			
Particulates from Surface Soils	None	None	None
Volatilization from Soils	Res./Constr.	None	None
Volatilization from Groundwater	Residential	None	None
Indoor Air:			
Volatilization from Subsurface Soils	Commercial	NA	NA
Volatilization from Groundwater	Commercial	NA	NA

Receptor Distance from Source Media	On-site	Off-site 1	Off-site 2	(Units)
Groundwater receptor	NA	NA	NA	(ft)
Soil leaching to groundwater receptor	NA	NA	NA	(ft)
Outdoor air inhalation receptor	0	NA	NA	(ft)

Target Health Risk Values		Individual	Cumulative
TR_{ab}	Target Risk (class A&B carcinogens)	1.0E-6	1.0E-6
TR_c	Target Risk (class C carcinogens)	1.0E-6	
THQ	Target Hazard Quotient (non-carcinogenic risk)	2.0E-1	2.0E-1

Modeling Options	
RBCA tier	Tier 2
Outdoor air volatilization model	Surface & subsurface models
Indoor air volatilization model	Johnson & Ettinger model
Soil leaching model	NA
Use soil attenuation model (SAM) for leachate?	NA
Air dilution factor	NA
Groundwater dilution-attenuation factor	NA

NOTE: NA = Not applicable

Surface Parameters		General	Construction	(Units)
A	Source zone area	5.4E+3	5.4E+3	(ft^2)
W	Length of source-zone area parallel to wind	2.4E+2	2.4E+2	(ft)
W_{gw}	Length of source-zone area parallel to GW flow	NA		(ft)
U_{air}	Ambient air velocity in mixing zone	1.1E+1		(ft/s)
δ_{air}	Air mixing zone height	6.9E+0		(ft)
P_e	Areal particulate emission rate	NA		(g/cm^2/s)
L_{ss}	Thickness of affected surface soils	1.4E+0		(ft)

Surface Soil Column Parameters		Value			(Units)
h_{cap}	Capillary zone thickness	5.0E+0			(ft)
h_v	Vadose zone thickness	1.4E+0			(ft)
ρ_s	Soil bulk density	1.7E+0			(g/cm^3)
f_{oc}	Fraction organic carbon	2.0E-2			(-)
θ_T	Soil total porosity	3.4E-1			(-)
K_{vs}	Vertical hydraulic conductivity	5.7E-7			(cm/s)
k_v	Vapor permeability	1.1E-16			(ft^2)
L_{gw}	Depth to groundwater	6.4E+0			(ft)
L_s	Depth to top of affected soils	6.4E+0			(ft)
L_{base}	Depth to base of affected soils	6.4E+0			(ft)
L_{subs}	Thickness of affected soils	0.0E+0			(ft)
pH	Soil/groundwater pH	6.8E+0			(-)
		capillary	vadose	foundation	
θ_w	Volumetric water content	0.3312	0.275	0.12	(-)
θ_a	Volumetric air content	0.01	0.0682	0.26	(-)

Building Parameters		Residential	Commercial	(Units)
L_b	Building volume/area ratio	NA	1.20E+1	(ft)
A_b	Foundation area	NA	5.42E+3	(ft^2)
X_{crk}	Foundation perimeter	NA	3.38E+2	(ft)
ER	Building air exchange rate	NA	1.40E-3	(1/s)
L_{crk}	Foundation thickness	NA	4.20E-1	(ft)
Z_{crk}	Depth to bottom of foundation slab	NA	4.20E-1	(ft)
η	Foundation crack fraction	NA	1.00E-3	(-)
dP	Indoor/outdoor differential pressure	NA	1.00E-2	(psi)
Q_s	Convective air flow through slab	NA	2.25E-7	(ft^3/s)

Groundwater Parameters		Value	(Units)
δ_{gw}	Groundwater mixing zone depth	NA	(ft)
I_f	Net groundwater infiltration rate	NA	(mm/yr)
U_{gw}	Groundwater Darcy velocity	NA	(cm/s)
V_{gw}	Groundwater seepage velocity	NA	(cm/s)
K_s	Saturated hydraulic conductivity	NA	(cm/s)
i	Groundwater gradient	NA	(-)
S_w	Width of groundwater source zone	NA	(ft)
S_d	Depth of groundwater source zone	NA	(ft)
θ_{eff}	Effective porosity in water-bearing unit	NA	(-)
f_{oc-sat}	Fraction organic carbon in water-bearing unit	NA	(-)
pH_{sat}	Groundwater pH	NA	(-)
	Biodegradation considered?	NA	

Transport Parameters		Off-site 1	Off-site 2	Off-site 1	Off-site 2	(Units)
Lateral Groundwater Transport		Groundwater Ingestion		Soil Leaching to GW		
α_x	Longitudinal dispersivity	NA	NA	NA	NA	(ft)
α_y	Transverse dispersivity	NA	NA	NA	NA	(ft)
α_z	Vertical dispersivity	NA	NA	NA	NA	(ft)
Lateral Outdoor Air Transport		Soil to Outdoor Air Inhal.		GW to Outdoor Air Inhal.		
σ_y	Transverse dispersion coefficient	NA	NA	NA	NA	(ft)
σ_z	Vertical dispersion coefficient	NA	NA	NA	NA	(ft)
ADF	Air dispersion factor	NA	NA	NA	NA	(-)

Surface Water Parameters		Off-site 2	(Units)
Q_{sw}	Surface water flowrate	NA	(ft^3/s)
W_{pl}	Width of GW plume at SW discharge	NA	(ft)
δ_{pl}	Thickness of GW plume at SW discharge	NA	(ft)
DF_{sw}	Groundwater-to-surface water dilution factor	NA	(-)

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

SUBSURFACE SOILS (6.4 - 6.4 ft):

VAPOR INHALATION

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/kg) Receptor			3) Exposure Medium Outdoor Air: POE Conc. (mg/m^3) (1) / (2)		
	Soil Conc. (mg/kg)	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	2.8E-1	NA					
Toluene	6.4E-1	NA					
Ethylbenzene	2.2E+0	NA					
Xylene (mixed isomers)	9.6E+0	NA					
Methyl t-Butyl ether	2.5E-3	NA					
Naphthalene	1.7E-1	NA					

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

SUBSURFACE SOILS (6.4 - 6.4 ft):

VAPOR INHALATION (cont'd)

Constituents of Concern	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)			5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)		
	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	4.1E-1					
Toluene	9.6E-1					
Ethylbenzene	9.6E-1					
Xylene (mixed isomers)	9.6E-1					
Methyl t-Butyl ether	9.6E-1					
Naphthalene	9.6E-1					

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr)

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: VAPOR INHALATION

Exposure Concentration

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/L) Receptor			3) Exposure Medium Outdoor Air: POE Conc. (mg/m^3) (1) / (2)		
	Groundwater Conc. (mg/L)	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	1.5E+0	1.3E+6			1.2E-6		
Toluene	2.4E+0	1.3E+6			1.8E-6		
Ethylbenzene	7.3E-1	1.6E+6			4.6E-7		
Xylene (mixed isomers)	3.7E+0	1.5E+6			2.5E-6		
Methyl t-Butyl ether	7.4E-2	1.9E+5			3.9E-7		
Naphthalene	1.4E-1	2.0E+6			6.9E-8		

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

GROUNDWATER: VAPOR INHALATION (cont'd)

Constituents of Concern	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)			5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)		
	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	4.1E-1			4.8E-7		
Toluene	9.6E-1			1.7E-6		
Ethylbenzene	9.6E-1			4.4E-7		
Xylene (mixed isomers)	9.6E-1			2.4E-6		
Methyl t-Butyl ether	9.6E-1			3.7E-7		
Naphthalene	9.6E-1			6.7E-8		

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr)

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

TOTAL PATHWAY EXPOSURE (mg/m^3)
(Sum average expsosure concentrations from soil and groundwater routes.)

Constituents of Concern	On-site (0 ft) Residential	On-site (0 ft) Construction Worker	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	4.8E-7			
Toluene	1.7E-6			
Ethylbenzene	4.4E-7			
Xylene (mixed isomers)	2.4E-6			
Methyl t-Butyl ether	3.7E-7			
Naphthalene	6.7E-8			

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

CARCINOGENIC RISK

Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Exposure (mg/m^3)				(3) Inhalation Unit Risk Factor (ug/m^3)^-1	(4) Individual COC Risk (2) x (3) x 1000			
		On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)		On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
		Residential	Construction Worker	None	None		Residential	Construction Worker	None	None
Benzene	A	4.8E-7				8.3E-6	4.0E-9			
Toluene	D									
Ethylbenzene	D									
Xylene (mixed isomers)	D									
Methyl t-Butyl ether	-									
Naphthalene	D									
Total Pathway Carcinogenic Risk =							4.0E-9			

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

TOXIC EFFECTS

	(5) Total Toxicant Exposure (mg/m^3)				(6) Inhalation Reference Conc (mg/m^3)	(7) Individual COC Hazard Quotient (5) / (6)			
	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)		On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern	Residential	Construction Worker	None	None		Residential	Construction Worker	None	None
Benzene	1.1E-6				6.0E-3	1.9E-4			
Toluene	1.7E-6				4.0E-1	4.4E-6			
Ethylbenzene	4.4E-7				1.0E+0	4.4E-7			
Xylene (mixed isomers)	2.4E-6				7.0E+0	3.5E-7			
Methyl t-Butyl ether	3.7E-7				3.0E+0	1.2E-7			
Naphthalene	6.7E-8				1.4E+0	4.8E-8			
Total Pathway Hazard Index =						1.9E-4			

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

SOILS (6.4 - 6.4 ft): VAPOR INTRUSION INTO ON-SITE BUILDINGS

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/kg) Receptor	3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2)	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)	5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)
	Soil Conc. (mg/kg)	Commercial	Commercial	Commercial	Commercial
Benzene	2.8E-1	NA		2.4E-1	
Toluene	6.4E-1	NA		6.8E-1	
Ethylbenzene	2.2E+0	NA		6.8E-1	
Xylene (mixed isomers)	9.6E+0	NA		6.8E-1	
Methyl t-Butyl ether	2.5E-3	NA		6.8E-1	
Naphthalene	1.7E-1	NA		6.8E-1	

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr) NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

Building 1

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: VAPOR INTRUSION INTO ON-SITE BUILDINGS

Exposure Concentration

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/L) Receptor	3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2)	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)	5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)
	Groundwater Conc. (mg/L)	Commercial	Commercial	Commercial	Commercial
Benzene	1.5E+0	4.1E+4	3.6E-5	2.4E-1	8.9E-6
Toluene	2.4E+0	4.2E+4	5.7E-5	6.8E-1	3.9E-5
Ethylbenzene	7.3E-1	4.9E+4	1.5E-5	6.8E-1	1.0E-5
Xylene (mixed isomers)	3.7E+0	4.7E+4	8.0E-5	6.8E-1	5.4E-5
Methyl t-Butyl ether	7.4E-2	5.0E+4	1.5E-6	6.8E-1	1.0E-6
Naphthalene	1.4E-1	1.3E+5	1.1E-6	6.8E-1	7.4E-7

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr) NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

Building 1

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

3 OF 3

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS

Constituents of Concern	TOTAL PATHWAY EXPOSURE (mg/m^3) *(Sum average expsosure concentrations from soil and groundwater routes.)* Commercial
Benzene	8.9E-6
Toluene	3.9E-5
Ethylbenzene	1.0E-5
Xylene (mixed isomers)	5.4E-5
Methyl t-Butyl ether	1.0E-6
Naphthalene	7.4E-7

Site Name: SNK Andante Bld. 1 Date Completed: 30-Aug-03
Site Location: 3992 San Pablo Ave. Emeryville Job ID: 9401.205
Completed By: Dai Watkins

Building 1

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

	CARCINOGENIC RISK			
Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Exposure (mg/m^3) Commercial	(3) Inhalation Unit Risk Factor (ug/m^3)^-1	(4) Individual COC Risk (2) x (3) x 1000 Commercial
Benzene	A	8.9E-6	8.3E-6	7.4E-8
Toluene	D			
Ethylbenzene	D			
Xylene (mixed isomers)	D			
Methyl t-Butyl ether	-			
Naphthalene	D			

Total Pathway Carcinogenic Risk = 7.4E-8

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

	TOXIC EFFECTS		
	(5) Total Toxicant Exposure (mg/m^3)	(6) Inhalation Reference Concentration (mg/m^3)	(7) Individual COC Hazard Quotient (5) / (6)
Constituents of Concern	Commercial		Commercial
Benzene	2.5E-5	6.0E-3	4.2E-3
Toluene	3.9E-5	4.0E-1	9.7E-5
Ethylbenzene	1.0E-5	1.0E+0	1.0E-5
Xylene (mixed isomers)	5.4E-5	7.0E+0	7.8E-6
Methyl t-Butyl ether	1.0E-6	3.0E+0	3.4E-7
Naphthalene	7.4E-7	1.4E+0	5.3E-7

Total Pathway Hazard Index = **4.3E-3**

Site Name: SNK Andante Bld. 1
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401 205

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT — **Baseline Risk Summary-All Pathways**

Site Name: SNK Andante Bld. 1 — Completed By: Dai Watkins
Site Location: 3992 San Pablo Ave. Emeryville — Date Completed: 30-Aug-03

TIER 2 BASELINE RISK SUMMARY TABLE

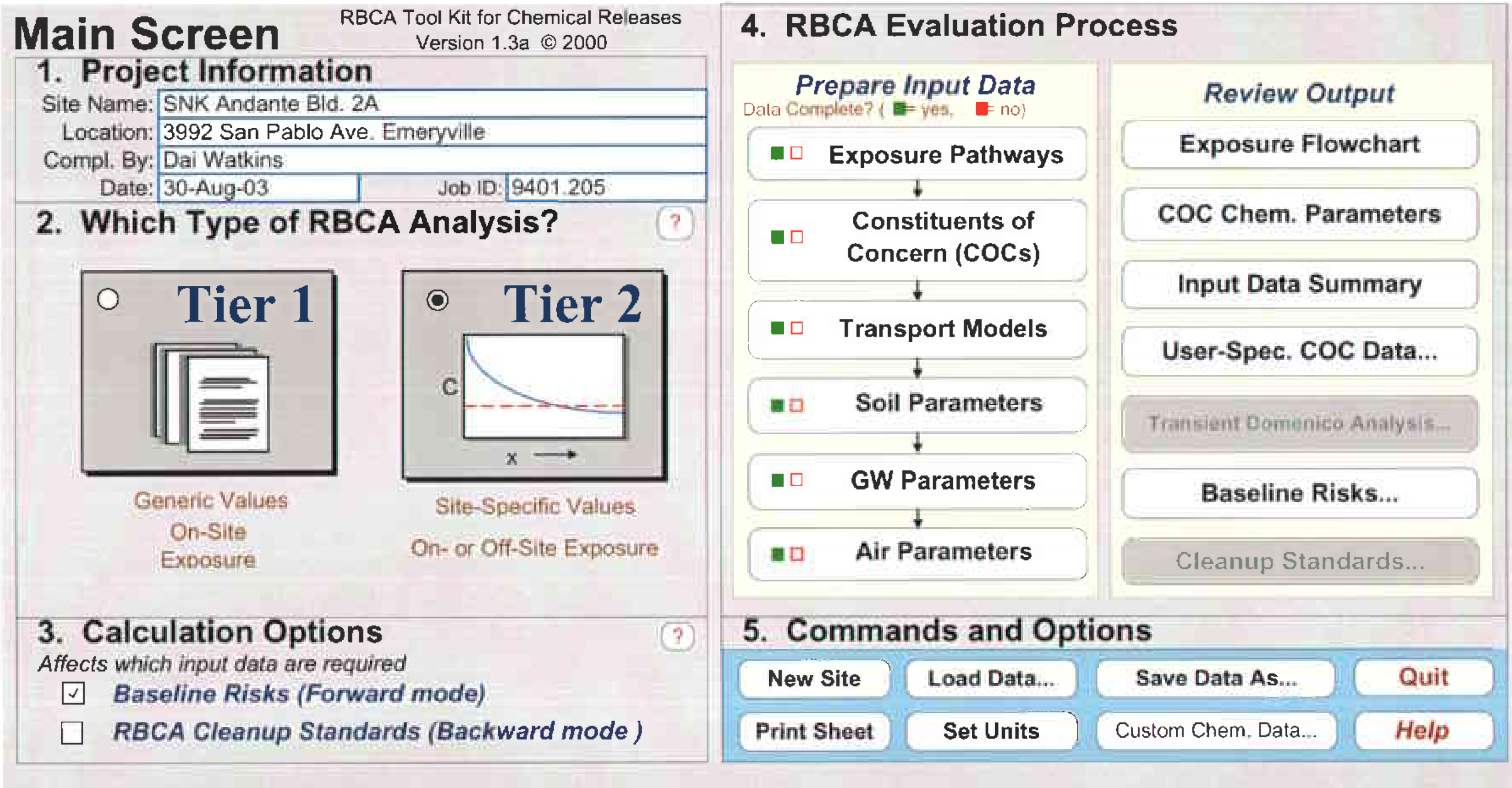
EXPOSURE PATHWAY	BASELINE CARCINOGENIC RISK: Individual COC Risk: Maximum Value	Individual COC Risk: Target Risk	Cumulative COC Risk: Total Value	Cumulative COC Risk: Target Risk	Risk Limit(s) Exceeded?	BASELINE TOXIC EFFECTS: Hazard Quotient: Maximum Value	Hazard Quotient: Applicable Limit	Hazard Index: Total Value	Hazard Index: Applicable Limit	Toxicity Limit(s) Exceeded?
OUTDOOR AIR EXPOSURE PATHWAYS										
Complete:	4.0E-9	1.0E-6	4.0E-9	1.0E-6	☐	1.9E-4	2.0E-1	1.9E-4	2.0E-1	☐
INDOOR AIR EXPOSURE PATHWAYS										
Complete:	7.4E-8	1.0E-6	7.4E-8	1.0E-6	☐	4.2E-3	2.0E-1	4.3E-3	2.0E-1	☐
SOIL EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
SURFACE WATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
CRITICAL EXPOSURE PATHWAY (Maximum Values From Complete Pathways)										
	7.4E-8	***1.0E-6***	***7.4E-8***	***1.0E-6***	☐	***4.2E-3***	***2.0E-1***	***4.3E-3***	***2.0E-1***	☐
	Indoor Air		***Indoor Air***			***Indoor Air***		***Indoor Air***		

APPENDIX II-E

Health Risk Assessment Building 2-A

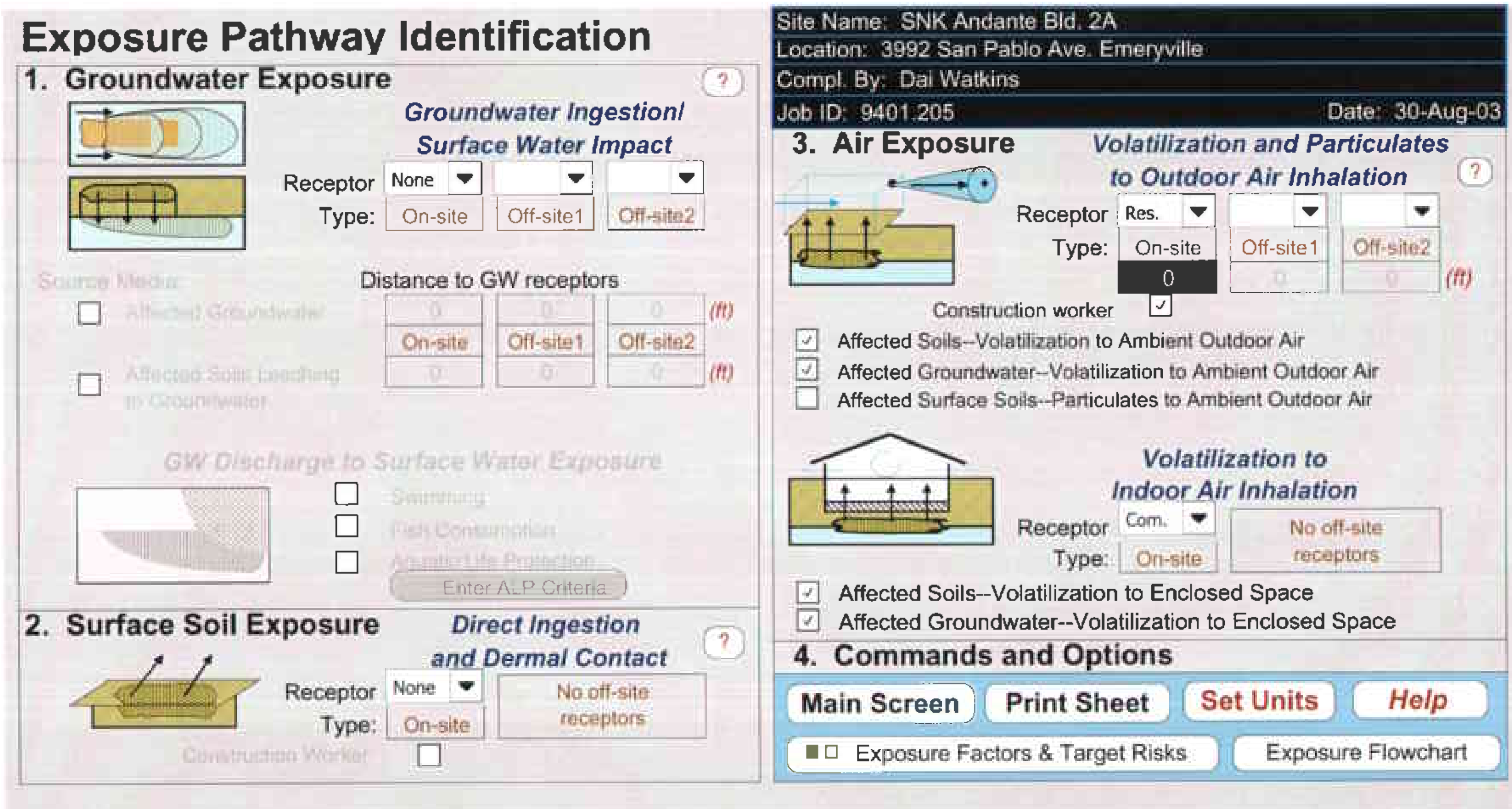
Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a



Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a



Exposure Pathway Identification

Site Name: SNK Andante Bld. 2A
Location: 3992 San Pablo Ave. Emeryville
Compl. By: Dai Watkins
Job ID: 9401.205 Date: 30-Aug-03

1. Groundwater Exposure

Groundwater Ingestion/ Surface Water Impact

Receptor: None
Type: On-site | Off-site1 | Off-site2

Source Media:

Distance to GW receptors

☐ Affected Groundwater — 0 | 0 | 0 (ft)

On-site | Off-site1 | Off-site2

☐ Affected Soils Leaching to Groundwater — 0 | 0 | 0 (ft)

GW Discharge to Surface Water Exposure

☐ Swimming
☐ Fish Consumption
☐ Aquatic Life Protection

Enter ALP Criteria

2. Surface Soil Exposure

Direct Ingestion and Dermal Contact

Receptor: None
Type: On-site | No off-site receptors

Construction Worker ☐

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation

Receptor: Res.
Type: On-site | Off-site1 | Off-site2
0 | 0 | 0 (ft)

Construction worker ☑

☑ Affected Soils--Volatilization to Ambient Outdoor Air
☑ Affected Groundwater--Volatilization to Ambient Outdoor Air
☐ Affected Surface Soils--Particulates to Ambient Outdoor Air

Volatilization to Indoor Air Inhalation

Receptor: Com.
Type: On-site | No off-site receptors

☑ Affected Soils--Volatilization to Enclosed Space
☑ Affected Groundwater--Volatilization to Enclosed Space

4. Commands and Options

Main Screen | Print Sheet | Set Units | Help

Exposure Factors & Target Risks | Exposure Flowchart

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

Exposure Factors and Target Risk Limits

Site Name:	SNK Andante Bld. 2A
Location:	3992 San Pablo Ave. Emeryville
Compl. By:	Dai Watkins
Job ID:	9401.205
Date:	30-Aug-03

1. Exposure Parameters

	Age Adjustment?	Residential: Adult	Residential: (Age 0-6)	Residential: (Age 0-16)	Commercial: Chronic	Commercial: Construc.
Averaging time, carcinogens (yr)		70				
Averaging time, non-carcinogens (yr)		30			25	1
Body weight (kg)		70	15	35	70	
Exposure duration (yr)		30	6	16	25	1
Exposure frequency (days/yr)		350			250	180
Dermal exposure frequency (days/yr)		350			250	
Skin surface area, soil contact (cm^2)	☑	5800		2023	5800	5800
Soil dermal adherence factor ($mg/cm^2/day$)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☑	100	200		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☑	0.05	0.5			
Skin surface area, swimming (cm^2)	☑	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				

2. Risk Goal Calculation Options

○ Individual Constituent Risk Goals Only

◉ Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcins.)	1.0E-6	1.0E-6
Target Risk (Class C carcinogens)	1.0E-6	
Target Hazard Quotient	2.0E-1	
Target Hazard Index		2.0E-1

4. Commands and Options

Return to Exposure Pathways

Use Default Values

Print Sheet

Help

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

Site Name: SNK Andante Bld. 2A — Job ID: 9401.205

Location: 3992 San Pablo Ave. Emeryville — Date: 30-Aug-03

Compl. By: Dai Watkins

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

☐ Apply Raoult's Law ?

Selected COCs

COC Select: Add/Insert | Delete

Sort List: ? Top | Bottom | MoveUp | MoveDown

Representative COC Concentration ?

Selected COCs	Groundwater Source Zone (mg/L)	note	Soil Source Zone (mg/kg)	note	Mole Fraction in Source Material (-)
Benzene	1.5E+0		2.2E-2		
Toluene	2.4E+0		2.8E-2		
Ethylbenzene	7.3E-1		2.2E-1		
Xylene (mixed isomers)	3.7E+0		2.2E-1		
Methyl t-Butyl ether	7.4E-2		2.5E-3		
Naphthalene	1.4E-1		1.7E-1		

Groundwater Source Zone: Enter Directly | ■ ☐ Enter Site Data

Soil Source Zone: Enter Directly | ■ ☐ Enter Site Data

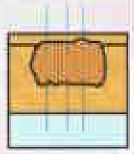
RBCA Tool Kit for Chemical Releases, Version 1.3a

Transport Modeling Options

Site Name: SNK Andante Bld. 2A | Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville | Date: 30-Aug-03
Compl. By: Dai Watkins

1. Vertical Transport, Surface Soil Column

Outdoor Air Volatilization Factors (?)



- ○ Surface soil volatilization model only
- ◉ Combination surface soil/Johnson & Ettinger models
  - Thickness of surface soil zone: 1.66 *(ft)*
- ○ User-specified VF from other model [Enter VF Values]

Indoor Air Volatilization Factors (?)

- ◉ Johnson & Ettinger model
- ○ User-specified VF from other model [Enter VF Values]

Soil-to-Groundwater Leaching Factor (?)

- ○ ASTM Model
  - ☐ Apply Soil Attenuation Model (SAM)
  - ☐ Allow first-order biodecay [Enter Decay Rates]
- ○ User-specified LF from other model [Enter LF Values]

2. Lateral Air Dispersion Factor

(?)

	Off-site 1	Off-site 2	
○ 3-D Gaussian dispersion model			
○ User-Specified ADF	1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor

Calculate DAF using Domenico Model (?)

- ○ Domenico equation with dispersion only (no biodegradation)
- ○ Domenico equation first-order decay [Enter Decay Rates]
- ○ Modified Domenico equation using electron acceptor superposition [Enter Site Data]
  - [Enter Directly] Biodegradation Capacity: NC (mg/L)

— or —

User-Specified DAF Values

- ○ DAF values from other model or site data [Enter DAF Values]

4. Commands and Options

[Main Screen] [Print Sheet] [*Help*]

RBCA Tool Kit for Chemical Releases, Version 1.3a

Site-Specific Soil Parameters

Site Name: SNK Andante Bld. 2A — Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville — Date: 30-Aug-03
Compl. By: Dai Watkins

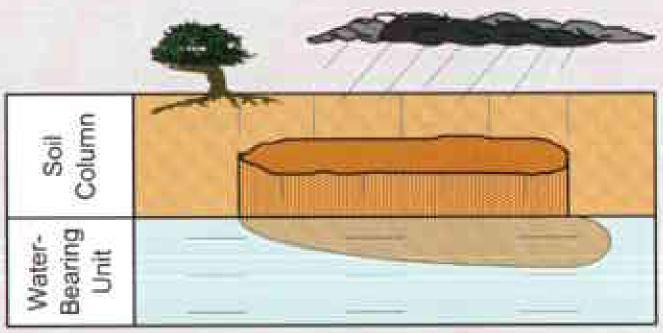
1. Soil Source Zone Characteristics

Hydrogeology

	General Case	Construction	
Depth to water-bearing unit	6.66		(ft)
Capillary zone thickness	5		(ft)
Soil column thickness	1.66		(ft)

Affected Soil Zone

	General Case	Construction	
Depth to top of affected soils	6.66		(ft)
Depth to base of affected soils	6.66		(ft)
Affected soil area	2640	2640	(ft^2)
Length of affected soil parallel to assumed wind direction	235	235	(ft)
Length of affected soil parallel to assumed GW flow direction			(ft)



2. Surface Soil Column

	Vadose Zone	Capillary Fringe	
Predominant USCS Soil Type			
or (Calculate)	or		
Total porosity	0.3412		(-)
Volumetric water content	0.275	0.3312	(-)
Volumetric air content	0.0662	0.01	(-)
Dry bulk density	1.7		(kg/L)
Vertical hydraulic conductivity	5.7E-7		(cm/s)
Vapor permeability	1.1E-16		(ft^2)
Capillary zone thickness	5.0E+0		(ft)

Net Rainfall Infiltration

Net infiltration estimate		(cm/yr)
or (NA)	or	
Average annual precipitation		(cm/yr)

Partitioning Parameters

Fraction organic carbon	0.02	(-)
Soil/water pH	6.8	(-)

3. Commands and Options

Main Screen | Use Default Values | Print Sheet
Set Units | Help

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

Site-Specific Air Parameters

Site Name: SNK Andante Bld. 2A	Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville	Date: 30-Aug-03
Compl. By: Dai Watkins	

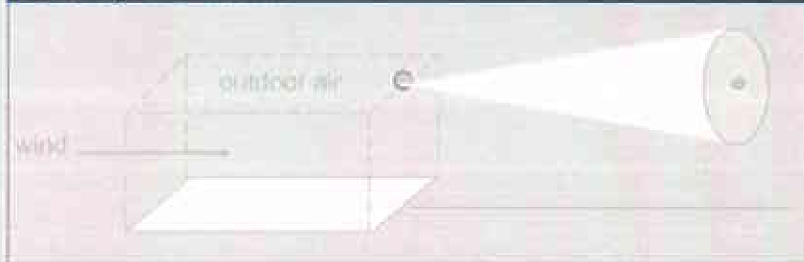
1. Outdoor Air Pathway

Dispersion in Air

	Off-site 1	Off-site 2	
Distance to offsite air receptor			(ft)
or NA	or		
Horizontal dispersivity			(ft)
Vertical dispersivity			(ft)

Air Source Zone

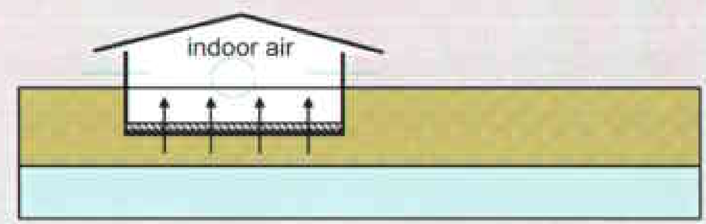
Air mixing zone height	6.56	*(ft)*
Ambient air velocity in mixing zone	10.56	*(ft/s)*
Areal particulate emission flux	6.9E-14	(g/cm^2/s)



2. Indoor Air Pathway

Building Parameters

	Residential	Commercial	
Building volume/area ratio	10	10	*(ft)*
Foundation area	2640	2640	*(ft^2)*
Foundation perimeter	212	212	*(ft)*
Building air exchange rate	5.7E-4	1.4E-3	*(1/s)*
Depth to bottom of foundation slab	0.42	0.42	*(ft)*
Convective air flow through cracks	1.3E-7	1.3E-7	*(ft^3/s)*
Foundation thickness	0.42		*(ft)*
Foundation crack fraction	0.001		(-)
Volumetric water content of cracks	0.12		(-)
Volumetric air content of cracks	0.26		(-)
Indoor/Outdoor differential pressure	0.01		*(psi)*



3. Commands and Options

Main Screen | Use Default Values | Print Sheet

Set Units | *Help*

RBCA Tool Kit for Chemical Releases, Version 1.3a

Commands and Options

Return | Print Sheet | *Help*

Site Name: SNK Andante Bld. 2A   Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville   Date: 30-Aug-03
Compl. By: Dai Watkins

Groundwater Source Zone Concentration Calculator

Paste Defaults

UCL Percentile: 95%

Mean Option

Constituent	Detection Limit (mg/L)	No. of Samples	No. of Detects	Estimated Distribution of Data	Max. Conc. (mg/L)	Mean Conc. (mg/L)	UCL on Mean (mg/L)
Benzene	5.0E-4	1	1	-	1.5E+0	1.5E+0	NA
Toluene	5.0E-4	1	1	-	2.4E+0	2.4E+0	NA
Ethylbenzene	5.0E-4	1	1	-	7.3E-1	7.3E-1	NA
Xylene (mixed isomers)	1.0E-4	1	1	-	3.7E+0	3.7E+0	NA
Methyl t-Butyl ether	5.0E-4	1	1	-	7.4E-2	7.4E-2	NA
Naphthalene	1.0E-2	1	1	-	1.4E-1	1.4E-1	NA

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

Enter Analytical Data from Groundwater Source Zone (up to 50 Data Points)

Analytical Data

	1	2	3	4	5	6	7	8	9	10	11	12	13
ID	30S-40E												
Date	15-May-03												
	(mg/L)	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*
	1.50E+0												
	2.40E+0												
	7.30E-1												
	3.70E+0												
	7.40E-2												
	1.40E-1												

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

Enter Analytical Data from
Soil Source Zone
(up to 50 Data Points)

Analytical Data

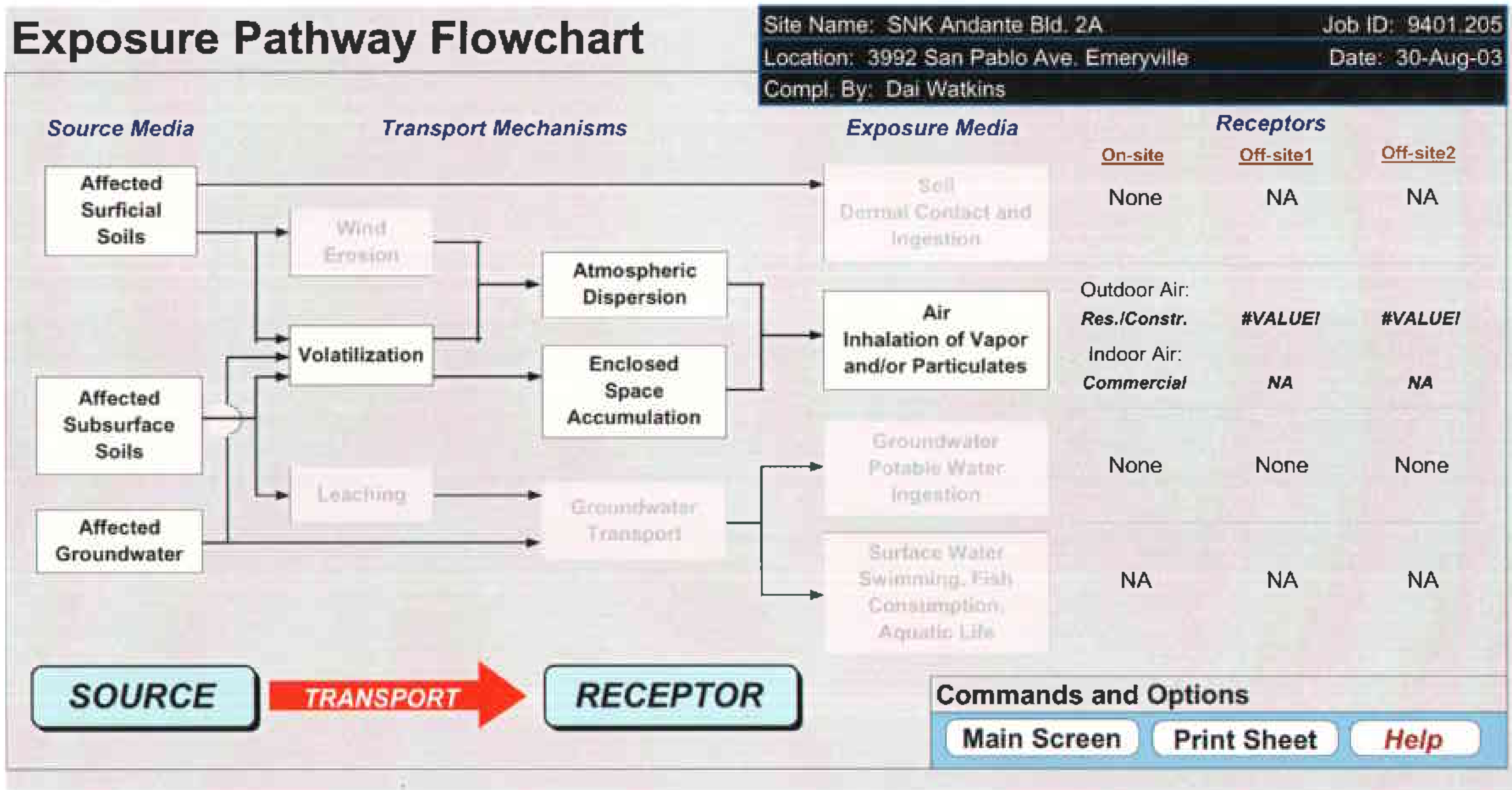
	1	2	3	4	5	6	7	8	9	10	11	12	13
ID	60S-0E	60S-20E	60S-40E	60S-60E	80S-0E	80S-20E	80S-40E	80S-60E	100S-0E	100S-20E	100S-40E	100S-60E	115S-60E
Date	9-May-03	16-May-03	16-May-03	13-May-03	19-May-03	13-May-03	23-May-03	23-May-03	5-May-03	19-May-03	21-May-03	22-May-03	22-May-03
	(mg/kg)	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
	3.40E+0	ND	1.20E+1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2.00E+1	ND	1.20E+1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2.20E+1	ND	2.80E+1	8.00E+0	6.80E-3	9.10E-1	ND	ND	ND	3.50E-2	ND	ND	2.30E-2
	1.20E+2	ND	1.40E+2	3.70E+1	ND	2.40E+0	ND	ND	ND	7.40E-3	ND	ND	3.40E-2
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a	n/a	n/a
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

											Analytical Data	
14	15	16	17	18	19	20	21	22	23	24	25	26
120S-0E	120S-20E	120S-40E										
5-May-03	15-May-03	16-May-03										
(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
ND	ND	ND										
ND	ND	ND										
ND	ND	3.20E+0										
ND	ND	ND										
ND	n/a	n/a										
ND	n/a	n/a										

RBCA Tool Kit for Chemical Releases, Version 1.3a



Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs | **Physical Property Data**

Constituent	CAS Number	type	Molecular Weight (g/mole) MW	ref	Diffusion Coefficients In air (cm2/s) Dair	ref	Diffusion Coefficients In water (cm2/s) Dwat	ref	log (Koc) or log(Kd) (@ 20 - 25 C) log(L/kg)	partition	ref	Henry's Law Constant (@ 20 - 25 C) (atm-m3) mol	Henry's Law Constant (@ 20 - 25 C) (unitless)	ref	Vapor Pressure (@ 20 - 25 C) (mm Hg)	ref	Solubility (@ 20 - 25 C) (mg/L)	ref	acid pKa	base pKb	ref
Benzene	71-43-2	A	78.1	PS	8.80E-02	PS	9.80E-06	PS	1.77	Koc	PS	5.55E-03	2.29E-01	PS	9.52E+01	PS	1.75E+03	PS	-	-	-
Toluene	108-88-3	A	92.4	5	8.50E-02	A	9.40E-06	A	2.13	Koc	A	6.30E-03	2.60E-01	A	3.00E+01	4	5.15E+02	29	-	-	-
Ethylbenzene	100-41-4	A	106.2	PS	7.50E-02	PS	7.80E-06	PS	2.56	Koc	PS	7.88E-03	3.25E-01	PS	1.00E+01	PS	1.69E+02	PS	-	-	-
Xylene (mixed isomers)	1330-20-7	A	106.2	5	7.20E-02	A	8.50E-06	A	2.38	Koc	A	7.03E-03	2.90E-01	A	7.00E+00	4	1.98E+02	5	-	-	-
Methyl t-Butyl ether	1634-04-4	O	88.146	5	7.92E-02	6	9.41E-05	7	1.08	Koc	A	5.77E-04	2.38E-02	-	2.49E+02	-	4.80E+04	A	-	-	-
Naphthalene	91-20-3	PAH	128.2	PS	5.90E-02	PS	7.50E-06	PS	3.30	Koc	PS	4.83E-04	1.99E-02	PS	2.30E-01	PS	3.10E+01	PS	-	-	-

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dal Walkins
Date Completed: 30-Aug-03

Job ID: 9401.205

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs	Toxicity Data

	Reference Dose (mg/kg/day)		(mg/kg/day)		Reference Conc. (mg/m3)		Slope Factors 1/(mg/kg/day)		1/(mg/kg/day)		Unit Risk Factor 1/(µg/m3)			
Constituent	Oral RfD_oral	ref	Dermal RfD_dermal	ref	Inhalation RfC_Inhal	ref	Oral SF_oral	ref	Dermal SF_dermal	ref	Inhalation URF_Inhal	ref	EPA Weight of Evidence	Is Constituent Carcinogenic ?
Benzene	3.00E-03	R	-	-	5.95E-03	R	2.90E-02	PS	2.99E-02	TX	8.29E-06	PS	A	TRUE
Toluene	2.00E-01	A,R	1.60E-01	TX	4.00E-01	A,R	-	-	-	-	-	-	D	FALSE
Ethylbenzene	1.00E-01	PS	9.70E-02	TX	1.00E+00	PS	-	-	-	-	-	-	D	FALSE
Xylene (mixed isomers)	2.00E+00	A,R	1.84E+00	TX	7.00E+00	A	-	-	-	-	-	-	D	FALSE
Methyl t-Butyl ether	1.00E-02	31	8.00E-03	TX	3.00E+00	R	-	-	-	-	-	-	-	FALSE
Naphthalene	4.00E-01	PS	3.56E-01	TX	1.40E+00	PS	-	-	-	-	-	-	D	FALSE

Site Name: SNK Andante Bld. 2
Site Location: 3992 San Pab

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

Miscellaneous Chemical Data

Constituent	Maximum Contaminant Level MCL (mg/L)	Maximum Contaminant Level ref	Time-Weighted Average Workplace Criteria TWA (mg/m3)	Time-Weighted Average Workplace Criteria ref	Aquatic Life Prot. Criteria AQL (mg/L)	Aquatic Life Prot. Criteria ref	Biocon-centration Factor (L-wat/kg-fish)
Benzene	5.00E-03	52 FR 25690	3.25E+00	PS	-	-	12.6
Toluene	1.00E+00	56 FR 3526 (30 Jan 91)	1.47E+02	ACGIH	-	-	70
Ethylbenzene	7.00E-01	56 FR 3526 (30 Jan 91)	4.35E+02	PS	-	-	1
Xylene (mixed isomers)	1.00E+01	56 FR 3526 (30 Jan 91)	4.34E+02	ACGIH	-	-	1
Methyl t-Butyl ether	-	-	6.00E+01	NIOSH	-	-	1
Naphthalene	-	-	5.00E+01	PS	-	-	430

Site Name: SNK Andante Bld. 2
Site Location: 3992 San Pab

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs — Miscellaneous Chemical Data

Constituent	Dermal Relative Absorp. Factor (unitless)	Water Dermal Permeability Data: Dermal Permeability Coeff. (cm/hr)	Lag time for Dermal Exposure (hr)	Critical Exposure Time (hr)	Relative Contr of Derm Perm Coeff (unitless)	Water/Skin Derm Adsorp Factor (cm/event)	ref	Detection Limits: Groundwater (mg/L)	ref	Soil (mg/kg)	ref	Half Life (First-Order Decay) (days): Saturated	Unsaturated	ref
Benzene	0.5	0.021	0.26	0.63	0.013	7.3E-2	D	0.002	S	0.005	S	720	720	H
Toluene	0.5	0.045	0.32	0.77	0.054	1.6E-1	D	0.002	S	0.005	S	28	28	H
Ethylbenzene	0.5	0.074	0.39	1.3	0.14	2.7E-1	D	0.002	S	0.005	S	228	228	H
Xylene (mixed isomers)	0.5	0.08	0.39	1.4	0.16	2.9E-1	D	0.005	S	0.005	S	360	360	H
Methyl t-Butyl ether	0.5	-	-	-	-	-	-	-	-	-	-	360	180	H
Naphthalene	0.05	0.069	0.53	2.2	0.2	2.7E-1	D	0.01	32	0.01	32	258	258	H

Site Name: SNK Andante Bld. 2

Site Location: 3992 San Pab

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

Input Parameter Summary

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

Exposure Parameters		Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Construc.
AT_c	Averaging time for carcinogens (yr)	70				
AT_n	Averaging time for non-carcinogens (yr)	30			25	1
BW	Body weight (kg)	70	15	35	70	
ED	Exposure duration (yr)	30	6	16	25	1
τ	Averaging time for vapor flux (yr)	30			25	1
EF	Exposure frequency (days/yr)	350			250	180
EF_D	Exposure frequency for dermal exposure	350			250	
IR_w	Ingestion rate of water (L/day)	2			1	
IR_s	Ingestion rate of soil (mg/day)	100	200		50	100
SA	Skin surface area (dermal) (cm^2)	5800		2023	5800	5800
M	Soil to skin adherence factor	1				
ET_{swim}	Swimming exposure time (hr/event)	3				
EV_{swim}	Swimming event frequency (events/yr)	12	12	12		
IR_{swim}	Water ingestion while swimming (L/hr)	0.05	0.5			
SA_{swim}	Skin surface area for swimming (cm^2)	23000		8100		
IR_{fish}	Ingestion rate of fish (kg/yr)	0.025				
Fl_{fish}	Contaminated fish fraction (unitless)	1				

Complete Exposure Pathways and Receptors	On-site	Off-site 1	Off-site 2
Groundwater:			
Groundwater Ingestion	None	None	None
Soil Leaching to Groundwater Ingestion	None	None	None
Applicable Surface Water Exposure Routes:			
Swimming			NA
Fish Consumption			NA
Aquatic Life Protection			NA
Soil:			
Direct Ingestion and Dermal Contact	None		
Outdoor Air:			
Particulates from Surface Soils	None	None	None
Volatilization from Soils	Res./Constr.	#VALUE!	#VALUE!
Volatilization from Groundwater	Residential	#VALUE!	#VALUE!
Indoor Air:			
Volatilization from Subsurface Soils	Commercial	NA	NA
Volatilization from Groundwater	Commercial	NA	NA

Receptor Distance from Source Media	On-site	Off-site 1	Off-site 2	(Units)
Groundwater receptor	NA	NA	NA	(ft)
Soil leaching to groundwater receptor	NA	NA	NA	(ft)
Outdoor air inhalation receptor	0	NA	NA	(ft)

Target Health Risk Values		Individual	Cumulative
TR_{ab}	Target Risk (class A&B carcinogens)	1.0E-6	1.0E-6
TR_c	Target Risk (class C carcinogens)	1.0E-6	
THQ	Target Hazard Quotient (non-carcinogenic risk)	2.0E-1	2.0E-1

Modeling Options	
RBCA tier	Tier 2
Outdoor air volatilization model	Surface & subsurface models
Indoor air volatilization model	Johnson & Ettinger model
Soil leaching model	NA
Use soil attenuation model (SAM) for leachate?	NA
Air dilution factor	NA
Groundwater dilution-attenuation factor	NA

NOTE: NA = Not applicable

Surface Parameters		General	Construction	(Units)
A	Source zone area	2.8E+3	2.8E+3	(ft^2)
W	Length of source-zone area parallel to wind	2.4E+2	2.4E+2	(ft)
W_{gw}	Length of source-zone area parallel to GW flow	NA		(ft)
U_{air}	Ambient air velocity in mixing zone	1.1E+1		(ft/s)
δ_{air}	Air mixing zone height	6.6E+0		(ft)
P_e	Areal particulate emission rate	NA		(g/cm^2/s)
L_{ss}	Thickness of affected surface soils	1.7E+0		(ft)

Surface Soil Column Parameters		Value			(Units)
h_{cap}	Capillary zone thickness	5.0E+0			(ft)
h_v	Vadose zone thickness	1.7E+0			(ft)
ρ_s	Soil bulk density	1.7E+0			(g/cm^3)
f_{oc}	Fraction organic carbon	2.0E-2			(-)
θ_T	Soil total porosity	3.4E-1			(-)
K_{vs}	Vertical hydraulic conductivity	5.7E-7			(cm/s)
k_v	Vapor permeability	1.1E-16			(ft^2)
L_{gw}	Depth to groundwater	6.7E+0			(ft)
L_s	Depth to top of affected soils	6.7E+0			(ft)
L_{base}	Depth to base of affected soils	6.7E+0			(ft)
L_{subs}	Thickness of affected soils	0.0E+0			(ft)
pH	Soil/groundwater pH	6.8E+0			(-)
		capillary	vadose	foundation	
θ_w	Volumetric water content	0.3312	0.275	0.12	(-)
θ_a	Volumetric air content	0.01	0.0662	0.26	(-)

Building Parameters		Residential	Commercial	(Units)
L_b	Building volume/area ratio	NA	1.00E+1	(ft)
A_b	Foundation area	NA	2.84E+3	(ft^2)
X_{crk}	Foundation perimeter	NA	2.12E+2	(ft)
ER	Building air exchange rate	NA	1.40E-3	(1/s)
L_{crk}	Foundation thickness	NA	4.20E-1	(ft)
Z_{crk}	Depth to bottom of foundation slab	NA	4.20E-1	(ft)
η	Foundation crack fraction	NA	1.00E-3	(-)
dP	Indoor/outdoor differential pressure	NA	1.00E-2	(psi)
Q_s	Convective air flow through slab	NA	1.33E-7	(ft^3/s)

Groundwater Parameters		Value	(Units)
δ_{gw}	Groundwater mixing zone depth	NA	(ft)
I_f	Net groundwater infiltration rate	NA	(cm/yr)
U_{gw}	Groundwater Darcy velocity	NA	(cm/s)
V_{gw}	Groundwater seepage velocity	NA	(cm/s)
K_s	Saturated hydraulic conductivity	NA	(cm/s)
i	Groundwater gradient	NA	(-)
S_w	Width of groundwater source zone	NA	(ft)
S_d	Depth of groundwater source zone	NA	(ft)
θ_{eff}	Effective porosity in water-bearing unit	NA	(-)
f_{oc-sat}	Fraction organic carbon in water-bearing unit	NA	(-)
pH_{sat}	Groundwater pH	NA	(-)
	Biodegradation considered?	NA	

Transport Parameters		Off-site 1	Off-site 2	Off-site 1	Off-site 2	(Units)
Lateral Groundwater Transport		Groundwater Ingestion		Soil Leaching to GW		
α_x	Longitudinal dispersivity	NA	NA	NA	NA	(ft)
α_y	Transverse dispersivity	NA	NA	NA	NA	(ft)
α_z	Vertical dispersivity	NA	NA	NA	NA	(ft)
Lateral Outdoor Air Transport		Soil to Outdoor Air Inhal.		GW to Outdoor Air Inhal.		
σ_y	Transverse dispersion coefficient	NA	NA	NA	NA	(ft)
σ_z	Vertical dispersion coefficient	NA	NA	NA	NA	(ft)
ADF	Air dispersion factor	NA	NA	NA	NA	(-)

Surface Water Parameters		Off-site 2	(Units)
Q_{sw}	Surface water flowrate	NA	(ft^3/s)
W_{pl}	Width of GW plume at SW discharge	NA	(ft)
δ_{pl}	Thickness of GW plume at SW discharge	NA	(ft)
DF_{sw}	Groundwater-to-surface water dilution factor	NA	(-)

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

SUBSURFACE SOILS (6.7 - 6.7 ft):

VAPOR INHALATION

	1) Source Medium	2) NAF Value (m^3/kg) Receptor			3) Exposure Medium Outdoor Air: POE Conc. (mg/m^3) (1) / (2)		
Constituents of Concern	Soil Conc. (mg/kg)	On-site (0 ft) Residential	Off-site 1 (0 ft) #VALUE!	Off-site 2 (0 ft) #VALUE!	On-site (0 ft) Residential	Off-site 1 (0 ft) #VALUE!	Off-site 2 (0 ft) #VALUE!
Benzene	2.2E-2	NA					
Toluene	2.8E-2	NA					
Ethylbenzene	2.2E-1	NA					
Xylene (mixed isomers)	2.2E-1	NA					
Methyl t-Butyl ether	2.5E-3	NA					
Naphthalene	1.7E-1	NA					

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

SUBSURFACE SOILS (6.7 - 6.7 ft):
VAPOR INHALATION (cont'd)

	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)			5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)		
	On-site (0 ft)	Off-site 1 (0 ft)	Off-site 2 (0 ft)	On-site (0 ft)	Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern	Residential	#VALUE!	#VALUE!	Residential	#VALUE!	#VALUE!
Benzene	4.1E-1					
Toluene	9.6E-1					
Ethylbenzene	9.6E-1					
Xylene (mixed isomers)	9.6E-1					
Methyl t-Butyl ether	9.6E-1					
Naphthalene	9.6E-1					

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr)

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: VAPOR INHALATION	Exposure Concentration 1) Source Medium	2) NAF Value (m^3/L) Receptor			3) Exposure Medium Outdoor Air: POE Conc. (mg/m^3) (1) / (2)		
Constituents of Concern	Groundwater Conc. (mg/L)	On-site (0 ft) Residential	Off-site 1 (0 ft) #VALUE!	Off-site 2 (0 ft) #VALUE!	On-site (0 ft) Residential	Off-site 1 (0 ft) #VALUE!	Off-site 2 (0 ft) #VALUE!
Benzene	1.5E+0	1.3E+6			1.2E-6		
Toluene	2.4E+0	1.3E+6			1.8E-6		
Ethylbenzene	7.3E-1	1.6E+6			4.6E-7		
Xylene (mixed isomers)	3.7E+0	1.5E+6			2.5E-6		
Methyl t-Butyl ether	7.4E-2	2.0E+5			3.7E-7		
Naphthalene	1.4E-1	2.1E+6			6.7E-8		

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

GROUNDWATER: VAPOR INHALATION (cont'd)

	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)			5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)		
	On-site (0 ft)	Off-site 1 (0 ft)	Off-site 2 (0 ft)	On-site (0 ft)	Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern	Residential	#VALUE!	#VALUE!	Residential	#VALUE!	#VALUE!
Benzene	4.1E-1			4.8E-7		
Toluene	9.6E-1			1.7E-6		
Ethylbenzene	9.6E-1			4.4E-7		
Xylene (mixed isomers)	9.6E-1			2.4E-6		
Methyl t-Butyl ether	9.6E-1			3.5E-7		
Naphthalene	9.6E-1			6.5E-8		

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr)

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

TOTAL PATHWAY EXPOSURE (mg/m^3)

(Sum average expsosure concentrations from soil and groundwater routes.)

	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern	Residential	Construction Worker	#VALUE!	#VALUE!
Benzene	4.8E-7			
Toluene	1.7E-6			
Ethylbenzene	4.4E-7			
Xylene (mixed isomers)	2.4E-6			
Methyl t-Butyl ether	3.5E-7			
Naphthalene	6.5E-8			

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

CARCINOGENIC RISK

Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Exposure (mg/m^3)				(3) Inhalation Unit Risk Factor (µg/m^3)^-1	(4) Individual COC Risk (2) x (3) x 1000			
		On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)		On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
		Residential	Construction Worker	#VALUE!	#VALUE!		Residential	Construction Worker	#VALUE!	#VALUE!
Benzene	A	4.8E-7				8.3E-6	4.0E-9			
Toluene	D									
Ethylbenzene	D									
Xylene (mixed isomers)	D									
Methyl t-Butyl ether	-									
Naphthalene	D									
						Total Pathway Carcinogenic Risk =	4.0E-9			

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

TOXIC EFFECTS

Constituents of Concern	(5) Total Toxicant Exposure (mg/m^3) On-site (0 ft) Residential	(5) On-site (0 ft) Construction Worker	(5) Off-site 1 (0 ft) #VALUE!	(5) Off-site 2 (0 ft) #VALUE!	(6) Inhalation Reference Conc. (mg/m^3)	(7) Individual COC Hazard Quotient (5) / (6) On-site (0 ft) Residential	(7) On-site (0 ft) Construction Worker	(7) Off-site 1 (0 ft) #VALUE!	(7) Off-site 2 (0 ft) #VALUE!
Benzene	1.1E-6				6.0E-3	1.9E-4			
Toluene	1.7E-6				4.0E-1	4.3E-6			
Ethylbenzene	4.4E-7				1.0E+0	4.4E-7			
Xylene (mixed isomers)	2.4E-6				7.0E+0	3.5E-7			
Methyl t-Butyl ether	3.5E-7				3.0E+0	1.2E-7			
Naphthalene	6.5E-8				1.4E+0	4.6E-8			
Total Pathway Hazard Index =						1.9E-4			

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

SOILS (6.7 - 6.7 ft): VAPOR INTRUSION INTO ON-SITE BUILDINGS	1) Source Medium	2) NAF Value (m^3/kg) Receptor	3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2)	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)	5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)
Constituents of Concern	Soil Conc. (mg/kg)	Commercial	Commercial	Commercial	Commercial
Benzene	2.2E-2	NA		2.4E-1	
Toluene	2.8E-2	NA		6.8E-1	
Ethylbenzene	2.2E-1	NA		6.8E-1	
Xylene (mixed isomers)	2.2E-1	NA		6.8E-1	
Methyl t-Butyl ether	2.5E-3	NA		6.8E-1	
Naphthalene	1.7E-1	NA		6.8E-1	

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr) NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

Building 2A

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: VAPOR INTRUSION INTO ON-SITE BUILDINGS

Exposure Concentration

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/L) Receptor	3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2)	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)	5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)
	Groundwater Conc. (mg/L)	Commercial	Commercial	Commercial	Commercial
Benzene	1.5E+0	3.5E+4	4.3E-5	2.4E-1	1.1E-5
Toluene	2.4E+0	3.5E+4	6.8E-5	6.8E-1	4.6E-5
Ethylbenzene	7.3E-1	4.1E+4	1.8E-5	6.8E-1	1.2E-5
Xylene (mixed isomers)	3.7E+0	3.9E+4	9.5E-5	6.8E-1	6.5E-5
Methyl t-Butyl ether	7.4E-2	4.2E+4	1.8E-6	6.8E-1	1.2E-6
Naphthalene	1.4E-1	1.1E+5	1.3E-6	6.8E-1	8.7E-7

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr) NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

3 OF 3

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS

Constituents of Concern	TOTAL PATHWAY EXPOSURE (mg/m^3) *(Sum average expsosure concentrations from soil and groundwater routes.)* Commercial
Benzene	1.1E-5
Toluene	4.6E-5
Ethylbenzene	1.2E-5
Xylene (mixed isomers)	6.5E-5
Methyl t-Butyl ether	1.2E-6
Naphthalene	8.7E-7

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins
Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

		CARCINOGENIC RISK		
Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Exposure (mg/m^3) Commercial	(3) Inhalation Unit Risk Factor (µg/m^3)^-1	(4) Individual COC Risk (2) x (3) x 1000 Commercial
Benzene	A	1.1E-5	8.3E-6	8.8E-8
Toluene	D			
Ethylbenzene	D			
Xylene (mixed isomers)	D			
Methyl t-Butyl ether	-			
Naphthalene	D			

Total Pathway Carcinogenic Risk = 8.8E-8

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

Building 2A

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAYS ARE ACTIVE)

TOXIC EFFECTS

Constituents of Concern	(5) Total Toxicant Exposure (mg/m^3) Commercial	(6) Inhalation Reference Concentration (mg/m^3)	(7) Individual COC Hazard Quotient (5) / (6) Commercial
Benzene	3.0E-5	6.0E-3	5.0E-3
Toluene	4.6E-5	4.0E-1	1.2E-4
Ethylbenzene	1.2E-5	1.0E+0	1.2E-5
Xylene (mixed isomers)	6.5E-5	7.0E+0	9.3E-6
Methyl t-Butyl ether	1.2E-6	3.0E+0	4.0E-7
Naphthalene	8.7E-7	1.4E+0	6.2E-7

Total Pathway Hazard Index = **5.1E-3**

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT — Baseline Risk Summary-All Pathways

Site Name: SNK Andante Bld. 2A
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

1 of 1

TIER 2 BASELINE RISK SUMMARY TABLE

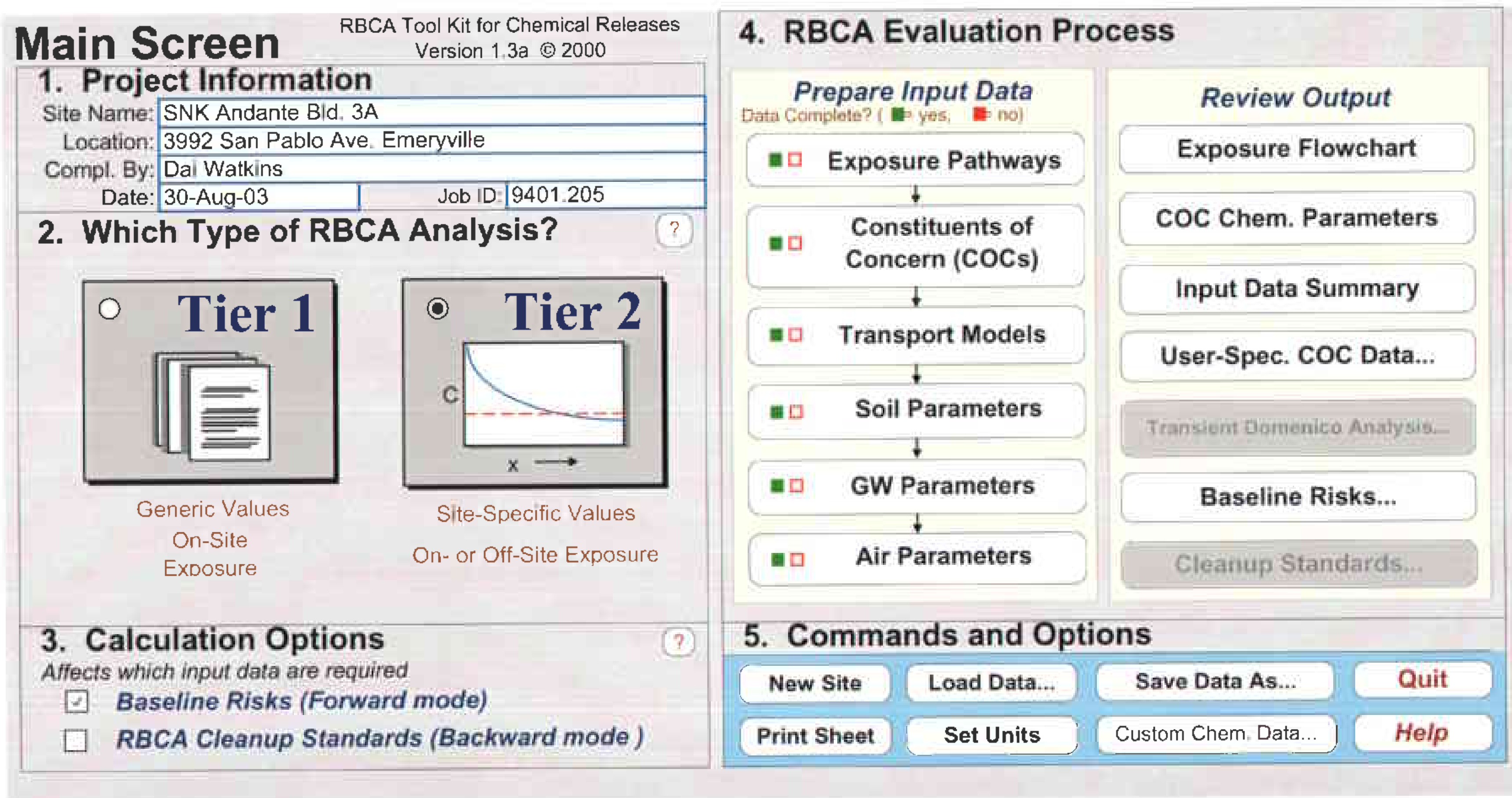
EXPOSURE PATHWAY	BASELINE CARCINOGENIC RISK: Individual COC Risk — Maximum Value	Individual COC Risk — Target Risk	Cumulative COC Risk — Total Value	Cumulative COC Risk — Target Risk	Risk Limit(s) Exceeded?	BASELINE TOXIC EFFECTS: Hazard Quotient — Maximum Value	Hazard Quotient — Applicable Limit	Hazard Index — Total Value	Hazard Index — Applicable Limit	Toxicity Limit(s) Exceeded?
OUTDOOR AIR EXPOSURE PATHWAYS										
Complete:	4.0E-9	1.0E-6	4.0E-9	1.0E-6	☐	1.9E-4	2.0E-1	1.9E-4	2.0E-1	☐
INDOOR AIR EXPOSURE PATHWAYS										
Complete:	8.8E-8	1.0E-6	8.8E-8	1.0E-6	☐	5.0E-3	2.0E-1	5.1E-3	2.0E-1	☐
SOIL EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
SURFACE WATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
CRITICAL EXPOSURE PATHWAY (Maximum Values From Complete Pathways)										
	8.8E-8	***1.0E-6***	***8.8E-8***	***1.0E-6***	☐	***5.0E-3***	***2.0E-1***	***5.1E-3***	***2.0E-1***	☐
	Indoor Air		***Indoor Air***			***Indoor Air***		***Indoor Air***		

APPENDIX II-F

Health Risk Assessment Building 3-A

Building 3A

RBCA Tool Kit for Chemical Releases, Version 1.3a

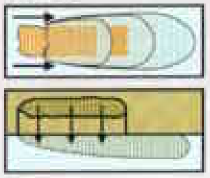


RBCA Tool Kit for Chemical Releases, Version 1.3a

Exposure Pathway Identification

Site Name: SNK Andante Bld. 3A
Location: 3992 San Pablo Ave. Emeryville
Compl. By: Dai Watkins
Job ID: 9401.205   Date: 30-Aug-03

1. Groundwater Exposure



Groundwater Ingestion/ Surface Water Impact

Receptor: None | None | None
Type: On-site | Off-site1 | Off-site2

Source Media:

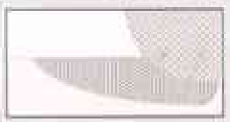
☐ Affected Groundwater

☐ Affected Soils Leaching to Groundwater

Distance to GW receptors

	On-site	Off-site1	Off-site2	
Affected Groundwater	0	0	0	(ft)
Affected Soils Leaching to Groundwater	0	0	0	(ft)

GW Discharge to Surface Water Exposure



☐ Swimming
☐ Fish Consumption
☐ Aquatic Life Protection

Enter ALP Criteria

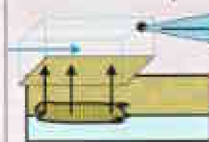
2. Surface Soil Exposure

Direct Ingestion and Dermal Contact

Receptor: None | No off-site receptors
Type: On-site

Construction Worker ☐

3. Air Exposure



Volatilization and Particulates to Outdoor Air Inhalation

Receptor: Res. | None | None
Type: On-site | Off-site1 | Off-site2
0 | 0 | 0 (ft)

Construction worker ☑

☑ Affected Soils--Volatilization to Ambient Outdoor Air
☑ Affected Groundwater--Volatilization to Ambient Outdoor Air
☐ Affected Surface Soils--Particulates to Ambient Outdoor Air

Volatilization to Indoor Air Inhalation

Receptor: Res. | No off-site receptors
Type: On-site

☑ Affected Soils--Volatilization to Enclosed Space
☑ Affected Groundwater--Volatilization to Enclosed Space

4. Commands and Options

Main Screen | Print Sheet | Set Units | Help

Exposure Factors & Target Risks | Exposure Flowchart

Building 3A

RBCA Tool Kit for Chemical Releases, Version 1.3a

Exposure Factors and Target Risk Limits

Site Name: SNK Andante Bld. 3A
Location: 3992 San Pablo Ave. Emeryville
Compl. By: Dai Watkins
Job ID: 9401.205 Date: 30-Aug-03

1. Exposure Parameters

	Age Adjustment?	Residential: Adult	Residential: (Age 0-6)	Residential: (Age 0-16)	Commercial: Chronic	Commercial: Construc
Averaging time, carcinogens (yr)		70				
Averaging time, non-carcinogens (yr)		30			25	1
Body weight (kg)		70	15	35	70	
Exposure duration (yr)		30	6	16	25	1
Exposure frequency (days/yr)		350			250	180
Dermal exposure frequency (days/yr)		350			250	
Skin surface area, soil contact (cm^2)	☑	5800		2023	5800	5800
Soil dermal adherence factor ($mg/cm^2/day$)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☑	100	200		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☑	0.05	0.5			
Skin surface area, swimming (cm^2)	☑	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				

2. Risk Goal Calculation Options

○ Individual Constituent Risk Goals Only
◉ Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcins.)	1.0E-6	1.0E-6
Target Risk (Class C carcinogens)	1.0E-6	
Target Hazard Quotient	2.0E-1	
Target Hazard Index		2.0E-1

4. Commands and Options

Return to Exposure Pathways

Use Default Values

Print Sheet

Help

Building 3A

RBCA Tool Kit for Chemical Releases, Version 1.3a

Site Name: SNK Andante Bld. 3A Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville Date: 30-Aug-03
Compl. By: Dai Watkins

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

Apply Raoult's Law ?

Selected COCs

COC Select: Add/Insert, Delete

Sort List: Top, Bottom, MoveUp, MoveDown ?

Representative COC Concentration ?

Selected COCs	Groundwater Source Zone (mg/L)	note	Soil Source Zone (mg/kg)	note	Mole Fraction in Source Material (-)
Benzene	1.5E+0		1.3E-2		
Toluene	2.4E+0		2.5E-3		
Ethylbenzene	7.3E-1		5.9E-2		
Xylene (mixed isomers)	3.7E+0		6.8E-2		
Methyl t-Butyl ether	7.4E-2		2.5E-3		
Naphthalene	1.4E-1		1.7E-1		

Groundwater Source Zone: Enter Directly | Enter Site Data

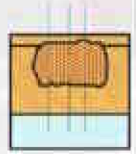
Soil Source Zone: Enter Directly | Enter Site Data

RBCA Tool Kit for Chemical Releases, Version 1.3a

Transport Modeling Options

Site Name: SNK Andante Bld. 3A — Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville — Date: 30-Aug-03
Compl. By: Dai Watkins

1. Vertical Transport, Surface Soil Column



Outdoor Air Volatilization Factors

?

- ○ Surface soil volatilization model only
- ◉ Combination surface soil/Johnson & Ettinger models
  - Thickness of surface soil zone: 2.31 (ft)
- ○ User-specified VF from other model — Enter VF Values

Indoor Air Volatilization Factors

?

- ◉ Johnson & Ettinger model
- ○ User-specified VF from other model — Enter VF Values

Soil-to-Groundwater Leaching Factor

?

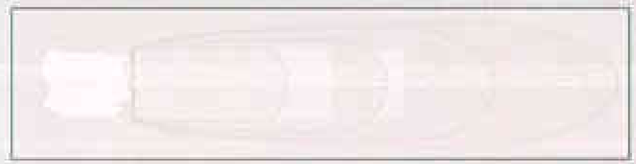
- ○ ASTM Model
  - ☐ Apply Soil Attenuation Model (SAM)
  - ☐ Allow first-order biodecay — Enter Decay Rates
- ○ User-specified LF from other model — Enter LF Values

2. Lateral Air Dispersion Factor

?

	Off-site 1	Off-site 2	
○ 3-D Gaussian dispersion model			
○ User-Specified ADF	1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor



Calculate DAF using Domenico Model

?

- ○ Domenico equation with dispersion only (no biodegradation)
- ○ Domenico equation first-order decay — Enter Decay Rates
- ○ Modified Domenico equation using electron acceptor superposition. — Enter Site Data
  - Enter Directly — Biodegradation Capacity: NC (mg/L)

— or —

User-Specified DAF Values

- ○ DAF values from other model or site data — Enter DAF Values

4. Commands and Options

Main Screen | Print Sheet | *Help*

Building 3A

RBCA Tool Kit for Chemical Releases, Version 1.3a

Site Name: SNK Andante Bld. 3A — Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville — Date: 30-Aug-03
Compl. By: Dai Watkins

Site-Specific Soil Parameters

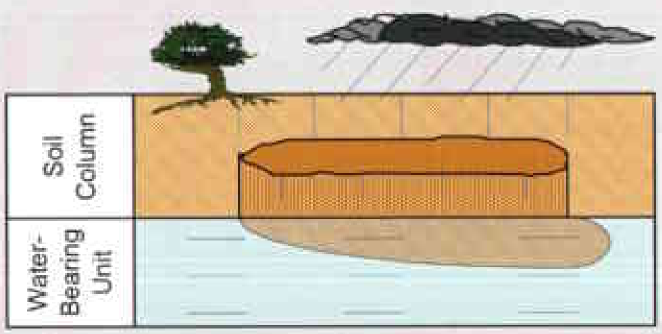
1. Soil Source Zone Characteristics

Hydrogeology

	General Case	Construction	
Depth to water-bearing unit	7.31		(ft)
Capillary zone thickness	5		(ft)
Soil column thickness	2.31		(ft)

Affected Soil Zone

	General Case	Construction	
Depth to top of affected soils	7.31		(ft)
Depth to base of affected soils	7.31		(ft)
Affected soil area	705	705	(ft^2)
Length of affected soil parallel to assumed wind direction	235	235	(ft)
Length of affected soil parallel to assumed GW flow direction	0		(ft)



2. Surface Soil Column

	Vadose Zone	Capillary Fringe	
Predominant USCS Soil Type			
or Calculate	or		
Total porosity	0.3412		(-)
Volumetric water content	0.275	0.3312	(-)
Volumetric air content	0.0662	0.01	(-)
Dry bulk density	1.7		(kg/L)
Vertical hydraulic conductivity	5.7E-7		(cm/s)
Vapor permeability	1.1E-16		(ft^2)
Capillary zone thickness	5.0E+0		(ft)

Net Rainfall Infiltration

Net infiltration estimate		(cm/yr)
or NA	or	
Average annual precipitation	0	(cm/yr)

Partitioning Parameters

Fraction organic carbon	0.02	(-)
Soil/water pH	6.8	(-)

3. Commands and Options

Main Screen | Use Default Values | Print Sheet | Set Units | Help

Site-Specific Air Parameters

Site Name: SNK Andante Bld. 3A — Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville — Date: 30-Aug-03
Compl. By: Dai Watkins

1. Outdoor Air Pathway

Dispersion in Air

	Off-site 1	Off-site 2	
Distance to offsite air receptor			(ft)
or NA	or		
Horizontal dispersivity			(ft)
Vertical dispersivity			(ft)

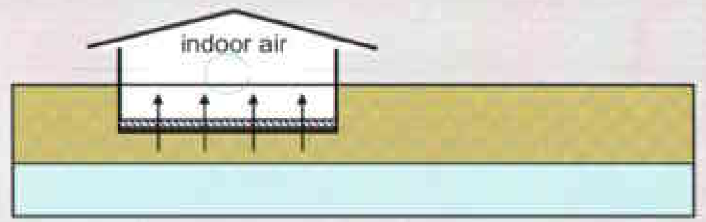
Air Source Zone

Air mixing zone height	6.56	(ft)
Ambient air velocity in mixing zone	10.56	(ft/s)
Areal particulate emission flux	6.9E-14	(g/cm^2/s)

2. Indoor Air Pathway

Building Parameters

	Residential	Commercial	
Building volume/area ratio	8.5	8.5	(ft)
Foundation area	705	705	(ft^2)
Foundation perimeter	126	126	(ft)
Building air exchange rate	5.6E-4	1.4E-3	(1/s)
Depth to bottom of foundation slab	0.42	0.42	(ft)
Convective air flow through cracks	6.6E-8	6.6E-8	(ft^3/s)
Foundation thickness	0.42		(ft)
Foundation crack fraction	0.001		(-)
Volumetric water content of cracks	0.12		(-)
Volumetric air content of cracks	0.26		(-)
Indoor/Outdoor differential pressure	0.01		(psi)



3. Commands and Options

Main Screen | Use Default Values | Print Sheet

Set Units | Help

RBCA Tool Kit for Chemical Releases, Version 1.3a

Commands and Options

Return | Print Sheet | Help

Site Name: SNK Andante Bld. 3A — Job ID: 9401.205

Location: 3992 San Pablo Ave. Emeryville — Date: 30-Aug-03

Compl. By: Dai Watkins

Groundwater Source Zone Concentration Calculator

Paste Defaults | Mean Option

UCL Percentile: 95%

Constituent	Detection Limit (mg/L)	No. of Samples	No. of Detects	Estimated Distribution of Data	Max. Conc. (mg/L)	Mean Conc. (mg/L)	UCL on Mean (mg/L)
Benzene	5.0E-4	1	1	-	1.5E+0	1.5E+0	NA
Toluene	5.0E-4	1	1	-	2.4E+0	2.4E+0	NA
Ethylbenzene	5.0E-4	1	1	-	7.3E-1	7.3E-1	NA
Xylene (mixed isomers)	1.0E-4	1	1	-	3.7E+0	3.7E+0	NA
Methyl t-Butyl ether	5.0E-4	1	1	-	7.4E-2	7.4E-2	NA
Naphthalene	1.0E-2	1	1	-	1.4E-1	1.4E-1	NA

RBCA Tool Kit for Chemical Releases, Version 1.3a

Enter Analytical Data from Groundwater Source Zone (up to 50 Data Points)

Analytical Data

	1	2	3	4	5	6	7	8	9	10	11	12	13
ID	30S-40E												
Date	16-May-03												
	(mg/L)	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*
	1.50E+0												
	2.40E+0												
	7.30E-1												
	3.70E+0												
	7.40E-2												
	1.40E-1												

RBCA Tool Kit for Chemical Releases, Version 1.3a

Commands and Options

Return | Print Sheet | Help

Site Name: SNK Andante Bld. 3A   Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville   Date: 30-Aug-03
Compl. By: Dai Watkins

Soil Source Zone Concentration Calculator

UCL Percentile: 95%

Paste Defaults | Mean Option

Constituent	Detection Limit (mg/kg)	No. of Samples	No. of Detects	Estimated Distribution of Data	Max. Conc. (mg/kg)	Mean Conc. (mg/kg)	UCL on Mean (mg/kg)
Benzene	5.0E-3	10	2	Lognormal	1.6E+0	4.3E-3	1.3E-2
Toluene	5.0E-3	10	0	Normal	0.0E+0	2.5E-3	2.5E-3
Ethylbenzene	5.0E-3	10	5	Lognormal	8.8E+0	1.1E-2	5.9E-2
Xylene (mixed isomers)	5.0E-3	10	5	Lognormal	3.7E+1	1.1E-2	6.8E-2
Methyl t-Butyl ether	5.0E-3	10	0	Normal	0.0E+0	2.5E-3	2.5E-3
Naphthalene	3.4E-1	10	0	Normal	0.0E+0	1.7E-1	1.7E-1

RBCA Tool Kit for Chemical Releases, Version 1.3a

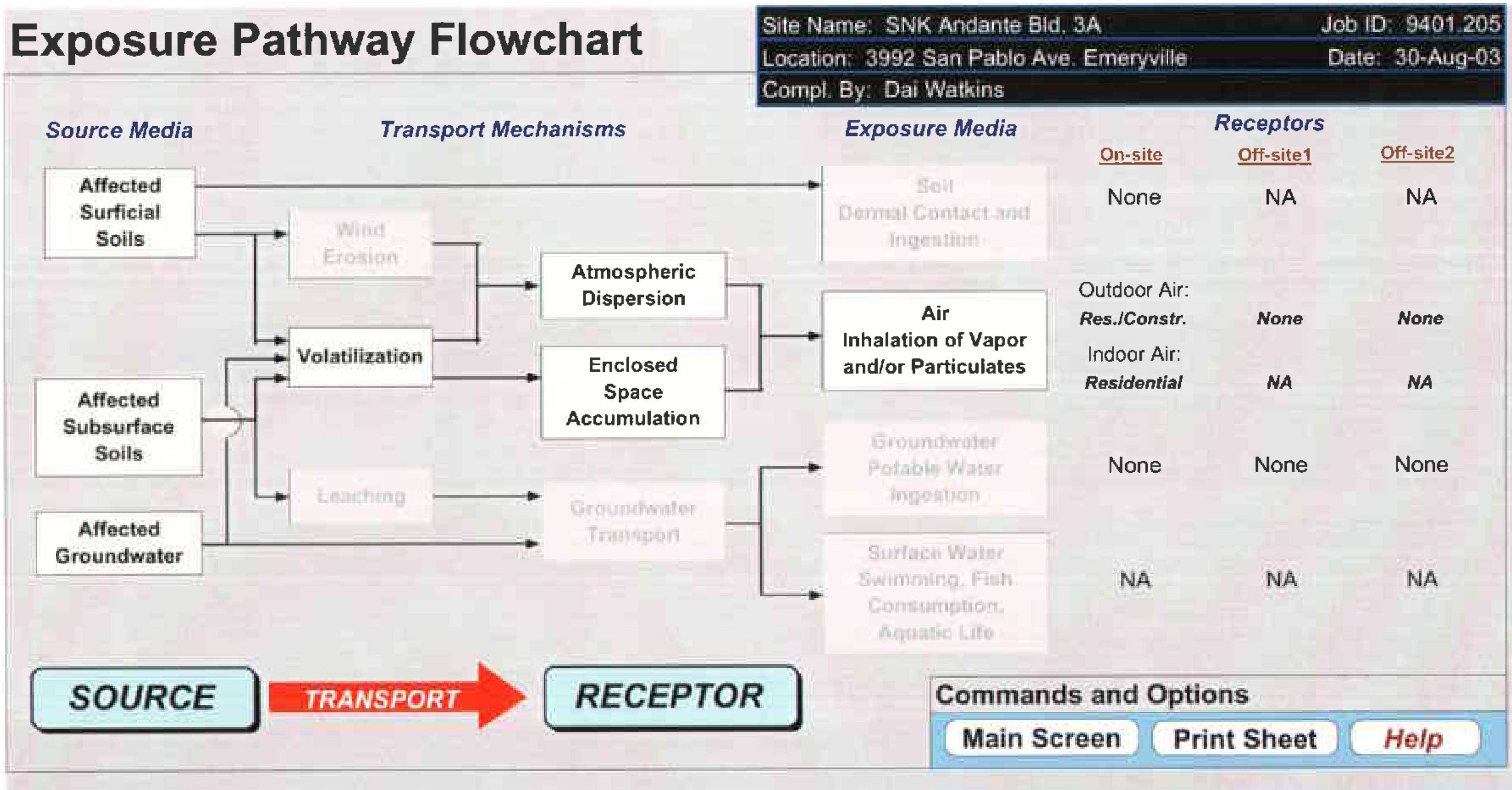
Enter Analytical Data from Soil Source Zone (up to 50 Data Points)

Analytical Data

	1	2	3	4	5	6	7	8	9	10	11	12	13
ID	60S-60E	60S-80E	60S-100E	60S-120E	80S-60E	80S-80E	80S-100E	80S-120E	100S-80E	100S-100E			
Date	13-May-03	27-May-03	20-May-03	20-May-03	23-May-03	27-May-03	13-May-03	15-May-03	22-May-03	5135/2003			
	(mg/kg)	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
	ND	ND	ND	ND	ND	ND	ND	1.60E+0	ND	8.70E-2			
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			
	8.00E+0	ND	ND	ND	ND	1.70E-2	8.80E+0	3.30E+0	ND	9.10E-2			
	3.70E+1	ND	ND	ND	ND	7.90E-3	2.80E+1	2.80E+0	ND	5.20E-2			
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			

Building 3A

RBCA Tool Kit for Chemical Releases, Version 1.3a



Building 3A

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs	Physical Property Data

Constituent	CAS Number	type	Molecular Weight (g/mole) MW	ref	Diffusion Coefficients In air (cm2/s) Dair	ref	Diffusion Coefficients In water (cm2/s) Dwat	ref	log (Koc) or log(Kd) (@ 20 - 25 C) log(L/kg)	partition	ref	Henry's Law Constant (@ 20 - 25 C) (atm-m3) mol	Henry's Law Constant (unitless)	ref	Vapor Pressure (@ 20 - 25 C) (mm Hg)	ref	Solubility (@ 20 - 25 C) (mg/L)	ref	acid pKa	base pKb	ref
Benzene	71-43-2	A	78.1	PS	8.80E-02	PS	9.80E-06	PS	1.77	Koc	PS	5.55E-03	2.29E-01	PS	9.52E+01	PS	1.75E+03	PS	-	-	-
Toluene	108-88-3	A	92.4	5	8.50E-02	A	9.40E-06	A	2.13	Koc	A	6.30E-03	2.60E-01	A	3.00E+01	4	5.15E+02	29	-	-	-
Ethylbenzene	100-41-4	A	106.2	PS	7.50E-02	PS	7.80E-06	PS	2.56	Koc	PS	7.88E-03	3.25E-01	PS	1.00E+01	PS	1.69E+02	PS	-	-	-
Xylene (mixed isomers)	1330-20-7	A	106.2	5	7.20E-02	A	8.50E-06	A	2.38	Koc	A	7.03E-03	2.90E-01	A	7.00E+00	4	1.98E+02	5	-	-	-
Methyl t-Butyl ether	1634-04-4	O	88.146	5	7.92E-02	6	9.41E-05	7	1.08	Koc	A	5.77E-04	2.38E-02	-	2.49E+02	-	4.80E+04	A	-	-	-
Naphthalene	91-20-3	PAH	128.2	PS	5.90E-02	PS	7.50E-06	PS	3.30	Koc	PS	4.83E-04	1.99E-02	PS	2.30E-01	PS	3.10E+01	PS	-	-	-

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs	Toxicity Data

Constituent	Reference Dose (mg/kg/day) Oral RfD_oral	ref	(mg/kg/day) Dermal RfD_dermal	ref	Reference Conc. (mg/m3) Inhalation RfC_inhal	ref	Slope Factors 1/(mg/kg/day) Oral SF_oral	ref	1/(mg/kg/day) Dermal SF_dermal	ref	Unit Risk Factor 1/(µg/m3) Inhalation URF_inhal	ref	EPA Weight of Evidence	Is Constituent Carcinogenic ?
Benzene	3.00E-03	R	-	-	5.95E-03	R	2.90E-02	PS	2.99E-02	TX	8.29E-06	PS	A	TRUE
Toluene	2.00E-01	A,R	1.60E-01	TX	4.00E-01	A,R	-	-	-	-	-	-	D	FALSE
Ethylbenzene	1.00E-01	PS	9.70E-02	TX	1.00E+00	PS	-	-	-	-	-	-	D	FALSE
Xylene (mixed isomers)	2.00E+00	A,R	1.84E+00	TX	7.00E+00	A	-	-	-	-	-	-	D	FALSE
Methyl t-Butyl ether	1.00E-02	31	8.00E-03	TX	3.00E+00	R	-	-	-	-	-	-	-	FALSE
Naphthalene	4.00E-01	PS	3.56E-01	TX	1.40E+00	PS	-	-	-	-	-	-	D	FALSE

Site Name: SNK Andante Bld. 3

Site Location: 3992 San Pab

Building 3A

RBCA Tool Kit for Chemical Releases, Version 1.3a

Miscellaneous Chemical Data

Constituent	Maximum Contaminant Level MCL (mg/L)	ref	Time-Weighted Average Workplace Criteria TWA (mg/m3)	ref	Aquatic Life Prot. Criteria AQL (mg/L)	ref	Bioconcentration Factor (L-wat/kg-fish)
Benzene	5.00E-03	52 FR 25690	3.25E+00	PS	-	-	12.6
Toluene	1.00E+00	56 FR 3526 (30 Jan 91)	1.47E+02	ACGIH	-	-	70
Ethylbenzene	7.00E-01	56 FR 3526 (30 Jan 91)	4.35E+02	PS	-	-	1
Xylene (mixed isomers)	1.00E+01	56 FR 3526 (30 Jan 91)	4.34E+02	ACGIH	-	-	1
Methyl t-Butyl ether	-	-	6.00E+01	NIOSH	-	-	1
Naphthalene	-	-	5.00E+01	PS	-	-	430

Site Name: SNK Andante Bld. 3

Site Location: 3992 San Pab

Building 3A

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs

Miscellaneous Chemical Data

Constituent	Dermal Relative Absorp. Factor (unitless)	Water Dermal Permeability Data: Dermal Permeability Coeff. (cm/hr)	Lag time for Dermal Exposure (hr)	Critical Exposure Time (hr)	Relative Contr of Derm Perm Coeff (unitless)	Water/Skin Derm Adsorp Factor (cm/event)	ref	Detection Limits: Groundwater (mg/L)	ref	Soil (mg/kg)	ref	Half Life (First-Order Decay) (days): Saturated	Unsaturated	ref
Benzene	0.5	0.021	0.26	0.63	0.013	7.3E-2	D	0.002	S	0.005	S	720	720	H
Toluene	0.5	0.045	0.32	0.77	0.054	1.6E-1	D	0.002	S	0.005	S	28	28	H
Ethylbenzene	0.5	0.074	0.39	1.3	0.14	2.7E-1	D	0.002	S	0.005	S	228	228	H
Xylene (mixed isomers)	0.5	0.08	0.39	1.4	0.16	2.9E-1	D	0.005	S	0.005	S	360	360	H
Methyl t-Butyl ether	0.5	-	-	-	-	-	-	-	-	-	-	360	180	H
Naphthalene	0.05	0.069	0.53	2.2	0.2	2.7E-1	D	0.01	32	0.01	32	258	258	H

Site Name: SNK Andante Bld. 3

Site Location: 3992 San Pab

Building 3A

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

Input Parameter Summary

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave, Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

Exposure Parameters		Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Construc.
AT_c	Averaging time for carcinogens (yr)	70				
AT_n	Averaging time for non-carcinogens (yr)	30			25	1
BW	Body weight (kg)	70	15	35	70	
ED	Exposure duration (yr)	30	6	16	25	1
τ	Averaging time for vapor flux (yr)	30			25	1
EF	Exposure frequency (days/yr)	350			250	180
EF_D	Exposure frequency for dermal exposure	350			250	
IR_w	Ingestion rate of water (L/day)	2			1	
IR_s	Ingestion rate of soil (mg/day)	100	200		50	100
SA	Skin surface area (dermal) (cm^2)	5800		2023	5800	5800
M	Soil to skin adherence factor	1				
ET_{swim}	Swimming exposure time (hr/event)	3				
EV_{swim}	Swimming event frequency (events/yr)	12	12	12		
IR_{swim}	Water ingestion while swimming (L/hr)	0.05	0.5			
SA_{swim}	Skin surface area for swimming (cm^2)	23000		8100		
IR_{fish}	Ingestion rate of fish (kg/yr)	0.025				
Fl_{fish}	Contaminated fish fraction (unitless)	1				

Complete Exposure Pathways and Receptors	On-site	Off-site 1	Off-site 2
Groundwater:			
Groundwater Ingestion	None	None	None
Soil Leaching to Groundwater Ingestion	None	None	None
Applicable Surface Water Exposure Routes:			
Swimming			NA
Fish Consumption			NA
Aquatic Life Protection			NA
Soil:			
Direct Ingestion and Dermal Contact	None		
Outdoor Air:			
Particulates from Surface Soils	None	None	None
Volatilization from Soils	Res./Constr.	None	None
Volatilization from Groundwater	Residential	None	None
Indoor Air:			
Volatilization from Subsurface Soils	Residential	NA	NA
Volatilization from Groundwater	Residential	NA	NA

Receptor Distance from Source Media	On-site	Off-site 1	Off-site 2	(Units)
Groundwater receptor	NA	NA	NA	(ft)
Soil leaching to groundwater receptor	NA	NA	NA	(ft)
Outdoor air inhalation receptor	0	NA	NA	(ft)

Target Health Risk Values		Individual	Cumulative
TR_{ab}	Target Risk (class A&B carcinogens)	1.0E-6	1.0E-6
TR_c	Target Risk (class C carcinogens)	1.0E-6	
THQ	Target Hazard Quotient (non-carcinogenic risk)	2.0E-1	2.0E-1

Modeling Options	
RBCA tier	Tier 2
Outdoor air volatilization model	Surface & subsurface models
Indoor air volatilization model	Johnson & Ettinger model
Soil leaching model	NA
Use soil attenuation model (SAM) for leachate?	NA
Air dilution factor	NA
Groundwater dilution-attenuation factor	NA

NOTE: NA = Not applicable

Surface Parameters		General	Construction	(Units)
A	Source zone area	7.1E+2	7.1E+2	(ft^2)
W	Length of source-zone area parallel to wind	2.4E+2	2.4E+2	(ft)
W_{gw}	Length of source-zone area parallel to GW flow	NA		(ft)
U_{air}	Ambient air velocity in mixing zone	1.1E+1		(ft/s)
δ_{air}	Air mixing zone height	6.6E+0		(ft)
P_e	Areal particulate emission rate	NA		(g/cm^2/s)
L_{ss}	Thickness of affected surface soils	2.3E+0		(ft)

Surface Soil Column Parameters		Value			(Units)
h_{cap}	Capillary zone thickness	5.0E+0			(ft)
h_v	Vadose zone thickness	2.3E+0			(ft)
ρ_s	Soil bulk density	1.7E+0			(g/cm^3)
f_{oc}	Fraction organic carbon	2.0E-2			(-)
θ_T	Soil total porosity	3.4E-1			(-)
K_{vs}	Vertical hydraulic conductivity	5.7E-7			(cm/s)
k_v	Vapor permeability	1.1E-16			(ft^2)
L_{gw}	Depth to groundwater	7.3E+0			(ft)
L_s	Depth to top of affected soils	7.3E+0			(ft)
L_{base}	Depth to base of affected soils	7.3E+0			(ft)
L_{subs}	Thickness of affected soils	0.0E+0			(ft)
pH	Soil/groundwater pH	6.8E+0			(-)
		capillary	vadose	foundation	
θ_w	Volumetric water content	0.3312	0.275	0.12	(-)
θ_a	Volumetric air content	0.01	0.0662	0.26	(-)

Building Parameters		Residential	Commercial	(Units)
L_b	Building volume/area ratio	8.50E+0	NA	(ft)
A_b	Foundation area	7.05E+2	NA	(ft^2)
X_{crk}	Foundation perimeter	1.26E+2	NA	(ft)
ER	Building air exchange rate	5.60E-4	NA	(1/s)
L_{crk}	Foundation thickness	4.20E-1	NA	(ft)
Z_{crk}	Depth to bottom of foundation slab	4.20E-1	NA	(ft)
η	Foundation crack fraction	1.00E-3	NA	(-)
dP	Indoor/outdoor differential pressure	1.00E-2	NA	(psi)
Q_s	Convective air flow through slab	6.62E-8	NA	(ft^3/s)

Groundwater Parameters		Value	(Units)
δ_{gw}	Groundwater mixing zone depth	NA	(ft)
I_f	Net groundwater infiltration rate	NA	(cm/yr)
U_{gw}	Groundwater Darcy velocity	NA	(cm/s)
V_{gw}	Groundwater seepage velocity	NA	(cm/s)
K_s	Saturated hydraulic conductivity	NA	(cm/s)
i	Groundwater gradient	NA	(-)
S_w	Width of groundwater source zone	NA	(ft)
S_d	Depth of groundwater source zone	NA	(ft)
θ_{eff}	Effective porosity in water-bearing unit	NA	(-)
f_{oc-sat}	Fraction organic carbon in water-bearing unit	NA	(-)
pH_{sat}	Groundwater pH	NA	(-)
	Biodegradation considered?	NA	

Transport Parameters		Off-site 1	Off-site 2	Off-site 1	Off-site 2	(Units)
Lateral Groundwater Transport		Groundwater Ingestion		Soil Leaching to GW		
α_x	Longitudinal dispersivity	NA	NA	NA	NA	(ft)
α_y	Transverse dispersivity	NA	NA	NA	NA	(ft)
α_z	Vertical dispersivity	NA	NA	NA	NA	(ft)
Lateral Outdoor Air Transport		Soil to Outdoor Air Inhal.		GW to Outdoor Air Inhal.		
σ_y	Transverse dispersion coefficient	NA	NA	NA	NA	(ft)
σ_z	Vertical dispersion coefficient	NA	NA	NA	NA	(ft)
ADF	Air dispersion factor	NA	NA	NA	NA	(-)

Surface Water Parameters		Off-site 2	(Units)
Q_{sw}	Surface water flowrate	NA	(ft^3/s)
W_{pl}	Width of GW plume at SW discharge	NA	(ft)
δ_{pl}	Thickness of GW plume at SW discharge	NA	(ft)
DF_{sw}	Groundwater-to-surface water dilution factor	NA	(-)

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

SUBSURFACE SOILS (7.3 - 7.3 ft):

VAPOR INHALATION

	1) Source Medium	2) NAF Value (m^3/kg) Receptor			3) Exposure Medium Outdoor Air: POE Conc. (mg/m^3) (1) / (2)		
Constituents of Concern	Soil Conc. (mg/kg)	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	1.3E-2	NA					
Toluene	2.5E-3	NA					
Ethylbenzene	5.9E-2	NA					
Xylene (mixed isomers)	6.8E-2	NA					
Methyl t-Butyl ether	2.5E-3	NA					
Naphthalene	1.7E-1	NA					

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dal Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

SUBSURFACE SOILS (7.3 - 7.3 ft):
VAPOR INHALATION (cont'd)

Constituents of Concern	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)			5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)		
	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	4.1E-1					
Toluene	9.6E-1					
Ethylbenzene	9.6E-1					
Xylene (mixed isomers)	9.6E-1					
Methyl t-Butyl ether	9.6E-1					
Naphthalene	9.6E-1					

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr)

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

GROUNDWATER: VAPOR INHALATION

Exposure Concentration

	1) Source Medium	2) NAF Value (m^3/L) Receptor			3) Exposure Medium Outdoor Air: POE Conc. (mg/m^3) (1) / (2)		
Constituents of Concern	Groundwater Conc. (mg/L)	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	1.5E+0	1.3E+6			1.2E-6		
Toluene	2.4E+0	1.3E+6			1.8E-6		
Ethylbenzene	7.3E-1	1.6E+6			4.6E-7		
Xylene (mixed isomers)	3.7E+0	1.5E+6			2.5E-6		
Methyl t-Butyl ether	7.4E-2	2.3E+5			3.3E-7		
Naphthalene	1.4E-1	2.2E+6			6.2E-8		

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

GROUNDWATER: VAPOR INHALATION (cont'd)

Constituents of Concern	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)			5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)		
	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	4.1E-1			4.7E-7		
Toluene	9.6E-1			1.7E-6		
Ethylbenzene	9.6E-1			4.4E-7		
Xylene (mixed isomers)	9.6E-1			2.4E-6		
Methyl t-Butyl ether	9.6E-1			3.1E-7		
Naphthalene	9.6E-1			6.0E-8		

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr)

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

TOTAL PATHWAY EXPOSURE (mg/m^3)
(Sum average expsosure concentrations from soil and groundwater routes.)

	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern	Residential	Construction Worker	None	None
Benzene	4.7E-7			
Toluene	1.7E-6			
Ethylbenzene	4.4E-7			
Xylene (mixed isomers)	2.4E-6			
Methyl t-Butyl ether	3.1E-7			
Naphthalene	6.0E-8			

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

CARCINOGENIC RISK

Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Exposure (mg/m^3)				(3) Inhalation Unit Risk Factor (µg/m^3)^-1	(4) Individual COC Risk (2) x (3) x 1000			
		On-site (0 ft) Residential	On-site (0 ft) Construction Worker	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None		On-site (0 ft) Residential	On-site (0 ft) Construction Worker	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	A	4.7E-7				8.3E-6	3.9E-9			
Toluene	D									
Ethylbenzene	D									
Xylene (mixed isomers)	D									
Methyl t-Butyl ether	-									
Naphthalene	D									
						Total Pathway Carcinogenic Risk =	**3.9E-9**			

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

TOXIC EFFECTS

	(5) Total Toxicant Exposure (mg/m^3)				(6) Inhalation Reference Conc. (mg/m^3)	(7) Individual COC Hazard Quotient (5) / (6)			
	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)		On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern	Residential	Construction Worker	None	None		Residential	Construction Worker	None	None
Benzene	1.1E-6				6.0E-3	1.9E-4			
Toluene	1.7E-6				4.0E-1	4.3E-6			
Ethylbenzene	4.4E-7				1.0E+0	4.4E-7			
Xylene (mixed isomers)	2.4E-6				7.0E+0	3.4E-7			
Methyl t-Butyl ether	3.1E-7				3.0E+0	1.0E-7			
Naphthalene	6.0E-8				1.4E+0	4.3E-8			
Total Pathway Hazard Index =						**1.9E-4**			

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

Building 3A

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

SOILS (7.3 - 7.3 ft): VAPOR INTRUSION INTO ON-SITE BUILDINGS

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/kg) Receptor	3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2)	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)	5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)
	Soil Conc. (mg/kg)	Residential	Residential	Residential	Residential
Benzene	1.3E-2	NA		4.1E-1	
Toluene	2.5E-3	NA		9.6E-1	
Ethylbenzene	5.9E-2	NA		9.6E-1	
Xylene (mixed isomers)	6.8E-2	NA		9.6E-1	
Methyl t-Butyl ether	2.5E-3	NA		9.6E-1	
Naphthalene	1.7E-1	NA		9.6E-1	

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr) NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

Building 3A

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

GROUNDWATER: VAPOR INTRUSION INTO ON-SITE BUILDINGS

Exposure Concentration

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/L) Receptor	3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2)	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)	5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)
	Groundwater Conc. (mg/L)	Residential	Residential	Residential	Residential
Benzene	1.5E+0	1.2E+4	1.3E-4	4.1E-1	5.2E-5
Toluene	2.4E+0	1.2E+4	2.0E-4	9.6E-1	1.9E-4
Ethylbenzene	7.3E-1	1.4E+4	5.2E-5	9.6E-1	5.0E-5
Xylene (mixed isomers)	3.7E+0	1.3E+4	2.8E-4	9.6E-1	2.7E-4
Methyl t-Butyl ether	7.4E-2	1.4E+4	5.1E-6	9.6E-1	4.9E-6
Naphthalene	1.4E-1	3.9E+4	3.6E-6	9.6E-1	3.5E-6

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr) NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave, Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

3 OF 3

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS

Constituents of Concern	TOTAL PATHWAY EXPOSURE (mg/m^3) (Sum average exposure concentrations from soil and groundwater routes.) Residential
Benzene	5.2E-5
Toluene	1.9E-4
Ethylbenzene	5.0E-5
Xylene (mixed isomers)	2.7E-4
Methyl t-Butyl ether	4.9E-6
Naphthalene	3.5E-6

Site Name: SNK Andante Bld: 3A
Site Location: 3992 San Pablo Ave, Emeryville
Completed By: Dai Watkins
Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAYS ARE ACTIVE)

Constituents of Concern	(1) EPA Carcinogenic Classification	CARCINOGENIC RISK (2) Total Carcinogenic Exposure (mg/m^3) Residential	(3) Inhalation Unit Risk Factor (μg/m^3)^-1	(4) Individual COC Risk (2) x (3) x 1000 Residential
Benzene	A	5.2E-5	8.3E-6	4.3E-7
Toluene	D			
Ethylbenzene	D			
Xylene (mixed isomers)	D			
Methyl t-Butyl ether	-			
Naphthalene	D			

Total Pathway Carcinogenic Risk = 4.3E-7

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAYS ARE ACTIVE)

	TOXIC EFFECTS		
	(5) Total Toxicant Exposure (mg/m^3)	(6) Inhalation Reference Concentration	(7) Individual COC Hazard Quotient (5) / (6)
Constituents of Concern	Residential	(mg/m^3)	Residential
Benzene	1.2E-4	6.0E-3	2.0E-2
Toluene	1.9E-4	4.0E-1	4.7E-4
Ethylbenzene	5.0E-5	1.0E+0	5.0E-5
Xylene (mixed isomers)	2.7E-4	7.0E+0	3.8E-5
Methyl t-Butyl ether	4.9E-6	3.0E+0	1.6E-6
Naphthalene	3.5E-6	1.4E+0	2.5E-6

Total Pathway Hazard Index = **2.1E-2**

Site Name: SNK Andante Bld. 3A
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT | **Baseline Risk Summary-All Pathways**

Site Name: SNK Andante Bld. 3A — Completed By: Dai Watkins
Site Location: 3992 San Pablo Ave. Emeryville — Date Completed: 30-Aug-03

1 of 1

TIER 2 BASELINE RISK SUMMARY TABLE

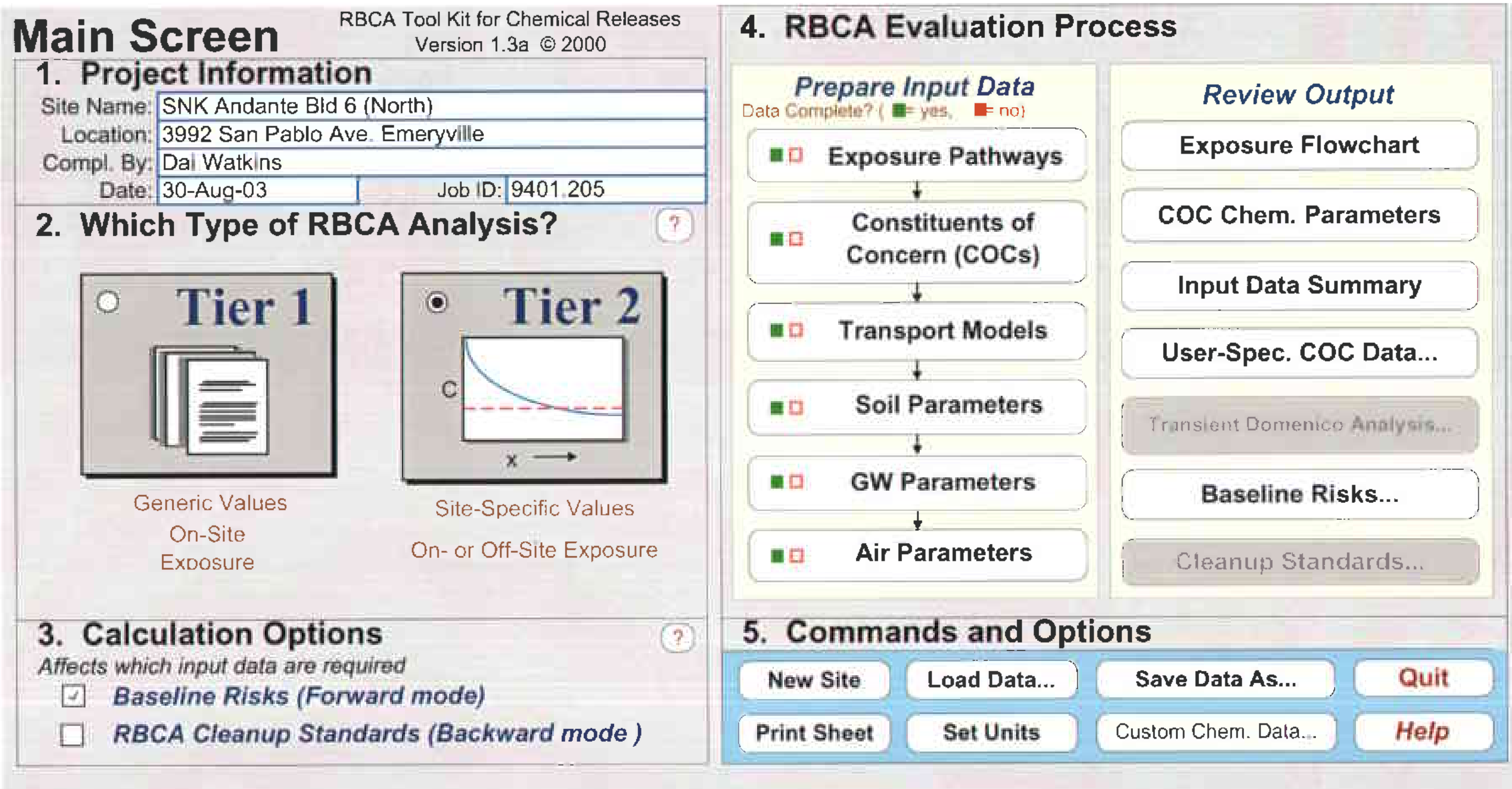
	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk	Hazard Quotient		Hazard Index		Toxicity
EXPOSURE PATHWAY	Maximum Value	Target Risk	Total Value	Target Risk	Limit(s) Exceeded?	Maximum Value	Applicable Limit	Total Value	Applicable Limit	Limit(s) Exceeded?
OUTDOOR AIR EXPOSURE PATHWAYS										
Complete:	3.9E-9	1.0E-6	3.9E-9	1.0E-6	☐	1.9E-4	2.0E-1	1.9E-4	2.0E-1	☐
INDOOR AIR EXPOSURE PATHWAYS										
Complete:	4.3E-7	1.0E-6	4.3E-7	1.0E-6	☐	2.0E-2	2.0E-1	2.1E-2	2.0E-1	☐
SOIL EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
SURFACE WATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
CRITICAL EXPOSURE PATHWAY (Maximum Values From Complete Pathways)										
	4.3E-7	*1.0E-6*	*4.3E-7*	*1.0E-6*	☐	*2.0E-2*	*2.0E-1*	*2.1E-2*	*2.0E-1*	☐
	Indoor Air		*Indoor Air*			*Indoor Air*		*Indoor Air*		

APPENDIX II-G

Health Risk Assessment Building 6

SJC

RBCA Tool Kit for Chemical Releases, Version 1.3a

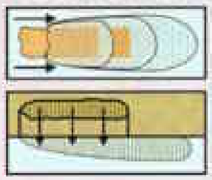


RBCA Tool Kit for Chemical Releases, Version 1.0

Exposure Pathway Identification

Site Name: SNK Andante Bld 6 (North)
Location: 3992 San Pablo Ave. Emeryville
Compl. By: Dai Watkins
Job ID: 9401.205 Date: 30-Aug-03

1. Groundwater Exposure



Groundwater Ingestion/ Surface Water Impact

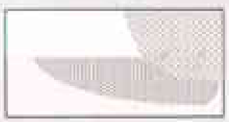
Receptor	None	None	None
Type:	On-site	Off-site1	Off-site2

Source Media

Distance to GW receptors

☐ Affected Groundwater				(ft)
	On-site	Off-site1	Off-site2	
☐ Affected Soils Leaching to Groundwater				(ft)

GW Discharge to Surface Water Exposure



- ☐ Swimming
- ☐ Fish Consumption
- ☐ Aquatic Life Protection

Enter ALP Criteria

2. Surface Soil Exposure

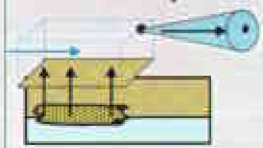
Direct Ingestion and Dermal Contact

Receptor	None	No off-site receptors
Type:	On-site	

Construction Worker ☐

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation



Receptor	Res.	None	None	
Type:	On-site	Off-site1	Off-site2	
	0	0	0	(ft)

Construction worker ☑

- ☑ Affected Soils--Volatilization to Ambient Outdoor Air
- ☑ Affected Groundwater--Volatilization to Ambient Outdoor Air
- ☐ Affected Surface Soils--Particulates to Ambient Outdoor Air

Volatilization to Indoor Air Inhalation

Receptor	Com.	No off-site receptors
Type:	On-site	

- ☑ Affected Soils--Volatilization to Enclosed Space
- ☑ Affected Groundwater--Volatilization to Enclosed Space

4. Commands and Options

Main Screen | **Print Sheet** | **Set Units** | ***Help***

Exposure Factors & Target Risks | Exposure Flowchart

Exposure Factors and Target Risk Limits

Site Name: SNK Andante Bld 6 (North)
Location: 3992 San Pablo Ave. Emeryville
Compl. By: Dai Watkins
Job ID: 9401.205 Date: 30-Aug-03

1. Exposure Parameters

	Age Adjustment?	Residential: Adult	Residential: (Age 0-6)	Residential: (Age 0-16)	Commercial: Chronic	Commercial: Construc.
Averaging time, carcinogens (yr)		70				
Averaging time, non-carcinogens (yr)		30			25	1
Body weight (kg)		70	15	35	70	
Exposure duration (yr)		30	6	16	25	1
Exposure frequency (days/yr)		350			250	180
Dermal exposure frequency (days/yr)		350			250	
Skin surface area, soil contact (cm^2)	☑	5800		2023	5800	5800
Soil dermal adherence factor ($mg/cm^2/day$)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☑	100	200		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☑	0.05	0.5			
Skin surface area, swimming (cm^2)	☑	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				

2. Risk Goal Calculation Options

○ Individual Constituent Risk Goals Only
◉ Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcins.)	1.0E-6	1.0E-6
Target Risk (Class C carcinogens)	1.0E-6	
Target Hazard Quotient	2.0E-1	
Target Hazard Index		2.0E-1

4. Commands and Options

Return to Exposure Pathways

Use Default Values

Print Sheet

Help

Building 6 (North)

RBCA Tool Kit for Chemical Releases, Version 1.3a

Site Name: SNK Andante Bld 6 (North)	Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville	Date: 30-Aug-03
Compl. By: Dai Watkins	

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

Apply Raoult's Law ?

Selected COCs

COC Select: Add/Insert, Delete

Sort List: ? Top, Bottom, MoveUp, MoveDown

Representative COC Concentration ?

Groundwater Source Zone: Enter Directly | Enter Site Data

Soil Source Zone: Enter Directly | Enter Site Data

Selected COCs	Groundwater Source Zone *(mg/L)*	note	Soil Source Zone *(mg/kg)*	note
Benzene	1.5E+0		1.6E-2	
Toluene	2.4E+0		2.5E-3	
Ethylbenzene	7.3E-1		7.6E-2	
Xylene (mixed isomers)	3.7E+0		5.4E-2	
Methyl t-Butyl ether	7.4E-2		2.5E-3	
Naphthalene	1.4E-1		1.7E-1	

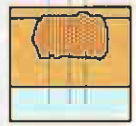
Building 6 (North)

RBCA Tool Kit for Chemical Releases, Version 1.3a

Transport Modeling Options

Site Name: SNK Andante Bld 6 (North)	Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville	Date: 30-Aug-03
Compl. By: Dai Watkins	

1. Vertical Transport, Surface Soil Column



Outdoor Air Volatilization Factors ?

○ Surface soil volatilization model only

◉ Combination surface soil/Johnson & Ettinger models

Thickness of surface soil zone 5.87 *(ft)*

○ User-specified VF from other model [Enter VF Values]

Indoor Air Volatilization Factors ?

◉ Johnson & Ettinger model

○ User-specified VF from other model [Enter VF Values]

Soil-to-Groundwater Leaching Factor ?

○ ASTM Model

☐ Apply Soil Attenuation Model (SAM)

☐ Allow first-order biodecay [Enter Decay Rates]

○ User-specified LF from other model [Enter LF Values]

2. Lateral Air Dispersion Factor

Wind ?

○ 3-D Gaussian dispersion model

○ User-Specified ADF

	Off-site 1	Off-site 2	
	1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor

Calculate DAF using Domenico Model ?

○ Domenico equation with dispersion only (no biodegradation)

○ Domenico equation first-order decay [Enter Decay Rates]

○ Modified Domenico equation using electron acceptor superposition [Enter Site Data]

[Enter Directly] Biodegradation Capacity NC (mg/L)

— or —

User-Specified DAF Values

○ DAF values from other model or site data [Enter DAF Values]

4. Commands and Options

[Main Screen] [Print Sheet] [*Help*]

Building 6 (North)

RBCA Tool Kit for Chemical Releases, Version 1.3a

Site-Specific Soil Parameters

Site Name: SNK Andante Bld 6 (North)	Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville	Date: 30-Aug-03
Compl. By: Dai Watkins	

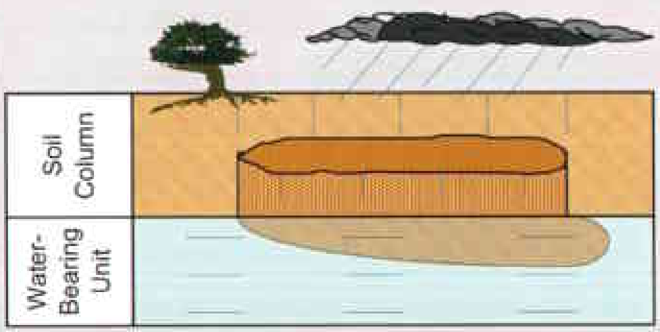
1. Soil Source Zone Characteristics

Hydrogeology

	General Case	Construction	
Depth to water-bearing unit	5.87		(ft)
Capillary zone thickness	5		(ft)
Soil column thickness	0.87		(ft)

Affected Soil Zone

	General Case	Construction	
Depth to top of affected soils	5.87		(ft)
Depth to base of affected soils	5.87		(ft)
Affected soil area	9720	9720	(ft^2)
Length of affected soil parallel to assumed wind direction	235	235	(ft)
Length of affected soil parallel to assumed GW flow direction			(ft)



2. Surface Soil Column

	Vadose Zone	Capillary Fringe	
Predominant USCS Soil Type			
or (Calculate)	or		
Total porosity	0.3412		(-)
Volumetric water content	0.275	0.3312	(-)
Volumetric air content	0.0662	0.01	(-)
Dry bulk density	1.7		(kg/L)
Vertical hydraulic conductivity	5.7E-7		(cm/s)
Vapor permeability	1.1E-16		(ft^2)
Capillary zone thickness	5.0E+0		(ft)

Net Rainfall Infiltration

Net infiltration estimate		(cm/yr)
or (NA)	or	
Average annual precipitation		(cm/yr)

Partitioning Parameters

Fraction organic carbon	0.02	(-)
Soil/water pH	6.8	(-)

3. Commands and Options

Main Screen | Use Default Values | Print Sheet

Set Units | Help

RBCA Tool Kit for Chemical Releases, Version 1.3a

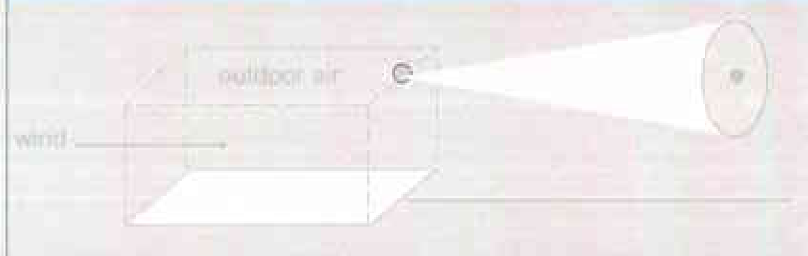
Site-Specific Air Parameters

Site Name: SNK Andante Bld 6 (North) Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville Date: 30-Aug-03
Compl. By: Dai Watkins

1. Outdoor Air Pathway

Dispersion in Air

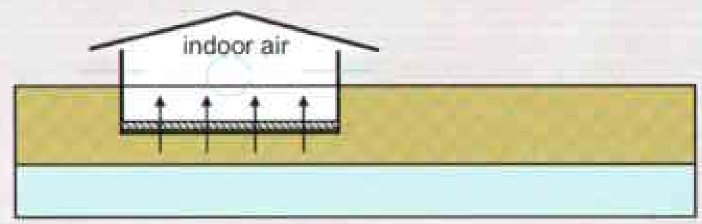
	Off-site 1	Off-site 2	
Distance to offsite air receptor			(ft)
or NA			
Horizontal dispersivity			(ft)
Vertical dispersivity			(ft)



Air Source Zone

Air mixing zone height	6.56	(ft)
Ambient air velocity in mixing zone	10.56	(ft/s)
Areal particulate emission flux	6.9E-14	(g/cm^2/s)

2. Indoor Air Pathway



Building Parameters

	Residential	Commercial	
Building volume/area ratio	8	8	(ft)
Foundation area	9720	9720	(ft^2)
Foundation perimeter	402	402	(ft)
Building air exchange rate	5.6E-4	1.4E-3	(1/s)
Depth to bottom of foundation slab	0.42	0.42	(ft)
Convective air flow through cracks	3.0E-7	3.0E-7	(ft^3/s)
Foundation thickness	0.42		(ft)
Foundation crack fraction	0.001		(-)
Volumetric water content of cracks	0.12		(-)
Volumetric air content of cracks	0.26		(-)
Indoor/Outdoor differential pressure	0.01		(psi)

3. Commands and Options

Main Screen | Use Default Values | Print Sheet
Set Units | Help

RBCA Tool Kit for Chemical Releases, Version 1.3a

Commands and Options

Return | Print Sheet | Help

Site Name: SNK Andante Bld 6 (North) Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville Date: 30-Aug-03
Compl. By: Dai Watkins

Groundwater Source Zone Concentration Calculator

Paste Defaults

UCL Percentile: 95%

Mean Option

Constituent	Detection Limit (mg/L)	No. of Samples	No. of Detects	Estimated Distribution of Data	Max. Conc. (mg/L)	Mean Conc. (mg/L)	UCL on Mean (mg/L)
Benzene	5.0E-4	1	1	-	1.5E+0	1.5E+0	NA
Toluene	5.0E-4	1	1	-	2.4E+0	2.4E+0	NA
Ethylbenzene	5.0E-4	1	1	-	7.3E-1	7.3E-1	NA
Xylene (mixed isomers)	1.0E-4	1	1	-	3.7E+0	3.7E+0	NA
Methyl t-Butyl ether	5.0E-4	1	1	-	7.4E-2	7.4E-2	NA
Naphthalene	1.0E-2	1	1	-	1.4E-1	1.4E-1	NA

RBCA Tool Kit for Chemical Releases, Version 1.3a

Enter Analytical Data from Groundwater Source Zone (up to 50 Data Points)

Analytical Data

	1	2	3	4	5	6	7	8	9	10	11	12	13
ID	1.00E+0												
Date	10-Jun-03												
	(mg/L)	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*
	1.50E+0												
	2.40E+0												
	7.30E-1												
	3.70E+0												
	7.40E-2												
	1.40E-1												

RBCA Tool Kit for Chemical Releases, Version 1.3a

Commands and Options

Return | Print Sheet | *Help*

Site Name: SNK Andante Bld 6 (North) Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville Date: 30-Aug-03
Compl. By: Dai Watkins

Soil Source Zone Concentration Calculator

UCL Percentile: 95%

Paste Defaults | Mean Option

Constituent	Detection Limit (mg/kg)	No. of Samples	No. of Detects	Estimated Distribution of Data	Max. Conc. (mg/kg)	Mean Conc. (mg/kg)	UCL on Mean (mg/kg)
Benzene	5.0E-3	17	3	Lognormal	7.8E+0	6.1E-3	1.6E-2
Toluene	5.0E-3	17	0	Normal	0.0E+0	2.5E-3	2.5E-3
Ethylbenzene	5.0E-3	17	7	Lognormal	3.8E+1	2.0E-2	7.6E-2
Xylene (mixed isomers)	5.0E-3	17	6	Lognormal	8.7E+1	1.5E-2	5.4E-2
Methyl t-Butyl ether	5.0E-3	17	0	Normal	0.0E+0	2.5E-3	2.5E-3
Naphthalene	3.4E-1	17	0	Normal	0.0E+0	1.7E-1	1.7E-1

RBCA Tool Kit for Chemical Releases, Version 1.3a

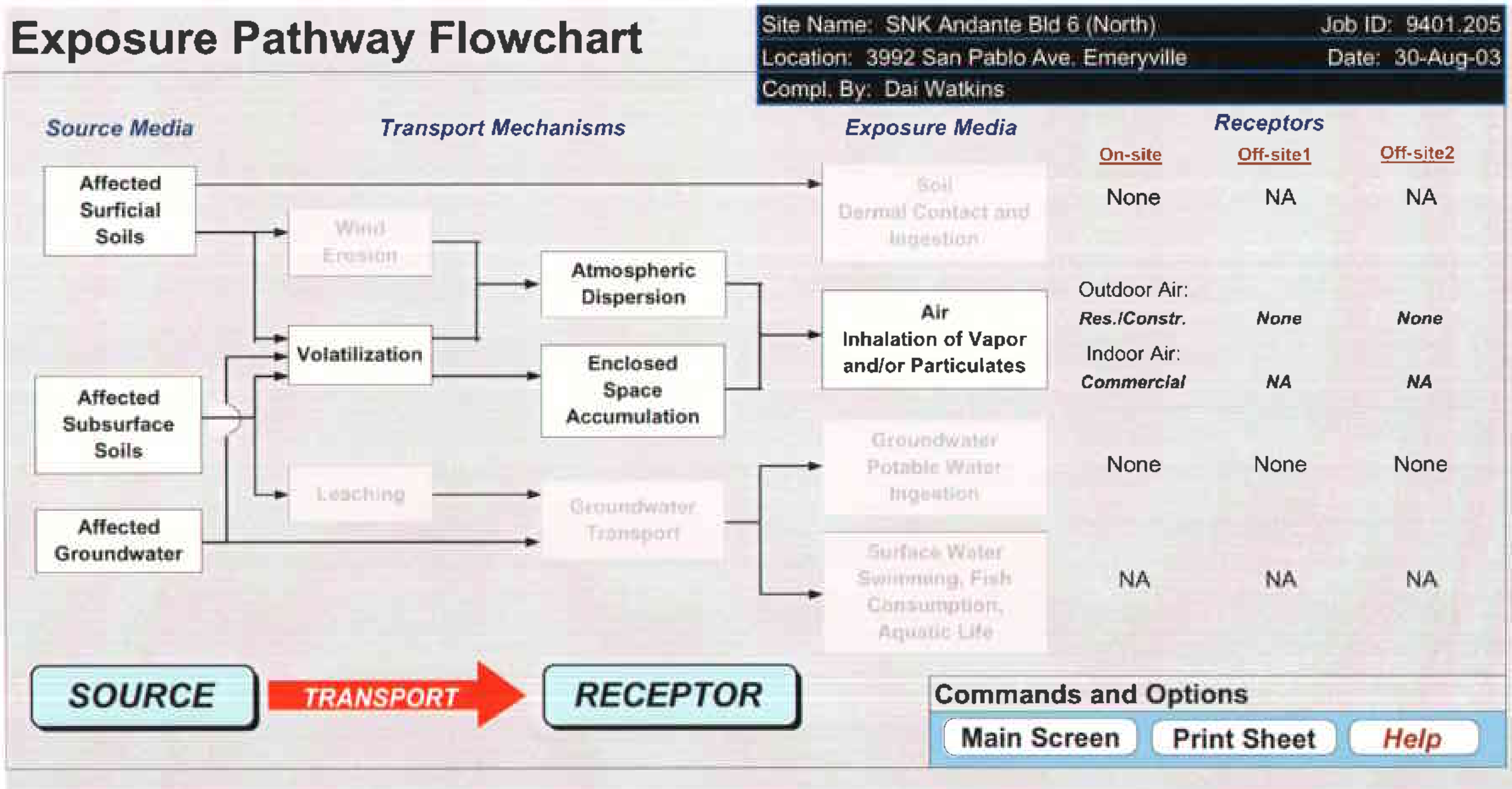
Enter Analytical Data from Soil Source Zone (up to 50 Data Points)

Analytical Data

	1	2	3	4	5	6	7	8	9	10	11	12	13
ID	0S-140E	0S-180E	0S-200E	0S-220E	20S-140E	20S-160E	20S-180E	20S-200E	20S-220E	35S-200E	40S-140E	40S-160E	40S-180E
Date	14-May-03	12-May-03	6-May-03	6-May-03	27-May-03	13-May-03	27-May-03	7-May-03	9-May-03	9-May-03	21-May-03	21-May-03	6-May-03
	(mg/kg)	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
	ND	ND	3.60E-2	2.10E-1	7.80E+0	ND	ND	ND	ND	ND	ND	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2.30E+0	1.60E+0	1.30E-1	6.80E-1	3.80E+1	ND	ND	ND	ND	ND	ND	9.70E-3	ND
	1.10E+0	1.40E+0	ND	5.80E-2	8.70E+1	ND	2.00E-2	ND	ND	ND	ND	1.80E-2	ND
	n/a	n/a	ND	ND	n/a	n/a	n/a	ND	n/a	n/a	n/a	n/a	ND
	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

RBCA Tool Kit for Chemical Releases, Version 1.3a

											Analytical Data	
14	15	16	17	18	19	20	21	22	23	24	25	26
40S-200E	50S-180E	60S-140E	70S-135E									
7-May-03	6-May-03	6-May-03	6-May-03									
(mg/kg)	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*	*(mg/kg)*
ND	ND	ND	ND									
ND	ND	ND	ND									
ND	ND	ND	1.20E-2									
ND	ND	ND	ND									
ND	ND	n/a	n/a									
n/a	n/a	n/a	n/a									


Exposure Pathway Flowchart
Site Name: SNK Andante Bld 6 (North)
Job ID: 9401.205
Location: 3992 San Pablo Ave. Emeryville
Date: 30-Aug-03
Compl. By: Dai Watkins
Source Media
Transport Mechanisms
Exposure Media
Receptors
On-site
Off-site1
Off-site2
Affected Surficial Soils
Wind Erosion
Soil Dermal Contact and Ingestion
None
NA
NA
Atmospheric Dispersion
Volatilization
Enclosed Space Accumulation
Air Inhalation of Vapor and/or Particulates
Outdoor Air:
Res./Constr.
None
None
Indoor Air:
Commercial
NA
NA
Affected Subsurface Soils
Leaching
Groundwater Transport
Groundwater Potable Water Ingestion
None
None
None
Affected Groundwater
Surface Water Swimming, Fish Consumption, Aquatic Life
NA
NA
NA
SOURCE
TRANSPORT
RECEPTOR
Commands and Options
Main Screen
Print Sheet
Help

Building 6 (North)

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs | **Physical Property Data**

Constituent	CAS Number	type	Molecular Weight (g/mole) MW	ref	Diffusion Coefficients In air (cm2/s) Dair	ref	Diffusion Coefficients in water (cm2/s) Dwat	ref	log (Koc) or log(Kd) (@ 20 - 25 C) log(L/kg)	partition	ref	Henry's Law Constant (@ 20 - 25 C) (atm-m3) mol	Henry's Law Constant (@ 20 - 25 C) (unitless)	ref	Vapor Pressure (@ 20 - 25 C) (mm Hg)	ref	Solubility (@ 20 - 25 C) (mg/L)	ref	acid pKa	base pKb	ref
Benzene	71-43-2	A	78 1	PS	8 80E-02	PS	9 80E-06	PS	1.77	Koc	PS	5.55E-03	2.29E-01	PS	9.52E+01	PS	1.75E+03	PS	-	-	-
Toluene	108-88-3	A	92 4	5	8 50E-02	A	9 40E-06	A	2 13	Koc	A	6 30E-03	2 60E-01	A	3 00E+01	4	5.15E+02	29	-	-	-
Ethylbenzene	100-41-4	A	106.2	PS	7.50E-02	PS	7 80E-06	PS	2 56	Koc	PS	7.88E-03	3.25E-01	PS	1.00E+01	PS	1.69E+02	PS	-	-	-
Xylene (mixed isomers)	1330-20-7	A	106 2	5	7.20E-02	A	8 50E-06	A	2 38	Koc	A	7.03E-03	2 90E-01	A	7 00E+00	4	1.98E+02	5	-	-	-
Methyl t-Butyl ether	1634-04-4	O	88.146	5	7.92E-02	6	9 41E-05	7	1 08	Koc	A	5.77E-04	2.38E-02	-	2 49E+02	-	4.60E+04	A	-	-	-
Naphthalene	91-20-3	PAH	128.2	PS	5.90E-02	PS	7 50E-06	PS	3 30	Koc	PS	4.63E-04	1.99E-02	PS	2 30E-01	PS	3.10E+01	PS	-	-	-

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dal Watkins
Date Completed: 30-Aug-03

Job ID: 9401 205

Building 6 (North)

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs

Toxicity Data

	Reference Dose (mg/kg/day)				Reference Conc. (mg/m3)		Slope Factors 1/(mg/kg/day)				Unit Risk Factor 1/(µg/m3)			
			(mg/kg/day)						1/(mg/kg/day)				EPA Weight	Is
Constituent	Oral RfD_oral	ref	Dermal RfD_dermal	ref	Inhalation RfC_inhal	ref	Oral SF_oral	ref	Dermal SF_dermal	ref	Inhalation URF_inhal	ref	of Evidence	Constituent Carcinogenic ?
Benzene	3.00E-03	R	-	-	5.95E-03	R	2.90E-02	PS	2.99E-02	TX	8.29E-06	PS	A	TRUE
Toluene	2.00E-01	A,R	1.60E-01	TX	4.00E-01	A,R	-	-	-	-	-	-	D	FALSE
Ethylbenzene	1.00E-01	PS	9.70E-02	TX	1.00E+00	PS	-	-	-	-	-	-	D	FALSE
Xylene (mixed isomers)	2.00E+00	A,R	1.84E+00	TX	7.00E+00	A	-	-	-	-	-	-	D	FALSE
Methyl t-Butyl ether	1.00E-02	31	8.00E-03	TX	3.00E+00	R	-	-	-	-	-	-	-	FALSE
Naphthalene	4.00E-01	PS	3.56E-01	TX	1.40E+00	PS	-	-	-	-	-	-	D	FALSE

Site Name: SNK Andante Bld 6

Site Location: 3992 San Pab

RBCA Tool Kit for Chemical Releases, Version 1.3a

Miscellaneous Chemical Data

	Maximum Contaminant Level		Time-Weighted Average Workplace Criteria		Aquatic Life Prot. Criteria		Biocon-centration Factor
Constituent	MCL (mg/L)	ref	TWA (mg/m3)	ref	AQL (mg/L)	ref	(L-wat/kg-fish)
Benzene	5.00E-03	52 FR 25690	3.25E+00	PS	-	-	12.6
Toluene	1.00E+00	56 FR 3526 (30 Jan 91)	1.47E+02	ACGIH	-	-	70
Ethylbenzene	7.00E-01	56 FR 3526 (30 Jan 91)	4.35E+02	PS	-	-	1
Xylene (mixed isomers)	1.00E+01	56 FR 3526 (30 Jan 91)	4.34E+02	ACGIH	-	-	1
Methyl t-Butyl ether	-	-	6.00E+01	NIOSH	-	-	1
Naphthalene	-	-	5.00E+01	PS	-	-	430

Site Name: SNK Andante Bld 6

Site Location: 3992 San Pab

RBCA Tool Kit for Chemical Releases, Version 1.3a

CHEMICAL DATA FOR SELECTED COCs

Miscellaneous Chemical Data

Constituent	Dermal Relative Absorp. Factor (unitless)	Water Dermal Permeability Data: Dermal Permeability Coeff. (cm/hr)	Lag time for Dermal Exposure (hr)	Critical Exposure Time (hr)	Relative Contr of Derm Perm Coeff (unitless)	Water/Skin Derm Adsorp Factor (cm/event)	ref	Detection Limits: Groundwater (mg/L)	ref	Soil (mg/kg)	ref	Half Life (First-Order Decay) (days): Saturated	Unsaturated	ref
Benzene	0.5	0.021	0.26	0.63	0.013	7.3E-2	D	0.002	S	0.005	S	720	720	H
Toluene	0.5	0.045	0.32	0.77	0.054	1.6E-1	D	0.002	S	0.005	S	28	28	H
Ethylbenzene	0.5	0.074	0.39	1.3	0.14	2.7E-1	D	0.002	S	0.005	S	228	228	H
Xylene (mixed isomers)	0.5	0.08	0.39	1.4	0.16	2.9E-1	D	0.005	S	0.005	S	360	360	H
Methyl t-Butyl ether	0.5	-	-	-	-	-	-	-	-	-	-	360	180	H
Naphthalene	0.05	0.069	0.53	2.2	0.2	2.7E-1	D	0.01	32	0.01	32	258	258	H

Site Name: SNK Andante Bld 6
Site Location: 3992 San Pab

Building 6 (North)

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

Input Parameter Summary

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401 205

Exposure Parameters		Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Construc.
AT_c	Averaging time for carcinogens (yr)	70				
AT_n	Averaging time for non-carcinogens (yr)	30			25	1
BW	Body weight (kg)	70	15	35	70	
ED	Exposure duration (yr)	30	6	16	25	1
t	Averaging time for vapor flux (yr)	30			25	1
EF	Exposure frequency (days/yr)	350			250	180
EF_D	Exposure frequency for dermal exposure	350			250	
IR_w	Ingestion rate of water (L/day)	2			1	
IR_s	Ingestion rate of soil (mg/day)	100	200		50	100
SA	Skin surface area (dermal) (cm^2)	5800		2023	5800	5800
M	Soil to skin adherence factor	1				
ET_{swim}	Swimming exposure time (hr/event)	3				
EV_{swim}	Swimming event frequency (events/yr)	12	12	12		
IR_{swim}	Water ingestion while swimming (L/hr)	0.05	0.5			
SA_{swim}	Skin surface area for swimming (cm^2)	23000		8100		
IR_{fish}	Ingestion rate of fish (kg/yr)	0.025				
Fl_{fish}	Contaminated fish fraction (unitless)	1				

Complete Exposure Pathways and Receptors	On-site	Off-site 1	Off-site 2
Groundwater:			
Groundwater Ingestion	None	None	None
Soil Leaching to Groundwater Ingestion	None	None	None
Applicable Surface Water Exposure Routes:			
Swimming			NA
Fish Consumption			NA
Aquatic Life Protection			NA
Soil:			
Direct Ingestion and Dermal Contact	None		
Outdoor Air:			
Particulates from Surface Soils	None	None	None
Volatilization from Soils	Res./Constr.	None	None
Volatilization from Groundwater	Residential	None	None
Indoor Air:			
Volatilization from Subsurface Soils	Commercial	NA	NA
Volatilization from Groundwater	Commercial	NA	NA

Receptor Distance from Source Media	On-site	Off-site 1	Off-site 2	(Units)
Groundwater receptor	NA	NA	NA	(ft)
Soil leaching to groundwater receptor	NA	NA	NA	(ft)
Outdoor air inhalation receptor	0	NA	NA	(ft)

Target Health Risk Values		Individual	Cumulative
TR_{ab}	Target Risk (class A&B carcinogens)	1.0E-6	1.0E-6
TR_c	Target Risk (class C carcinogens)	1.0E-6	
THQ	Target Hazard Quotient (non-carcinogenic risk)	2.0E-1	2.0E-1

Modeling Options	
RBCA tier	Tier 2
Outdoor air volatilization model	Surface & subsurface models
Indoor air volatilization model	Johnson & Ettinger model
Soil leaching model	NA
Use soil attenuation model (SAM) for leachate?	NA
Air dilution factor	NA
Groundwater dilution-attenuation factor	NA

NOTE: NA = Not applicable

Surface Parameters		General	Construction	(Units)
A	Source zone area	9.7E+3	9.7E+3	(ft^2)
W	Length of source-zone area parallel to wind	2.4E+2	2.4E+2	(ft)
W_{gw}	Length of source-zone area parallel to GW flow	NA		(ft)
U_{air}	Ambient air velocity in mixing zone	1.1E+1		(ft/s)
δ_{air}	Air mixing zone height	6.6E+0		(ft)
P_e	Areal particulate emission rate	NA		(g/cm^2/s)
L_{ss}	Thickness of affected surface soils	5.9E+0		(ft)

Surface Soil Column Parameters		Value			(Units)
h_{cap}	Capillary zone thickness	5.5E+0			(ft)
h_v	Vadose zone thickness	6.7E-1			(ft)
ρ_s	Soil bulk density	1.7E+0			(g/cm^3)
f_{oc}	Fraction organic carbon	2.0E-2			(-)
θ_T	Soil total porosity	3.4E-1			(-)
K_{vs}	Vertical hydraulic conductivity	5.7E-7			(cm/s)
k_v	Vapor permeability	1.1E-16			(ft^2)
L_{gw}	Depth to groundwater	5.9E+0			(ft)
L_s	Depth to top of affected soils	5.9E+0			(ft)
L_{base}	Depth to base of affected soils	5.9E+0			(ft)
L_{subs}	Thickness of affected soils	0.0E+0			(ft)
pH	Soil/groundwater pH	6.8E+0			(-)
		capillary	vadose	foundation	
θ_w	Volumetric water content	0.3312	0.275	0.12	(-)
θ_a	Volumetric air content	0.01	0.0682	0.26	(-)

Building Parameters		Residential	Commercial	(Units)
L_b	Building volume/area ratio	NA	8.00E+0	(ft)
A_b	Foundation area	NA	9.72E+3	(ft^2)
X_{crk}	Foundation perimeter	NA	4.02E+2	(ft)
ER	Building air exchange rate	NA	1.40E-3	(1/s)
L_{crk}	Foundation thickness	NA	4.20E-1	(ft)
Z_{crk}	Depth to bottom of foundation slab	NA	4.20E-1	(ft)
η	Foundation crack fraction	NA	1.00E-3	(-)
dP	Indoor/outdoor differential pressure	NA	1.00E-2	(psi)
Q_s	Convective air flow through slab	NA	2.98E-7	(ft^3/s)

Groundwater Parameters		Value	(Units)
δ_{gw}	Groundwater mixing zone depth	NA	(ft)
I_f	Net groundwater infiltration rate	NA	(cm/yr)
U_{gw}	Groundwater Darcy velocity	NA	(cm/s)
V_{gw}	Groundwater seepage velocity	NA	(cm/s)
K_s	Saturated hydraulic conductivity	NA	(cm/s)
i	Groundwater gradient	NA	(-)
S_w	Width of groundwater source zone	NA	(ft)
S_d	Depth of groundwater source zone	NA	(ft)
θ_{eff}	Effective porosity in water-bearing unit	NA	(-)
f_{oc-sat}	Fraction organic carbon in water-bearing unit	NA	(-)
pH_{sat}	Groundwater pH	NA	(-)
	Biodegradation considered?	NA	

Transport Parameters		Off-site 1	Off-site 2	Off-site 1	Off-site 2	(Units)
Lateral Groundwater Transport		Groundwater Ingestion		Soil Leaching to GW		
α_x	Longitudinal dispersivity	NA	NA	NA	NA	(ft)
α_y	Transverse dispersivity	NA	NA	NA	NA	(ft)
α_z	Vertical dispersivity	NA	NA	NA	NA	(ft)
Lateral Outdoor Air Transport		Soil to Outdoor Air Inhal.		GW to Outdoor Air Inhal.		
σ_y	Transverse dispersion coefficient	NA	NA	NA	NA	(ft)
σ_z	Vertical dispersion coefficient	NA	NA	NA	NA	(ft)
ADF	Air dispersion factor	NA	NA	NA	NA	(-)

Surface Water Parameters		Off-site 2	(Units)
Q_{sw}	Surface water flowrate	NA	(ft^3/s)
W_{pl}	Width of GW plume at SW discharge	NA	(ft)
δ_{pl}	Thickness of GW plume at SW discharge	NA	(ft)
DF_{sw}	Groundwater-to-surface water dilution factor	NA	(-)

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

GROUNDWATER: VAPOR INHALATION

Exposure Concentration

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/L) Receptor			3) Exposure Medium Outdoor Air: POE Conc. (mg/m^3) (1) / (2)		
	Groundwater Conc. (mg/L)	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	1.5E+0	1.3E+6			1.2E-6		
Toluene	2.4E+0	1.3E+6			1.8E-6		
Ethylbenzene	7.3E-1	1.6E+6			4.7E-7		
Xylene (mixed isomers)	3.7E+0	1.4E+6			2.6E-6		
Methyl t-Butyl ether	7.4E-2	1.7E+5			4.4E-7		
Naphthalene	1.4E-1	1.9E+6			7.5E-8		

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

GROUNDWATER: VAPOR INHALATION (cont'd)

Constituents of Concern	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)			5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)		
	On-site (0 ft)	Off-site 1 (0 ft)	Off-site 2 (0 ft)	On-site (0 ft)	Off-site 1 (0 ft)	Off-site 2 (0 ft)
	Residential	None	None	Residential	None	None
Benzene	4.1E-1			4.9E-7		
Toluene	9.6E-1			1.8E-6		
Ethylbenzene	9.6E-1			4.5E-7		
Xylene (mixed isomers)	9.6E-1			2.5E-6		
Methyl t-Butyl ether	9.6E-1			4.2E-7		
Naphthalene	9.6E-1			7.2E-8		

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr)

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

TOTAL PATHWAY EXPOSURE (mg/m^3)
(Sum average expsosure concentrations from soil and groundwater routes.)

Constituents of Concern	On-site (0 ft) Residential	On-site (0 ft) Construction Worker	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	4.9E-7			
Toluene	1.8E-6			
Ethylbenzene	4.5E-7			
Xylene (mixed isomers)	2.5E-6			
Methyl t-Butyl ether	4.2E-7			
Naphthalene	7.2E-8			

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

CARCINOGENIC RISK

Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Exposure (mg/m^3) On-site (0 ft) Residential	(2) On-site (0 ft) Construction Worker	(2) Off-site 1 (0 ft) None	(2) Off-site 2 (0 ft) None	(3) Inhalation Unit Risk Factor (µg/m^3)^-1	(4) Individual COC Risk (2) x (3) x 1000 On-site (0 ft) Residential	(4) On-site (0 ft) Construction Worker	(4) Off-site 1 (0 ft) None	(4) Off-site 2 (0 ft) None
Benzene	A	4.9E-7				8.3E-6	4.0E-9			
Toluene	D									
Ethylbenzene	D									
Xylene (mixed isomers)	D									
Methyl t-Butyl ether	-									
Naphthalene	D									

Total Pathway Carcinogenic Risk = **4.0E-9**

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

Building 6 (North)

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

TOXIC EFFECTS

	(5) Total Toxicant Exposure (mg/m^3)				(6) Inhalation Reference	(7) Individual COC Hazard Quotient (5) / (6)			
	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)	Conc. (mg/m^3)	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern	Residential	Construction Worker	None	None		Residential	Construction Worker	None	None
Benzene	1.1E-6				6.0E-3	1.9E-4			
Toluene	1.8E-6				4.0E-1	4.4E-6			
Ethylbenzene	4.5E-7				1.0E+0	4.5E-7			
Xylene (mixed isomers)	2.5E-6				7.0E+0	3.5E-7			
Methyl t-Butyl ether	4.2E-7				3.0E+0	1.4E-7			
Naphthalene	7.2E-8				1.4E+0	5.1E-8			
Total Pathway Hazard Index =						2.0E-4			

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave. Emeryville

Completed By: Dai Watkins
Date Completed: 30-Aug-03

Job ID: 9401.205

Building 6 (North)

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

SOILS (5.9 - 5.9 ft): VAPOR INTRUSION INTO ON-SITE BUILDINGS

Constituents of Concern	1) Source Medium Soil Conc. (mg/kg)	2) NAF Value (m^3/kg) Receptor Commercial	3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2) Commercial	4) Exposure Multiplier (EFxED)/(ATx365) (unitless) Commercial	5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4) Commercial
Benzene	1.6E-2	NA		2.4E-1	
Toluene	2.5E-3	NA		6.8E-1	
Ethylbenzene	7.6E-2	NA		6.8E-1	
Xylene (mixed isomers)	5.4E-2	NA		6.8E-1	
Methyl t-Butyl ether	2.5E-3	NA		6.8E-1	
Naphthalene	1.7E-1	NA		6.8E-1	

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr) NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ (CHECKED IF PATHWAY IS ACTIVE)

GROUNDWATER: VAPOR INTRUSION INTO ON-SITE BUILDINGS

	Exposure Concentration				
	1) Source Medium	2) NAF Value (m^3/L) Receptor	3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2)	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)	5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)
Constituents of Concern	Groundwater Conc. (mg/L)	Commercial	Commercial	Commercial	Commercial
Benzene	1.5E+0	2.7E+4	5.5E-5	2.4E-1	1.3E-5
Toluene	2.4E+0	2.8E+4	8.6E-5	6.8E-1	5.9E-5
Ethylbenzene	7.3E-1	3.3E+4	2.2E-5	6.8E-1	1.5E-5
Xylene (mixed isomers)	3.7E+0	3.1E+4	1.2E-4	6.8E-1	8.2E-5
Methyl t-Butyl ether	7.4E-2	3.3E+4	2.3E-6	6.8E-1	1.5E-6
Naphthalene	1.4E-1	8.4E+4	1.7E-6	6.8E-1	1.1E-6

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr) NAF = Natural attenuation factor POE = Point of exposure

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins
Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

RBCA SITE ASSESSMENT

3 OF 3

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS

Constituents of Concern	TOTAL PATHWAY EXPOSURE (mg/m^3) *(Sum average exposure concentrations from soil and groundwater routes.)* Commercial
Benzene	1.3E-5
Toluene	5.9E-5
Ethylbenzene	1.5E-5
Xylene (mixed isomers)	8.2E-5
Methyl t-Butyl ether	1.5E-6
Naphthalene	1.1E-6

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins
Date Completed: 30-Aug-03
Job ID: 9401.205

Building 6 (North)

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

		CARCINOGENIC RISK		
	(1) EPA Carcinogenic	(2) Total Carcinogenic Exposure (mg/m^3)	(3) Inhalation Unit Risk Factor	(4) Individual COC Risk (2) x (3) x 1000
Constituents of Concern	Classification	Commercial	(µg/m^3)^-1	Commercial
Benzene	A	1.3E-5	8.3E-6	1.1E-7
Toluene	D			
Ethylbenzene	D			
Xylene (mixed isomers)	D			
Methyl t-Butyl ether	-			
Naphthalene	D			

Total Pathway Carcinogenic Risk = 1.1E-7

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave. Emeryville
Completed By: Dai Watkins

Date Completed: 30-Aug-03
Job ID: 9401.205

RBCA Tool Kit for Chemical Releases, Version 1.3a

TIER 2 PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

	TOXIC EFFECTS		
	(5) Total Toxicant Exposure (mg/m^3)	(6) Inhalation Reference Concentration (mg/m^3)	(7) Individual COC Hazard Quotient (5) / (6)
Constituents of Concern	Commercial		Commercial
Benzene	3.8E-5	6.0E-3	6.3E-3
Toluene	5.9E-5	4.0E-1	1.5E-4
Ethylbenzene	1.5E-5	1.0E+0	1.5E-5
Xylene (mixed isomers)	8.2E-5	7.0E+0	1.2E-5
Methyl t-Butyl ether	1.5E-6	3.0E+0	5.1E-7
Naphthalene	1.1E-6	1.4E+0	8.2E-7

Total Pathway Hazard Index = **6.5E-3**

Site Name: SNK Andante Bld 6 (North)
Site Location: 3992 San Pablo Ave Emeryville
Completed By: Dai Watkins
Date Completed: 30-Aug-03
Job ID: 9401.205

Building 6 (North)

RBCA SITE ASSESSMENT | **Baseline Risk Summary-All Pathways**

Site Name: SNK Andante Bld 6 (North) Completed By: Dai Watkins
Site Location: 3992 San Pablo Ave. Emeryville Date Completed: 30-Aug-03

TIER 2 BASELINE RISK SUMMARY TABLE

	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk	Hazard Quotient		Hazard Index		Toxicity
EXPOSURE PATHWAY	Maximum Value	Target Risk	Total Value	Target Risk	Limit(s) Exceeded?	Maximum Value	Applicable Limit	Total Value	Applicable Limit	Limit(s) Exceeded?
OUTDOOR AIR EXPOSURE PATHWAYS										
Complete:	4.0E-9	1.0E-6	4.0E-9	1.0E-6	☐	1.9E-4	2.0E-1	2.0E-4	2.0E-1	☐
INDOOR AIR EXPOSURE PATHWAYS										
Complete:	1.1E-7	1.0E-6	1.1E-7	1.0E-6	☐	6.3E-3	2.0E-1	6.5E-3	2.0E-1	☐
SOIL EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
SURFACE WATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
CRITICAL EXPOSURE PATHWAY (Maximum Values From Complete Pathways)										
	1.1E-7	***1.0E-6***	***1.1E-7***	***1.0E-6***	☐	***6.3E-3***	***2.0E-1***	***6.5E-3***	***2.0E-1***	☐
	Indoor Air		***Indoor Air***			***Indoor Air***		***Indoor Air***		