APPENDIX H

Human Health Risk Assessment for Arsenic

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APPENDIX H

HUMAN HEALTH RISK ASSESSMENT FOR ARSENIC
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

1.0 INTRODUCTION

AMEC Geomatrix, Inc. (AMEC) has prepared this human health risk assessment (HHRA) for arsenic on behalf of Santa Cruz County Regional Transportation Commission (SCCRTC) for the Santa Cruz Branch Line (Branch Line) located in Santa Cruz and Monterey Counties, California. This HHRA evaluates the incremental human health risk associated with possible exposures to arsenic detected in soil at various locations along the Branch Line under a baseline "no remedial action" scenario and is based on the future potential use of the Branch Line as a recreational trail. This Appendix was prepared as an accompaniment to the Phase II Investigations and Human Health Risk Assessment for Arsenic report (the Phase II Report).

This HHRA follows guidelines specified in United States Environmental Protection Agency (U.S. EPA) and California Environmental Protection Agency (Cal-EPA) for the performance of risk assessments as specified in the following documents:

- Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A), U.S. EPA, Office of Emergency and Remedial Response, December 1989 (U.S. EPA, 1989);
- Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities, Cal-EPA, Department of Toxic Substances Control (DTSC), Office of the Science Advisor, July 1992, corrected and reprinted, 1996 (DTSC, 1996);
- Preliminary Endangerment Assessment Guidance Manual, Cal-EPA, DTSC, 1999 (DTSC, 1999); and
- Human-Exposed-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil, OEHHA, updated January 2005 (OEHHA, 2005).

Other regulatory reference documents were used as appropriate to supplement the information in these documents.

This report is organized as follows in a manner consistent with the referenced guidance documents and includes the following as outlined by U.S. EPA (1989): data evaluation, exposure assessment, toxicity assessment, risk characterization, uncertainties, and conclusions.

2.0 DATA EVALUATION

Data evaluation is the process of analyzing site characteristics and analytical data to identify data of sufficient quality for inclusion in the risk assessment and, based on these data, to identify chemicals of potential concern (COPCs). COPCs are generally defined as those chemicals that are most likely to be of concern to human health.

As described in the Phase II Report, soil samples were collected along the Branch Line from depths ranging from 0.5 to 10 feet below ground surface (bgs) as part of Phase II site characterization and supplemental investigations activities. Soil samples were analyzed for total petroleum hydrocarbons (TPH), select metals, polynuclear aromatic hydrocarbons (PAHs), and pesticides. Analytical results for arsenic in soil samples collected along the Branch Line are presented in Table H-1. Analytical results for all other analytes are presented in the Phase II Report.

The analytical results for chemicals detected in soil were first compared to applicable screening criteria. Specifically, data were compared to residential and commercial/industrial Environmental Screening Levels (ESLs) for direct exposure to soil published by the Regional Water Quality Control Board, San Francisco Bay Region (Water Board; 2008). Because ESLs are not available for every chemical detected in soil along the Branch Line, residential Preliminary Remediation Goals (PRGs) published by the U.S. EPA Region IX were used as a screening criteria for chemicals without published ESLs. Although several chemicals were detected at concentrations above their respective screening criteria, these chemicals are addressed in the Phase II Report with recommendations for further characterization, risk management, and/or mitigation measures. Only arsenic is evaluated as a COPC in this HHRA.

As part of the 2005 Phase II investigation 107 soil samples were collected and analyzed for arsenic. Of these samples, 82 were collected from 30 locations at historical railroad features (targeted sampling locations) along the Branch Line that were identified during the 1996 Phase I environmental assessment performed by AMEC on behalf SCCRTC (Geomatrix, 1997). The remaining 25 samples were collected from 24 systematic sampling locations to assess environmental conditions along portions of the Branch Line outside targeted locations. The systematic sampling approach consisted of selecting 1-mile sections along the Branch Line through a variety of industrial, residential, undeveloped, and agricultural land uses. The initial 1-mile sections of rail line included one section surrounded by mostly industrial properties, one section surrounded by primarily residential properties, two non-contiguous sections surrounded primarily by agricultural lands, and one section surrounded by open, undeveloped land. The industrial section was located in Watsonville, California, which is within the most heavily industrialized section of the Branch Line. One of the agricultural sections was located west of Santa Cruz (referred to as agricultural-north section) and one west of Watsonville (referred to as agricultural-south section) where crops and farming practices may differ.

As part of the 2009 supplemental investigation activities, an additional 31 soil samples were collected from 11 targeted boring locations and analyzed for arsenic. The additional targeted investigation included sampling to delineate elevated arsenic concentrations at previous boring locations SB-23 and to investigate potential environmental impacts to the Branch Line near the Gino Rinaldi, Inc. property, as described in the Phase II Report. Additional targeted sampling also was conducted at previous boring location SB-10 to delineate the extent of elevated PAHs detected in this area during the 2005 Phase II investigation. These targeted samples collected around SB-10 also were analyzed for arsenic.

In addition to the targeted sampling locations, 96 samples were collected from 32 systematic sampling locations to assist in determining the distribution and concentration of arsenic in soil samples along the alignment of the Branch to evaluate whether the presence of arsenic is naturally-occurring or likely the result of railroad operations, and acquire a sufficient number of representative samples to perform a preliminary HHRA.

The additional systematic sampling was conducted in a manner to increase the sample density within each of the residential, undeveloped, and agricultural-south sections, and to include an additional 1-mile residential section located between Seascape and Capitola. The 1-mile systematic sampling sections are located as follows:

Agricultural—North	Approximately from Milepost 26.11 to Milepost 27.00 (Figure 3)
Agricultural—South	Approximately from Milepost 2.82 to Milepost 3.89 (Figure 10)
Industrial	Approximately from Milepost 1.68 to Milepost 2.61 (Figure 11)
Residential—Santa Cruz	Approximately from Milepost 16.89 to Milepost 17.86 (Figure 5a)
Residential—Seascape to Capitola	Approximately from Milepost 10.81 to Milepost 12.01 (Figure 7)
Undeveloped	Approximately from Milepost 6.55 to Milepost 7.73 (Figure 9)

Analytical results for arsenic in soil samples, and sample depths are presented in Table H-1. Sample locations are presented on Figures 2 through 12 of the Phase II Report.

As discussed in Appendix E, the site-specific background concentration of arsenic in soil along the Branch Line was estimated to be 14.4 mg/kg based on soil samples collected at depths greater than 1.5 feet bgs. Samples collected at depths greater than 1.5 feet bgs were considered as naturally-occurring. Statistical tests to support this assumption are presented in Appendix E. Concentrations of arsenic greater than the calculated site-specific background concentration were identified as potentially affected. A concentration of 14.4 mg/kg was used to calculate potential risks to receptors exposed to background concentrations of arsenic. Since the risk estimate is proportional to the soil exposure point concentration (EPC), the incremental excess risk and noncarcinogenic health effects were evaluated in the Risk Characterization Section of this HHRA (Section 5).

3.0 EXPOSURE ASSESSMENT

Exposure assessment is the process of describing, measuring or estimating the intensity, frequency, and duration of potential human exposure to chemicals of potential concern (COPCs) in environmental media (e.g., soil) at a site. This section of the report discusses the mechanisms by which people (receptors) might come in contact with COPCs at the Site. In accordance with U.S. EPA (1989), an exposure assessment consists of three basic steps:

- Characterization of the exposure setting (physical environment) and identification of potential receptors;
- Identification of exposure pathways (potential sources, points of release, and exposure routes); and,
- Quantification of pathway-specific exposures (exposure point concentrations [EPC] and intake assumptions).

3.1 CHARACTERIZATION OF SETTING AND IDENTIFICATION OF POTENTIAL RECEPTORS

As described in the Phase II Report, the Branch Line is currently an active rail line, which extends approximately 31.4 miles from Pajaro in Monterey County, to Davenport north of Santa Cruz. The right-of-way is generally 100 feet wide; however, it is wider or narrower in some sections, sometimes due to encroachment by surrounding uses. Land uses adjacent to the rail line include residential, commercial, industrial, agricultural and park land/open space. The right-of-way is immediately adjacent to downtown Watsonville, Aptos Village, Capitola Village, and the Santa Cruz Beach area. Also adjacent to the rail right-of-way are many state/local parks and recreational facilities.

The Branch Line right-of-way is the subject of acquisition negotiations between the SCCRTC and Union Pacific Railroad (UPRR). Upon acquiring the Branch Line right-of-way, we understand that portions of the right-of-way may be redeveloped into a recreational trail that would be used by residents and visitors for activities such as walking and running for exercise or biking. Potential exposures to areas outside the Branch Line were not evaluated in this HHRA. Based on U.S. EPA's directive requiring the consideration of reasonably anticipated future land use (U.S. EPA, 1995), potential future human receptors along the Branch Line include construction workers involved in redevelopment and future recreational users. No other use (i.e., residential, commercial/industrial, or agricultural) is reasonably anticipated for the Branch Line.

3.2 IDENTIFICATION OF EXPOSURE PATHWAYS

This section describes the potential pathways by which the receptors described above could be exposed to arsenic in soil. An exposure pathway is a description of the mechanism by which an individual may come into contact with COPCs in the environment. In accordance with U.S. EPA's "Risk Assessment for Superfund" (RAGS; U.S. EPA, 1989), all potential exposure pathways applicable to the site have been identified and addressed. An exposure pathway is defined by four elements (U.S. EPA, 1989):

1. A source and mechanism of COPC release to the environment;
2. An environmental receiving or transport medium (e.g., air, soil) for the released COPC;
3. A point of potential contact with the medium of concern; and
4. A potential exposure route (e.g., ingestion) at the contact point.

An exposure pathway is considered "complete" if all elements are present. Only complete exposure pathways need to be evaluated. The characterization of the potential exposure pathways based on existing information is presented in a site conceptual model (SCM) in Figure H-1. As described in U.S. EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (U.S. EPA, 1988), the purpose of the SCM is to describe what is known about chemical sources, migration pathways, exposure routes, and possible exposure scenarios.

Arsenic is a naturally occurring element and can be present in soil in various oxidation states and chemical species depending on the soil pH and oxidation-reduction potential (ATDSR, 2005). The specific form of arsenic currently present in soil along the Branch Line has not been determined but is assumed that all site-related arsenic is inorganic. Additionally, it is assumed that the source of arsenic in soil is primarily associated with the historical application of arsenical herbicides for weed control.

There are a number of mechanisms by which arsenic can migrate from release points to other areas or other media. Although unlikely given the physical properties of arsenic, chemicals in soil could be leached from soil as a result of precipitation and percolation. Arsenic in surface soil may be released to ambient air via wind erosion of mechanical disturbances.

Exposure to arsenic in soil could potentially occur via direct exposure pathways involving dermal contact and or incidental ingestion. Indirect pathways involve the migration of chemicals from the site medium (soil) to another medium (air) to which people are then exposed. Dusts generated from wind erosion or from soil disturbances could also be inhaled.

Thus, the primary exposure pathways associated with arsenic in soil is direct contact from accidental incidental ingestion, dermal contact, and inhalation of arsenic adhered to dust in outdoor air.

3.3 EXPOSURE QUANTIFICATION

The U.S. EPA defines exposure point concentrations as the representative chemical concentrations a receptor may contact within an exposure area over the duration of exposure (U.S. EPA, 1989). The concept of human exposure at a site or within a defined exposure area is that individuals contact the environmental medium (e.g., soil) on a periodic and random basis. Because of the repeated nature of such contact, human exposure does not occur at a fixed point but rather at a variety of points with equal likelihood that any given point within the exposure area will be the contact location on any given day.

Development of long-term exposure point concentrations requires an underlying assumption. Ideally, the exposure point concentration should be representative of the average concentration to which a person would be exposed. These concentrations are typically estimated using measured data in environmental media or estimated based on fate and transport models. In order to not underestimate the exposure point concentration, U.S. EPA supplemental risk assessment guidance (U.S. EPA, 2002) stipulates that exposure point concentration estimates should be based on the 95 percent upper confidence limit (95% UCL) of the mean to estimate a reasonable maximum exposure for a given exposure unit. This assumption reflects the possibility that within any area the locations with the highest concentrations of a chemical may not have been measured. In the event that the calculated 95% UCLs exceed the maximum detected value, the maximum value will be used as the exposure point concentration.

As previously discussed, the chemical properties for arsenic suggest that the compound does not migrate through soil except for short distances and at high source soil concentrations, unless there was a transport mechanism to facilitate vertical migration. Deeper depth intervals are likely not affected by the application of arsenical herbicides along the Branch Line. An evaluation of the distribution of arsenic in soil suggests that arsenic is present at naturally-occurring levels at depths greater than 1.5 feet bgs (Appendix E). Therefore, only data collected from shallow depths of less than or equal to 1.5 feet bgs were evaluated in this HHRA.

Before quantification of potential exposures could be estimated, it was necessary to identify the appropriate dataset from which to derive exposure point concentrations.

Exposure Units

The Branch Line passes through agricultural, residential, industrial, mixed-use, and undeveloped areas from Davenport (milepost 31.4) to Santa Cruz Junction (milepost 21.11) to Pajaro (Salinas Road, milepost 0.45). Given the length of the Branch Line, any future redevelopment along the Branch Line will likely occur within small sections. The objective of this risk assessment is to assess the potential exposures based on the area where exposures could occur. These areas are referred to as exposure units.

Because the Branch Line is approximately 31.4 miles long, potential exposures are best evaluated by dividing the line into exposure units to provide a realistic, yet conservative, exposure evaluation. The impetus for identifying exposure units is the need to accurately estimate the average concentrations of arsenic to which future receptors may be exposed over time. Sample locations in close proximity of each other were grouped to identify individual exposure units.

Based on the general spatial distribution of arsenic in soil samples relative to the adjacent areas, eleven subsections of the Branch Line were identified to represent exposure units. In addition, the entire Branch Line was evaluated as a separate exposure unit. These exposure units consist of both systematic and targeted sampling locations. Two exposure units were identified adjacent to industrial areas where multiple targeted samples were collected. Although these targeted samples were selected to investigate specific features, the data derived from these samples are useful in characterizing impacts to soil along the Branch Line. The analytical results of arsenic in soil grouped by exposure unit are presented in Table H-2; the exposure units and the adjacent land use are summarized below relative to the approximate mileposts.

Exposure Unit	Surrounding Land Use	Milepost
Sitewide	--	0.45 to 31.4
South of Davenport	--	31.40 to 31.42
East of Wilder State Park	--	20.12 to 20.29
East of Watsonville	--	0.7
Agricultural—North	Agricultural	26.11 to 27.00
Agricultural—South	Agricultural	2.82 to 3.89
Mission Industrial Land	Industrial	20.30 to 21.70
Freight House	Industrial	16.38 to 16.40
Industrial South	Industrial	1.18 to 2.79
Residential—Santa Cruz	Residential	16.88 to 17.87
Residential— Seascape	Residential	9.69 to 12.01
Undeveloped	Undeveloped	6.55 to 7.74

Every sample that was collected at a depth shallower than 1.5 feet bgs was evaluated in individual exposure units except for sample SB-15-1. Because this sample is geographically isolated from other sample locations and exposure units, arsenic in soil sample SB-15-1 was only evaluated as part of the Sitewide exposure unit.

In aggregate, a total of 150 soil samples at depths of less than or equal to 1.5 feet bgs from 97 locations serve as the basis for this HHRA. Exposure point concentrations for each exposure unit were calculated based on the 95% UCL using ProUCL 4.00.04 (U.S. EPA, 2009a). The computation of an appropriate 95% UCL depends upon the data distribution and the skewness associated with the specific data set. ProUCL can be used to compute an appropriate UCL of the unknown population mean using a discernible probability distribution (e.g., normal, lognormal, gamma) and/or a suitable non-parametric distribution-free method. Summary statistics by exposure unit and exposure point concentrations are presented in Table H-3. Statistical output from the ProUCL calculations is presented in Attachment H-1.

3.4 EXPOSURE PARAMETERS

Exposure parameters are quantitative estimates of the frequency, duration, and magnitude of exposure to various media. The exposure parameters were selected from U.S. EPA (1989; 1991; 1997; 2002; and 2004) or DTSC (1994 and 1999) guidance, as appropriate, or are based on site-specific factors when applicable.

Exposure parameters for future construction workers are based on conservative default values from the U.S. EPA (1991, 2002) and DTSC (1996). Future construction workers are assumed to spend all of their time working outdoors and typically assumed to work 8 hours per day, 50 weeks per year (250 days/year) for a one-year exposure duration (i.e., length of construction period).

For the recreational user, professional judgment was used along with default values to select exposure parameters that apply to recreational users engaged in bicycling or hiking along the Branch Line that may be redeveloped as trails. Recreational users were assumed to visit the Branch Line 78 days per year based on an average use of 4 days per week during the summer months and 1 day per week during spring and fall. An exposure time of 2 hours was conservatively selected based on an upper bound estimate (i.e., 95th percentile) for the cumulative time spent traveling on a bicycle, skateboard, or roller skate (U.S. EPA, 1997) as well as professional judgment for recreational users that may use the right-of-way for exercise or commuting. The soil ingestion rate and soil-to-skin adherence factor were selected based on default residential values per agency recommendations.

Values used for each input parameter, including the source and rationale, are summarized in Tables H-4 and H-5.

3.5 BIOAVAILABLITY

A critical factor determining the magnitude of potential exposures and risks associated with arsenic is its bioavailability (i.e., the fraction of the chemical that is available for absorption into the body). Assumptions are typically made about the fraction of arsenic that is available for uptake in an individual's blood stream via the stomach and small intestine. A chemical's bioavailability is influenced by such factors as the species of the chemical, the matrix in which it is present, the amount of time that a chemical is in a matrix, and the route by which exposure occurs. When chemicals are ingested, bioavailability is determined by the amount of a chemical that is dissolved in gastrointestinal fluids and absorbed across the gastrointestinal tract into the bloodstream. An ingested chemical that is adsorbed to soil may be absorbed less completely than the same ingested dose when dissolved in water (NEPI, 2000).

In addition, another important factor to consider is the relative bioavailability of the chemical under the exposure conditions for the right-of-way compared to the bioavailability of the chemical under the exposure conditions present in the study that forms the basis for the quantitative toxicity facto (U.S. EPA, 1989). Toxicity factors are calculated based on studies where the chemical was administered in food or water. By contrast, risk assessments for chemicals in the environment often require assessments of the exposures and risks based on chemicals in soil or other solid media. Where the bioavailability of the chemical observed in the toxicity study is likely to differ from that under the exposure conditions of interest, a relative bioavailability absorption (RBA) factor may be derived. The RBA factor for a specific chemical reflects the absorption fraction from soil relative to the absorption fraction from the exposure medium used in the relevant toxicity study (e.g., food or water).

In general, the bioavailability of many metals and organic chemicals in soil tends to be considerably lower than bioavailability from food or water (Ruby et al., 1999). Bioavailability from soil can be affected by the form of the chemical, its solubility, the size distribution of the ingested soil particles, the type of soil, and the degree of encapsulation of the chemical within an insoluble matrix. For this risk assessment, it was conservatively assumed that arsenic in soil is 100 percent bioavailable due to the lack of site-specific bioavailability information.

3.6 DERMAL ABSORPTION

A dermal absorption factor is used when evaluating potential dermal exposures to arsenic in soil. The arsenic dermal absorption factor of 0.03 was obtained from DTSC dermal guidance (DTSC, 1999). Although absorption of arsenic by the dermal route has not been well characterized for humans, reviews of animal studies indicate that absorption through skin is expected be low compared to other exposure routes (ATSDR, 2005).

4.0 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is twofold (U.S. EPA, 1989):

- Hazard Identification evaluates available information regarding the potential for a chemical to cause adverse health effects in exposed individuals (hazard identification); and
- Dose-Response Assessment estimates the relationship between the extent of exposure and the increased likelihood (e.g., probability or chance) and/or severity of adverse effects.

Hazard identification entails determining if a chemical can cause an increase in a particular adverse effect (e.g., cancer) and the likelihood that the adverse effect will occur in humans. The result of hazard identification is a profile of the available toxicological information and its relevance to human exposure under conditions present in the environment.

Dose-response assessment entails quantifying the relationship between the dose of a chemical and the incidence of adverse effects in the exposed population. The result of the dose-response assessment is a set of toxicity criteria that are used in the risk characterization to estimate the likelihood of adverse effects occurring in humans at different exposure levels. The toxicity criteria used to evaluate noncarcinogenic and carcinogenic health risks are commonly referred to as reference doses (RfDs) and slope factors (SFs), respectively.

The associated toxicity criteria for arsenic are presented in Table H-6. These criteria were selected according to the following hierarchy:

- Office of Environmental Health Hazard Assessment,(OEHHA) Toxicity Criteria Database, on-line database, 2009;
- U.S. EPA Integrated Risk Information System (IRIS) on-line database, 2009b;

Dermal toxicity values may be calculated for evaluating dermal exposure by adjusting the oral RfDs or SFs according to U.S. EPA guidance (2004). For this HHRA and as conservative approach, no adjustments were made; the dermal toxicity criteria were based on either oral RfDs or SFs.

5.0 RISK CHARACTERIZATION

In risk characterization, the background and exposure point concentrations of arsenic at each exposure unit are compared to the risk-based screening levels (RBSLs) to generate a quantitative estimate of potential carcinogenic and noncarcinogenic health effects.

Using information from exposure and toxicity, RBSLs for arsenic in soil were developed for the future construction worker and future recreational user based on the methodologies outlined by OEHHA (2005) for the California Human Health Screening Levels (CHHSLs) for nonvolatile chemicals in soil. Potential non-carcinogenic and carcinogenic RBSLs were separately estimated. RBSLs for future construction worker and future recreational user are presented below:

Scenario	Risk-Based Screening Level—Cancer (mg/kg)	Risk-Based Screening Level—Noncancer Hazard (mg/kg)
Construction Worker	13.01	71
Recreational User	1.75	97

The equations and calculations used to develop the target concentrations in soil for future receptors are presented in Attachment H-2.

The CHHSL for arsenic, based on potential carcinogenic effects and default residential exposure assumptions, is 0.07 mg/kg. Because this risk-based screening value is significantly

1. The site-specific exposure frequency used is higher (250 days/year; U.S. EPA, 2002) compared to the assumption from the Water Board ESLs (140 days/year); therefore the site-specific risk-based screening level is slightly more stringent (i.e., lower) than the Water Board construction worker ESL of 15 mg/kg.

below naturally-occurring levels, the upper bound estimate of background is typically used as the screening criterion.[2] Compliance with background levels may result in increased risk posed by arsenic existing in soil. Therefore, there is a theoretical incremental risk beyond background that may be associated with exposure to arsenic in soil at any location along the Branch Line right-of-way. It is the difference in the risk between exposure to soil along the right-of-way and background conditions (e.g., areas that could not have been impacted by past railroad operations) that have been evaluated in this risk assessment.

The potential health risks are evaluated separately for the selected exposure units along the Branch Line and for background. The results are compared to the estimate of the increased incremental risk above background. This "incremental increase" in risk compared to background is the basis for identifying areas of the right-of-way that may warrant mitigation and/or management to reduce the potential incremental increase in risk. The estimated risks associated with exposure to background are based on the background dataset discussed in Appendix E.

In summary, the risk characterization steps are:

1. Estimate potential "baseline" human health risks associated with arsenic in soil along the Branch Line in the absence of any remedial action;
2. Estimate potential "background" human health risks associated with arsenic in soil;
3. Estimate the incremental increase, if any, in risk associated along the Branch Line above risk associated with background conditions.

The activities involved in the human health risk assessment are summarized in the subsections.

5.1 NONCARCINOGENIC HEALTH EFFECTS

Potential adverse noncarcinogenic health effects were estimated for exposures to arsenic along the Branch Line by using the hazard quotient (HQ) approach, as recommended by U.S. EPA (1989). The exposure point concentrations for each exposure unit were compared to receptor-specific RBSLs developed for noncarcinogenic health effects based on a target hazard quotient (THQ) of 1.0. The HQs calculated in this step are referred to as the baseline hazard index and is calculated by the following expression:

2. A background threshold value of 14.4 mg/kg was derived for the Branch Line as discussed in Appendix E.

$$\text{Baseline Hazard Index} = \frac{THQ \times EPC}{RBSL_{Haz}}$$

Where:	THQ	=	target hazard quotient of 1.0
	EPC	=	exposure point concentration (mg/kg)
	RBSL $_{Haz}$	=	risk-based screening level for noncarcinogenic effects (mg/kg)

A hazard index less than or equal to one indicates that the predicted exposure to that chemical is not expected to result in an adverse noncarcinogenic health effects (U.S. EPA, 1989) with a substantial margin of safety.

The baseline index by exposure unit for the future construction worker and future recreational user are presented in Tables H-7 and H-8, respectively. The baseline hazard index for the entire Branch Line is 0.6 and 0.4 for the future construction worker and future recreational user, respectively.

Baseline hazard indexes were also evaluated for potential exposures associated with the eight exposure units (Tables H-7 and H-8). For the future construction worker, the baseline hazard index range from 0.2 to 1.1. For the future recreational user, the baseline hazard index for all individual exposure units is less than 1.

For background arsenic, potential adverse noncarcinogenic health effects were estimated by comparing the arsenic Background Threshold Value (BTV; Appendix E) to receptor-specific RBSLs. The hazard index associated with exposure to background concentrations of arsenic (referred to as “background hazard index”) for each receptor was calculated with the following expression:

$$\text{Background Hazard Index} = \frac{THQ \times BTV}{RBSL_{Haz}}$$

Where:	THQ	=	target hazard quotient of 1.0
	BTV	=	background threshold value (mg/kg)
	RBSL $_{Haz}$	=	risk-based screening level for noncarcinogenic effects (mg/kg)

As presented in Table H-9, the background hazard index for the future construction worker and future recreational user is 0.20 and 0.15, respectively.

Based on these estimates, the incremental noncarcinogenic hazard index is the difference between baseline and background. As shown in Table H-10, the incremental noncarcinogenic hazard indexes are less than 1 for both the future construction worker and recreational user suggesting that potential exposure to arsenic along the entire Branch Line is not expected to result in an adverse noncarcinogenic health effects.

5.2 CARCINOGENIC RISK

Carcinogenic health risks are defined in terms of the increased probability of an individual developing cancer as the result of exposure to a given chemical at a given concentration. The risk is expressed as the maximum number of new cases of cancer projected to occur in a population of one million people due to exposure to arsenic over a 70-year lifetime. For example, a cancer risk of one-in-one million (1×10^{-6}) means that in a population of one million people, not more than one additional person would be expected to develop cancer as the result of the exposure to the substance causing that risk.

Baseline excess lifetime cancer risks were estimated by exposure unit by comparing exposure points concentrations to site-specific RBSLs based on a target excess cancer risk of 1×10^{-6} with the following equation:

$$\text{Baseline Risk} = \frac{TR \times EPC}{RBSL_{Risk}}$$

Where:	TR	=	target risk of 1×10^{-6}
	EPC	=	exposure point concentration (mg/kg)
	$RBSL_{Risk}$	=	risk-based screening level for carcinogenic effect (mg/kg)

Regulatory agencies such as the U.S. EPA and Cal-EPA have defined what is considered to be an acceptable level of risk in similar, albeit slightly different ways. The U.S. EPA considers one-in-one million (1×10^{-6}) to one-in-ten thousand (1×10^{-4}) to be the target range for acceptable risks at sites where remediation is considered (U.S. EPA, 1990a and 1990b). Estimates of lifetime excess cancer risk associated with exposure to chemicals of less than 1×10^{-6} are considered to be so low as to warrant no further investigation or analysis (U.S. EPA, 1990a). Within the state of California, the Cal-EPA tends to work within the same target range for acceptable risks.

It should be noted that cancer risks in the 1×10^{-6} to 1×10^{-4} range or higher do not necessarily mean that adverse health effects will be observed. Current methodology for estimating the carcinogenic potential of chemicals is believed to not underestimate the true risk, but could overestimate the true risk by a considerable degree.

The estimated baseline lifetime excess cancer risk associated with exposure to arsenic at each exposure unit for the future construction worker and future recreational user are presented in Tables H-7 and H-8, respectively. For the entire Branch Line, the baseline lifetime excess cancer risk is $3{\times}10^{-6}$ and $2{\times}10^{-5}$ for the future construction worker and future recreational user, respectively.

Baseline lifetime excess cancer risks were also evaluated for exposures associated with the eight exposure units selected based on the adjacent land use (Tables H-7 and H-8). For the future construction worker, the baseline lifetime excess cancer risk for these exposure units ranged from $8{\times}10^{-7}$ to $6{\times}10^{-6}$. For the future recreational user, the baseline lifetime excess cancer risk ranged from $6{\times}10^{-6}$ to $5{\times}10^{-5}$. The excess lifetime cancer risks associated with exposure to arsenic along specific exposure units are within the range considered acceptable by the U.S. EPA and Cal-EPA.

Since the site-specific RBSLs for carcinogenic risk for both the future construction worker and future recreational user are less than the BTV for arsenic, concentrations of arsenic detected along the Branch Line must also be compared to the BTV. The excess lifetime cancer risk associated with exposure to background concentrations of arsenic for each receptor was calculated with the following equations:

$$\text{Background Risk} = \frac{\text{TR} \times \text{BTV}}{\text{RBSL}_{Risk}}$$

Where:	TR	=	target risk of $1{\times}10^{-6}$
	EPC	=	exposure point concentration (mg/kg)
	RBSL_{Risk}	=	risk-based screening level for carcinogenic effect (mg/kg)

As presented in Table H-9, the background carcinogenic risk for the future construction worker and future recreational user is $1{\times}10^{-6}$ and $8{\times}10^{-6}$, respectively.

Based on these estimates, the incremental excess lifetime cancer risk is the difference between baseline and background. As shown in Table H-10, the incremental excess lifetime cancer risk range between $4{\times}10^{-7}$ and $5{\times}10^{-6}$ for the future construction worker and $3{\times}10^{-6}$ to $4{\times}10^{-5}$ for the future recreational user and are within the range considered acceptable by the U.S. EPA and Cal-EPA.

5.3 CHARACTERIZATION OF INCREMENTAL RISK ABOVE BACKGROUND.

In this step, the incremental increase in risk was evaluated from exposures of arsenic greater than the calculated site-specific background concentration along the Branch Line. The incremental increase in carcinogenic risk and the noncarcinogenic hazard quotient provides a framework for comparing risk associated with naturally occurring arsenic to potential exposures related to historical railroad operations along the Branch Line.

The incremental increase in risk associated with exposures to concentrations of arsenic greater than background concentrations for each exposure unit was estimated with the following expression:

$$\text{Incremental Increase in Risk} = \frac{\text{Risk}_{\text{Exposure Unit}}}{\text{Risk}_{\text{Background}}}$$

Since both the exposure unit and background risk estimates are calculated with the same RBSL, this ratio is equivalent to the exposure point concentration divided by the BTV. Therefore, the incremental increase in risk is the same for both receptors (the incremental increase in risk is also equivalent to the incremental increase in the hazard index). The incremental increase is presented by exposure unit in Tables H-11. For both receptors, the incremental increase in risk ranged from 2.0 to 5.6 for exposure units with exposure point concentrations greater than background.

6.0 UNCERTAINTY ANALYSIS

Uncertainty is inherent in many aspects of the risk assessment process, and generally arises from a lack of knowledge of (1) site conditions, (2) toxicity and dose-response of the arsenic, and (3) the extent to which an individual will be exposed to those chemicals (U.S. EPA, 1989). This lack of knowledge means that assumptions must be made based on information presented in the scientific literature or professional judgment. While some assumptions have significant scientific basis, others have much less. Pursuant to U.S. EPA requirements (1989), the assumptions that introduce the greatest amount of uncertainty and their effect on the noncarcinogenic and carcinogenic risk estimates must be included as part of the HHRA. Uncertainty relative to site characterization, the development of RBSLs, and the use of such RBSLs in the estimation of potential risks and hazards is included herein.

- The predominant sources of uncertainty and potential bias associated with site characterization are based on the procedures used for investigation (including sampling plan design and the methods used for sample collection, handling, and analysis) and from the procedures used for data evaluation. In general, a relatively comprehensive sampling program was implemented to characterize the distribution of arsenic in soil across the entire right-of-way.

- The most important measurements collected at the site that were used to support this risk assessment were the measurements of arsenic concentrations in soil. Estimation of exposure point concentrations is critical to exposure assessment. The 95% UCL was used as conservative estimates of average exposure unit concentrations. This methodology likely results in an overestimation of exposures and subsequent health risks.
- Exposure frequency and duration are likely the most sensitive parameters, particularly for recreational receptors. The inherent uncertainty in these parameters was accounted for by using conservative but reasonable estimates of exposure.
- The exposure parameters used in the development of RBSLs are based on a reasonable maximum exposure (RME) scenario, which is defined by U.S. EPA as the highest exposure that could reasonably be expected to occur for a given exposure pathway at a site (U.S. EPA, 1989). For example, the RME scenario assumes that a recreational user will visit the Branch Line 78 days per year for 30 years. This and other upper-bound estimates of exposure most likely overestimate the potential health risks associated with exposure to the arsenic along the Branch Line.
- The relative bioavailability of arsenic in soil was conservatively assumed to be 100% due to the lack of site-specific bioavailability information. However, it is likely that the actual bioavailability of arsenic in soil is significantly much lower than 100%. In fact, various studies using animal models (including rodents, swine, and monkeys) indicate that bioavailability of arsenic in soils is generally much lower, ranging from 0 to 50% (Ruby et al., 1999). Other relevant studies can also be found in ATSDR's Toxicological Profile for Arsenic (ATSDR, 2005). Therefore, using an assumption of 100% bioavailability likely overestimates potential exposure and risk.
- One of the largest sources of uncertainty in any risk assessment is associated with the scientific community's limited understanding of the toxicity of most chemicals in humans following exposure to the low concentrations generally encountered in the environment. The majority of available toxicity data are from animal studies, which are then extrapolated using mathematical models or multiple uncertainty factors to generate toxicity criteria used to predict what might occur in humans. Such purposeful bias in the development of toxicity criteria overestimates the actual potential for health risks for these chemicals.

In summary, these and other assumptions contribute to the overall uncertainty in the HHRA. Given that the methods employed in this report are conservative, it is highly likely that the risk estimates in this assessment are higher than risks that may actually or potentially occur. The results of the risk assessment should not be construed as presenting an absolute estimate of risk to human populations. Rather, it is a conservative analysis intended to indicate a plausible upper bound of the potential for adverse impacts to occur. Thus, the estimated risks estimated should be interpreted with caution when making risk management decisions.

7.0 CONCLUSIONS

AMEC conducted a human health risk assessment to evaluate the potential human health risks as a result of potential exposure to arsenic in soil along the Branch Line. The risk assessment provides a conservative, yet reasonable, estimate of the nature and extent of the health risks and was prepared using guidance provided by both Cal-EPA and U.S. EPA.

Potential noncarcinogenic hazard indices and theoretical lifetime excess cancer risks from potential exposures to arsenic in soil were estimated for future construction workers and future recreational receptors assuming conservative estimates of human exposure.

Based on the site-specific background concentration, the estimated cancer risk and noncarcinogenic hazard index for a future construction worker are $1x10^{-6}$ and 0.20, respectively. The estimated cancer risk and noncarcinogenic hazard index for a future recreational user are $8x10^{-6}$ and 0.15, respectively.

Assuming potential exposures throughout the entire Branch Line, the estimated baseline cancer risk and hazard index for the future construction worker are $3x10^{-6}$ and 0.6, respectively. The estimated baseline cancer risk and hazard index for a future recreational user are $2x10^{-5}$ and 0.4, respectively.

For individual exposure units, the estimated baseline cancer risks for a future construction worker range from $8x10^{-7}$ to $6x10^{-6}$. The hazard indexes range from 0.2 to 1.1. The estimated baseline cancer risks for a future recreational user range from $6x10^{-6}$ to $5x10^{-5}$. The hazard indexes range from 0.1 to 0.8.

Based on these estimates, the incremental excess lifetime cancer risk and noncarcinogenic hazard index is the difference between baseline and background. The incremental excess lifetime cancer risk range between 4×10^{-7} and 5×10^{-6} for the future construction worker and 3×10^{-6} to 4×10^{-5} for the future recreational user and are within the range considered acceptable by the U.S. EPA and Cal-EPA. The incremental noncarcinogenic hazard indexes are less than 1 for both the future construction worker and recreational user suggesting that potential exposure to arsenic along the entire Branch Line is not expected to result in an adverse noncarcinogenic health effects.

In summary, the results of the risk assessment indicate that the incremental increase in risk over background range from 2.0 to 5.6 times higher than baseline for individual exposure units, suggesting that potential exposures to arsenic in soil are not significantly different than naturally-occurring levels.

As in any risk assessment, the estimates of risk have many associated uncertainties. The procedures used in the HHRA result in conditional estimates of risk that incorporate assumptions concerning chemical toxicity and human exposure and unavoidable uncertainties. To be health protective, the types of assumptions used in the HHRA were generally conservative. Consequently, it is important that the magnitude of uncertainties and biases are considered when interpreting the health risk results. It is possible that currently unrecognized subsurface issues may be present at the site. However, the health risk assessment has been prepared in a manner consistent with that generally used in agency guidance at the time it was prepared. It is likely that risk assessment methods and data identifying and quantifying the toxicity of chemicals will improve with time. Should use, conditions, or toxicity criteria change, the information and conclusions in this report may no longer apply.

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TABLES

TABLE H-1

SOIL SAMPLE ANALYTICAL RESULTS FOR ARSENIC
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
Targeted Samples			
SB-01-5	4/25/2005	5	4.2
SB-01-10	4/25/2005	10	4.2
SB-02-1	4/25/2005	1	7.7
SB-02-5	4/25/2005	5	4.3
SB-02-10	4/25/2005	10	6.4
SB-03-1	4/25/2005	1	2.2
SB-03-5	4/25/2005	5	5.7
SB-03-10	4/25/2005	10	5
SB-04-1	4/28/2005	1	6.1
SB-04-5	4/28/2005	5	1.5
SB-04-10	4/28/2005	10	<1
SB-05-1	4/28/2005	1	6.2
SB-05-5	4/28/2005	5	2.3
SB-05-10	4/28/2005	10	14
SB-10-0.5	4/25/2005	0.5	5.5
SB-10-1.5	4/25/2005	1.5	1.8
SB-10-3	4/25/2005	3	1.6
SB-11-0.5	4/28/2005	0.5	16
SB-11-1.5	4/28/2005	1.5	5.1
SB-12-1	4/28/2005	1	6.5
SB-12-5	4/28/2005	5	2.4
SB-12-10	4/28/2005	10	1.8
SB-13-1	4/28/2005	1	5.3
SB-13-5	4/28/2005	5	2.5
SB-13-10	4/28/2005	10	2
SB-14-1	4/28/2005	1	20
SB-14-5	4/28/2005	5	4.4
SB-14-10	4/28/2005	10	3.7
SB-15-1	4/25/2005	1	1.9
SB-15-5	4/25/2005	5	6.1
SB-15-10	4/25/2005	10	4.2
SB-16-1	4/28/2005	1	8.1
SB-16-5	4/28/2005	5	1.8
SB-16-10	4/28/2005	10	<1
SB-17-1	4/28/2005	1	8.2
SB-17-5	4/28/2005	5	3.8
SB-17-10	4/28/2005	10	1.2
SB-22-1	4/27/2005	1	10
SB-22-5	4/27/2005	5	6.2
SB-22-10	4/27/2005	10	3

TABLE H-1

SOIL SAMPLE ANALYTICAL RESULTS FOR ARSENIC
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
SB-23-1	4/27/2005	1	52
SB-23-5	4/27/2005	5	5.2
SB-23-10	4/27/2005	10	8.4
SB-32-0.5	4/27/2005	0.5	22
SB-32-1.5	4/27/2005	1.5	5.6
SB-32-3	4/27/2005	3	5.4
SB-33-0.5	4/27/2005	0.5	5.4
SB-42-1	4/28/2005	1	<1
SB-42-5	4/26/2005	5	8.3
SB-42-10	4/26/2005	10	5
SB-43-0.5	4/26/2005	0.5	5.6
SB-43-1.5	4/26/2005	1.5	4.6
SB-43-3	4/26/2005	3	1.7
SB-44-0.5	4/26/2005	0.5	5.8
SB-44-1.5	4/26/2005	1.5	4.3
SB-44-3	4/26/2005	3	2.2
SB-45-0.5	4/26/2005	0.5	6
SB-45-3	4/26/2005	3	1.2
SB-46-0.5	4/26/2005	0.5	9.2
SB-46-1.5	4/26/2005	1.5	18
SB-46-3	4/26/2005	3	1.9
SB-47-0.5	4/26/2005	0.5	56
SB-47-1.5	4/26/2005	1.5	3.8
SB-47-3	4/26/2005	3	3.3
SB-48-0.5	4/26/2005	0.5	18
SB-48-1.5	4/26/2005	1.5	20
SB-48-3	4/26/2005	3	3.7
SB-49-1	4/26/2005	1	<1
SB-49-5	4/28/2005	5	<1
SB-49-10	4/26/2005	10	3.8
SB-50-1	4/26/2005	1	3
SB-50-5	4/26/2005	5	<1
SB-50-10	4/26/2005	10	3.2
SB-74-0.5	2/11/2009	0.5	21
SB-74-1.5	2/11/2009	1.5	19
SB-74-3.0	2/11/2009	3	5.9
SB-75-0.5	2/11/2009	0.5	3.9
SB-75-1.5	2/11/2009	1.5	2.9
SB-75-4.5	2/11/2009	4.5	4.9
SB-76-0.5	2/11/2009	0.5	30
SB-76-1.5	2/11/2009	1.5	8.5
SB-76-3.0	2/11/2009	3	4.0
SB-77-0.5	2/11/2009	0.5	2.0
SB-77-1.5	2/11/2009	1.5	1.4
SB-77-3.0	2/11/2009	3	3.3

TABLE H-1

SOIL SAMPLE ANALYTICAL RESULTS FOR ARSENIC

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
SB-78-0.5	2/11/2009	0.5	4.5
SB-78-1.5	2/11/2009	1.5	2.2
SB-78-4.5	2/11/2009	4.5	1.9
SB-79-0.5	2/11/2009	0.5	3.2
SB-79-1.5	2/11/2009	1.5	2.1
SB-79-4.5	2/11/2009	4.5	28
SB-80-0.5	2/11/2009	0.5	53
SB-80-4.5	2/11/2009	4.5	2.6
SB-80-5.5	2/11/2009	5.5	2.1
SB-81-0.5	2/11/2009	0.5	1.6
SB-81-1.5	2/11/2009	1.5	50
SB-81-4.5	2/11/2009	4.5	5.4
SB-82-0.5	2/11/2009	0.5	14
SB-82-1.5	2/11/2009	1.5	1.1
SB-82-4.5	2/11/2009	4.5	2.5
SB-95-0.5	2/12/2009	0.5	7.9
SB-95-1.5	2/12/2009	1.5	74
SB-96-0.5	2/12/2009	0.5	5.6
SB-96-1.5	2/12/2009	1.5	8.9
Systematic Samples			
Agricultural (North) Section			
SB-06-0.5	4/25/2005	0.5	8.1
SB-07-0.5	4/25/2005	0.5	4.7
SB-08-0.5	4/25/2005	0.5	9.5
SB-09-0.5	4/25/2005	0.5	14
Residential Section — Santa Cruz			
SB-18-0.5	4/27/2005	0.5	7.5
SB-19-0.5	4/27/2005	0.5	6.7
SB-20-0.5	4/27/2005	0.5	39
SB-21-0.5	4/27/2005	0.5	16
SB-83-0.5	2/12/2009	0.5	72
SB-83-1.5	2/12/2009	1.5	120
SB-83-4.5	2/12/2009	4.5	2.1
SB-84-0.5	2/12/2009	0.5	110
SB-84-1.5	2/12/2009	1.5	130
SB-84-4.5	2/12/2009	4.5	10
SB-85-0.5	2/12/2009	0.5	18
SB-85-1.2	2/12/2009	1.2	2.6
SB-85-4.5	2/12/2009	4.5	3.0
SB-86-0.5	2/12/2009	0.5	23
SB-86-1.5	2/12/2009	1.5	4.1
SB-86-4.5	2/12/2009	4.5	15

TABLE H-1

SOIL SAMPLE ANALYTICAL RESULTS FOR ARSENIC

Santa Cruz Branch Line

Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
SB-87-0.5	2/12/2009	0.5	16
SB-87-1.5	2/12/2009	1.5	11
SB-87-4.5	2/12/2009	4.5	3.0
SB-88-0.5	2/12/2009	0.5	8.5
SB-88-1.5	2/12/2009	1.5	1.4
SB-88-4.5	2/12/2009	4.5	1.4
SB-89-0.5	2/12/2009	0.5	7.5
SB-89-1.5	2/12/2009	1.5	79
SB-89-4.5	2/12/2009	4.5	4.4
SB-90-0.5	2/12/2009	0.5	2.1
SB-90-1.5	2/12/2009	1.5	38
SB-90-4.5	2/12/2009	4.5	14
SB-91-0.5	2/12/2009	0.5	13
SB-91-1.5	2/12/2009	1.5	4.8
SB-91-4.5	2/12/2009	4.5	3.7
SB-92-0.5	2/12/2009	0.5	37
SB-92-1.5	2/12/2009	1.5	190
SB-92-4.5	2/12/2009	4.5	11
SB-93-0.5	2/12/2009	0.5	57
SB-93-1.5	2/12/2009	1.5	2.9
SB-93-4.5	2/12/2009	4.5	2.9
SB-94-0.5	2/12/2009	0.5	16
SB-94-1.5	2/12/2009	1.5	1.6
SB-94-4.5	2/12/2009	4.5	1.9
Undeveloped Section			
SB-24-0.5	4/27/2005	0.5	15
SB-25-0.5	4/27/2005	0.5	21
SB-26-0.5	4/27/2005	0.5	5.4
SB-27-0.5	4/27/2005	0.5	48
SB-59-0.5	2/10/2009	0.5	31
SB-59-1.5	2/10/2009	1.5	2.7
SB-59-4.5	2/10/2009	4.5	3.4
SB-60-0.5	2/10/2009	0.5	47
SB-60-1.5	2/10/2009	1.5	110
SB-60-4.5	2/10/2009	4.5	4.7
SB-61-0.5	2/10/2009	0.5	240
SB-61-1.5	2/10/2009	1.5	10
SB-61-4.5	2/10/2009	4.5	6.9
SB-62-0.5	2/10/2009	0.5	66
SB-62-1.5	2/10/2009	1.5	150
SB-62-4.5	2/10/2009	4.5	46

TABLE H-1

SOIL SAMPLE ANALYTICAL RESULTS FOR ARSENIC
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
SB-63-0.5	2/10/2009	0.5	31
SB-63-1.5	2/10/2009	1.5	33
SB-63-4.5	2/10/2009	4.5	22
SB-64-0.5	2/10/2009	0.5	6.5
SB-64-1.5	2/10/2009	1.5	37
SB-64-4.5	2/10/2009	4.5	2.5
SB-65-0.5	2/10/2009	0.5	87
SB-65-1.5	2/10/2009	1.5	3.8
SB-65-4.5	2/10/2009	4.5	3.5
SB-66-0.5	2/10/2009	0.5	60
SB-66-1.5	2/10/2009	1.5	3.6
SB-66-4.5	2/10/2009	4.5	2.0
SB-67-0.5	2/10/2009	0.5	34
SB-67-1.5	2/10/2009	1.5	2.4
SB-67-4.5	2/10/2009	4.5	2.2
SB-68-0.5	2/10/2009	0.5	42
SB-68-1.5	2/10/2009	1.5	3.3
SB-68-4.5	2/10/2009	4.5	2.9
SB-69-0.5	2/10/2009	0.5	10
SB-69-1.5	2/10/2009	1.5	5.2
SB-69-4.5	2/10/2009	4.5	2.8
SB-70-0.5	2/10/2009	0.5	2.2
SB-70-1.5	2/10/2009	1.5	3.9
SB-70-4.5	2/10/2009	4.5	2.5
Agricultural (South) Section			
SB-28-0.5	4/27/2005	0.5	6.8
SB-29-0.5	4/27/2005	0.5	6.9
SB-30-0.5	4/27/2005	0.5	13
SB-31-0.5	4/27/2005	0.5	6.1
SB-55-0.5	2/9/2009	0.5	48
SB-55-1.5	2/9/2009	1.5	35
SB-55-4.5	2/9/2009	4.5	11
SB-56-0.5	2/9/2009	0.5	80
SB-56-1.5	2/9/2009	1.5	40
SB-56-4.5	2/9/2009	4.5	21
SB-57-0.5	2/9/2009	0.5	59
SB-57-1.5	2/9/2009	1.5	12
SB-57-4.5	2/9/2009	4.5	11
SB-58-0.5	2/9/2009	0.5	49
SB-58-1.5	2/9/2009	1.5	180
SB-58-3.5	2/9/2009	3.5	33

TABLE H-1

SOIL SAMPLE ANALYTICAL RESULTS FOR ARSENIC

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
Residential Section Between Seascape and Capitola			
SB-71-0.5	2/11/2009	0.5	23
SB-71-1.5	2/11/2009	1.5	47
SB-71-4.5	2/11/2009	4.5	2
SB-72-0.5	2/11/2009	0.5	69
SB-72-1.0	2/11/2009	1.5	3.9
SB-72-4.5	2/11/2009	4.5	2.0
SB-73-0.5	2/10/2009	0.5	8.8
SB-73-1.5	2/10/2009	1.5	4.7
SB-73-4.5	2/10/2009	4.5	6.7
SB-103-0.5	4/13/2009	0.5	14
SB-103-1.5	4/13/2009	1.5	36
SB-103-4.5	4/13/2009	4.5	23
Industrial			
SB-34-0.5	4/26/2005	0.5	57
SB-35-0.5	4/26/2005	0.5	16
SB-35-1.5	4/26/2005	1.5	14
SB-36-0.5	4/26/2005	0.5	15
SB-37-0.5	4/26/2005	0.5	23
SB-38-0.5	4/26/2005	0.5	4.4
SB-39-0.5	4/26/2005	0.5	140
SB-40-0.5	4/26/2005	0.5	80
SB-41-0.5	4/26/2005	0.5	15
Railroad Tie			
SB-51-0.5	4/29/2005	0.5	10
SB-51-1.5	4/29/2005	1.5	3.5
SB-54-0.5	4/29/2005	0.5	2.5
SB-52-0.5	4/29/2005	0.5	65
SB-52-1.5	4/29/2005	1.5	100
SB-52-3	4/29/2005	3	5.2
SB-53-0.5	4/29/2005	0.5	32
SB-53-1.5	4/29/2005	1.5	27
SB-53-3	4/29/2005	3	1.9

Notes

1. Soil samples collected by AMEC Geomatrix, Inc., and analyzed by Test America San Francisco of Pleasanton, California, for arsenic using EPA method 6010B.

Abbreviations

"<" = not detected at or above the laboratory reporting limit
bgs = below ground surface
mg/kg = milligrams per kilogram

TABLE H-2

SUMMARY OF ARSENIC IN SOIL BY EXPOSURE UNIT

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
South of Davenport			
SB-02-1	4/25/2005	1	7.7
SB-03-1	4/25/2005	1	2.2
East of Wilder State Park			
SB-11-0.5	4/28/2005	0.5	16
SB-11-1.5	4/28/2005	1.5	5.1
SB-12-1	4/28/2005	1	6.5
SB-13-1	4/28/2005	1	5.3
SB-14-1	4/28/2005	1	20
East of Watsonville			
SB-95-0.5	2/12/2009	0.5	7.9
SB-95-1.5	2/12/2009	1.5	74
SB-96-0.5	2/12/2009	0.5	5.6
SB-96-1.5	2/12/2009	1.5	8.9
Agricultural–North			
SB-04-1	4/28/2005	1	6.1
SB-04-5	4/28/2005	5	1.5
SB-04-10	4/28/2005	10	<1
SB-05-1	4/28/2005	1	6.2
SB-05-5	4/28/2005	5	2.3
SB-05-10	4/28/2005	10	14
SB-06-0.5	4/25/2005	0.5	8.1
SB-07-0.5	4/25/2005	0.5	4.7
SB-08-0.5	4/25/2005	0.5	9.5
SB-09-0.5	4/25/2005	0.5	14
Agricultural–South			
SB-28-0.5	4/27/2005	0.5	6.8
SB-29-0.5	4/27/2005	0.5	6.9
SB-30-0.5	4/27/2005	0.5	13
SB-31-0.5	4/27/2005	0.5	6.1
SB-55-0.5	2/9/2009	0.5	48
SB-55-1.5	2/9/2009	1.5	35
SB-55-4.5	2/9/2009	4.5	11
SB-56-0.5	2/9/2009	0.5	80
SB-56-1.5	2/9/2009	1.5	40
SB-56-4.5	2/9/2009	4.5	21
SB-57-0.5	2/9/2009	0.5	59
SB-57-1.5	2/9/2009	1.5	12
SB-57-4.5	2/9/2009	4.5	11
SB-58-0.5	2/9/2009	0.5	49
SB-58-1.5	2/9/2009	1.5	180
SB-58-3.5	2/9/2009	3.5	33

TABLE H-2

SUMMARY OF ARSENIC IN SOIL BY EXPOSURE UNIT

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
Mission Industrial Lands			
SB-10-0.5	4/25/2005	0.5	5.5
SB-10-1.5	4/25/2005	1.5	1.8
SB-10-3	4/25/2005	3	1.6
SB-51-0.5	4/29/2005	0.5	10
SB-51-1.5	4/29/2005	1.5	3.5
SB-54-0.5	4/29/2005	0.5	2.5
SB-77-0.5	2/11/2009	0.5	2.0
SB-77-1.5	2/11/2009	1.5	1.4
SB-77-3.0	2/11/2009	3	3.3
SB-78-0.5	2/11/2009	0.5	4.5
SB-78-1.5	2/11/2009	1.5	2.2
SB-78-4.5	2/11/2009	4.5	1.9
SB-79-0.5	2/11/2009	0.5	3.2
SB-79-1.5	2/11/2009	1.5	2.1
SB-79-4.5	2/11/2009	4.5	28
SB-80-0.5	2/11/2009	0.5	53
SB-80-4.5	2/11/2009	4.5	2.6
SB-80-5.5	2/11/2009	5.5	2.1
SB-81-0.5	2/11/2009	0.5	1.6
SB-81-1.5	2/11/2009	1.5	50
SB-81-4.5	2/11/2009	4.5	5.4
SB-82-0.5	2/11/2009	0.5	14
SB-82-1.5	2/11/2009	1.5	1.1
SB-82-4.5	2/11/2009	4.5	2.5
Freight House			
SB-22-1	4/27/2005	1	10
SB-22-5	4/27/2005	5	6.2
SB-22-10	4/27/2005	10	3
SB-23-1	4/27/2005	1	52
SB-23-5	4/27/2005	5	5.2
SB-23-10	4/27/2005	10	8.4
SB-74-0.5	2/11/2009	0.5	21
SB-74-1.5	2/11/2009	1.5	19
SB-74-3.0	2/11/2009	3	5.9
SB-75-0.5	2/11/2009	0.5	3.9
SB-75-1.5	2/11/2009	1.5	2.9
SB-75-4.5	2/11/2009	4.5	4.9
SB-76-0.5	2/11/2009	0.5	30
SB-76-1.5	2/11/2009	1.5	8.5
SB-76-3.0	2/11/2009	3	4.0

TABLE H-2

SUMMARY OF ARSENIC IN SOIL BY EXPOSURE UNIT
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
Industrial South			
SB-32-0.5	4/27/2005	0.5	22
SB-32-1.5	4/27/2005	1.5	5.6
SB-32-3	4/27/2005	3	5.4
SB-33-0.5	4/27/2005	0.5	5.4
SB-34-0.5	4/26/2005	0.5	57
SB-35-0.5	4/26/2005	0.5	16
SB-35-1.5	4/26/2005	1.5	14
SB-36-0.5	4/26/2005	0.5	15
SB-37-0.5	4/26/2005	0.5	23
SB-38-0.5	4/26/2005	0.5	4.4
SB-39-0.5	4/26/2005	0.5	140
SB-40-0.5	4/26/2005	0.5	80
SB-41-0.5	4/26/2005	0.5	15
SB-42-1	4/28/2005	1	<1
SB-42-5	4/26/2005	5	8.3
SB-42-10	4/26/2005	10	5
SB-43-0.5	4/26/2005	0.5	5.6
SB-43-1.5	4/26/2005	1.5	4.6
SB-43-3	4/26/2005	3	1.7
SB-44-0.5	4/26/2005	0.5	5.8
SB-44-1.5	4/26/2005	1.5	4.3
SB-44-3	4/26/2005	3	2.2
SB-45-0.5	4/26/2005	0.5	6
SB-45-3	4/26/2005	3	1.2
SB-46-0.5	4/26/2005	0.5	9.2
SB-46-1.5	4/26/2005	1.5	18
SB-46-3	4/26/2005	3	1.9
SB-47-0.5	4/26/2005	0.5	56
SB-47-1.5	4/26/2005	1.5	3.8
SB-47-3	4/26/2005	3	3.3
SB-48-0.5	4/26/2005	0.5	18
SB-48-1.5	4/26/2005	1.5	20
SB-48-3	4/26/2005	3	3.7
SB-49-1	4/26/2005	1	<1
SB-49-5	4/28/2005	5	<1
SB-49-10	4/26/2005	10	3.8
SB-50-1	4/26/2005	1	3
SB-50-5	4/26/2005	5	<1
SB-50-10	4/26/2005	10	3.2

TABLE H-2

SUMMARY OF ARSENIC IN SOIL BY EXPOSURE UNIT
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
Residential–Santa Cruz			
SB-18-0.5	4/27/2005	0.5	7.5
SB-19-0.5	4/27/2005	0.5	6.7
SB-20-0.5	4/27/2005	0.5	39
SB-21-0.5	4/27/2005	0.5	16
SB-83-0.5	2/12/2009	0.5	72
SB-83-1.5	2/12/2009	1.5	120
SB-83-4.5	2/12/2009	4.5	2.1
SB-84-0.5	2/12/2009	0.5	110
SB-84-1.5	2/12/2009	1.5	130
SB-84-4.5	2/12/2009	4.5	10
SB-85-0.5	2/12/2009	0.5	18
SB-85-1.2	2/12/2009	1.2	2.6
SB-85-4.5	2/12/2009	4.5	3.0
SB-86-0.5	2/12/2009	0.5	23
SB-86-1.5	2/12/2009	1.5	4.1
SB-86-4.5	2/12/2009	4.5	15
SB-87-0.5	2/12/2009	0.5	16
SB-87-1.5	2/12/2009	1.5	11
SB-87-4.5	2/12/2009	4.5	3.0
SB-88-0.5	2/12/2009	0.5	8.5
SB-88-1.5	2/12/2009	1.5	1.4
SB-88-4.5	2/12/2009	4.5	1.4
SB-89-0.5	2/12/2009	0.5	7.5
SB-89-1.5	2/12/2009	1.5	79
SB-89-4.5	2/12/2009	4.5	4.4
SB-90-0.5	2/12/2009	0.5	2.1
SB-90-1.5	2/12/2009	1.5	38
SB-90-4.5	2/12/2009	4.5	14
SB-91-0.5	2/12/2009	0.5	13
SB-91-1.5	2/12/2009	1.5	4.8
SB-91-4.5	2/12/2009	4.5	3.7
SB-92-0.5	2/12/2009	0.5	37
SB-92-1.5	2/12/2009	1.5	190
SB-92-4.5	2/12/2009	4.5	11
SB-93-0.5	2/12/2009	0.5	57
SB-93-1.5	2/12/2009	1.5	2.9
SB-93-4.5	2/12/2009	4.5	2.9
SB-94-0.5	2/12/2009	0.5	16
SB-94-1.5	2/12/2009	1.5	1.6
SB-94-4.5	2/12/2009	4.5	1.9

TABLE H-2

SUMMARY OF ARSENIC IN SOIL BY EXPOSURE UNIT
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
Residential Section Between Seascape and Capitola			
SB-52-0.5	4/29/2005	0.5	65
SB-52-1.5	4/29/2005	1.5	100
SB-52-3	4/29/2005	3	5.2
SB-71-0.5	2/11/2009	0.5	23
SB-71-1.5	2/11/2009	1.5	47
SB-71-4.5	2/11/2009	4.5	2
SB-72-0.5	2/11/2009	0.5	69
SB-72-1.0	2/11/2009	1.5	3.9
SB-72-4.5	2/11/2009	4.5	2.0
SB-73-0.5[4]	2/10/2009	0.5	8.8
SB-73-1.5[4]	2/10/2009	1.5	4.7
SB-73-4.5[4]	2/10/2009	4.5	6.7
SB-103-0.5	4/13/2009	0.5	14
SB-103-1.5	4/13/2009	1.5	36
SB-103-4.5	4/13/2009	4.5	23
Undeveloped			
SB-24-0.5	4/27/2005	0.5	15
SB-25-0.5	4/27/2005	0.5	21
SB-26-0.5	4/27/2005	0.5	5.4
SB-27-0.5	4/27/2005	0.5	48
SB-53-0.5	4/29/2005	0.5	32
SB-53-1.5	4/29/2005	1.5	27
SB-53-3	4/29/2005	3	1.9
SB-59-0.5	2/10/2009	0.5	31
SB-59-1.5	2/10/2009	1.5	2.7
SB-59-4.5	2/10/2009	4.5	3.4
SB-60-0.5	2/10/2009	0.5	47
SB-60-1.5	2/10/2009	1.5	110
SB-60-4.5	2/10/2009	4.5	4.7
SB-61-0.5	2/10/2009	0.5	240
SB-61-1.5	2/10/2009	1.5	10
SB-61-4.5	2/10/2009	4.5	6.9
SB-62-0.5	2/10/2009	0.5	66
SB-62-1.5	2/10/2009	1.5	150
SB-62-4.5	2/10/2009	4.5	46
SB-63-0.5	2/10/2009	0.5	31
SB-63-1.5	2/10/2009	1.5	33
SB-63-4.5	2/10/2009	4.5	22
SB-64-0.5	2/10/2009	0.5	6.5
SB-64-1.5	2/10/2009	1.5	37
SB-64-4.5	2/10/2009	4.5	2.5

TABLE H-2

SUMMARY OF ARSENIC IN SOIL BY EXPOSURE UNIT
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)
SB-65-0.5	2/10/2009	0.5	87
SB-65-1.5	2/10/2009	1.5	3.8
SB-65-4.5	2/10/2009	4.5	3.5
SB-66-0.5	2/10/2009	0.5	60
SB-66-1.5	2/10/2009	1.5	3.6
SB-66-4.5	2/10/2009	4.5	2.0
SB-67-0.5	2/10/2009	0.5	34
SB-67-1.5	2/10/2009	1.5	2.4
SB-67-4.5	2/10/2009	4.5	2.2
SB-68-0.5	2/10/2009	0.5	42
SB-68-1.5	2/10/2009	1.5	3.3
SB-68-4.5	2/10/2009	4.5	2.9
SB-69-0.5	2/10/2009	0.5	10
SB-69-1.5	2/10/2009	1.5	5.2
SB-69-4.5	2/10/2009	4.5	2.8
SB-70-0.5	2/10/2009	0.5	2.2
SB-70-1.5	2/10/2009	1.5	3.9
SB-70-4.5	2/10/2009	4.5	2.5

Abbreviations
"<" = not detected at or above the laboratory reporting limit
bgs = below ground surface
mg/kg = milligrams per kilogram

TABLE H-3

SUMMARY STATISTICS AND EXPOSURE POINT CONCENTRATIONS FOR ARSENIC BY EXPOSURE UNIT
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

All concentrations reported in milligrams per kilogram (mg/kg)

Exposure Unit	Adjacent Land Use	Count	Number of Detects	Number of Non Detects	Maximum Detected Concentration	Minimum Detected Concentration	Mean Detected Concentration	95% UCL[1]	Exposure Point Concentration[2]
Sitewide	--	150	148	2	240	1.1	28.3	42.0	42.0
South of Davenport	--	2	2	0	7.7	2.2	5.0	NA	7.7
East of Wilder State Park	--	5	5	0	20	5.1	10.6	NA	20.0
East of Watsonville	--	4	4	0	74	5.6	24.1	NA	74
Agricultural–North	Agricultural	6	6	0	14	4.7	8.1	10.9	10.85
Agricultural–South	Agricultural	12	12	0	180	6.1	44.7	80.7	80.7
Mission Industrial Land	Industrial	24	24	0	53	1.1	8.6	37.9	37.9
Freight House	Industrial	8	8	0	52	2.9	18.4	29.4	29.4
Industrial South	Industrial	26	24	2	140	3.0	23.0	59.3	59.3
Residential–Santa Cruz	Residential	28	28	0	190	1.4	37.0	56.9	56.9
Residential–Seascape	Residential	14	14	0	100	2.0	28.9	64.6	64.6
Undeveloped	Undeveloped	42	42	0	240	2.0	30.3	61.2	61.2

Notes
1. 95 percent upper confidence limit (95% UCL) calculated using ProUCL 4.00.04 software (U.S. EPA, 2009a).
2. The 95% UCL was selected for the exposure point concentration for every exposure with at least 6 samples. The maximum detected concentration was selected as the exposure point concentration for exposure unit with less than 6 samples.

TABLE H-4

EXPOSURE PARAMETERS FOR CONSTRUCTION WORKER SCENARIO
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Exposure Parameter	Units	Reasonable Maximum Exposure
General Exposure Parameters		
Exposure Frequency (EF)	days/year	Value: 250 Rationale: U.S. EPA, 2002
Exposure Duration (ED)	years	Value: 1 Rationale: U.S. EPA, 2002
Body Weight (BW)	kg	Value: 70 Rationale: DTSC, 1996; U.S. EPA, 1991; U.S. EPA, 2002
Averaging Time (AT)	days	Value: 25,550 (carcinogens) 365 (noncarcinogens) Rationale: DTSC, 1996; U.S. EPA, 1991; U.S. EPA, 2002
Pathway-Specific Parameters		
Incidental Soil Ingestion		
Soil Ingestion Rate (IR_s)	mg/day	Value: 330 Rationale: U.S. EPA, 2002
Dermal Contact with Soil		
Exposed Skin Surface Area (SA_s)	cm^2/day	Value: 3,300 Rationale: U.S. EPA, 2002
Soil-to-Skin Adherence Factor (SAF)	mg/cm^2	Value: 0.3 Rationale: U.S. EPA, 2002
Inhalation of Suspended Soil Particulates		
Particulate Emission Factor (PEF)	m^3/kg	Value: $2x10^7$ Rationale: based on recommended value of 50 µg/m^3 PM10 standard; DTSC, 1999; also consistent with U.S. EPA, 2002, recommended PEF for construction activities other than unpaved road traffic ($3.6x10^7$ m^3/kg)
Inhalation Rate (IHR_a)	m^3/hr	Value: 2.5 Rationale: U.S. EPA, 2002
Exposure Time (ET)	hours	Value: 8 Rationale: DTSC, 1996; U.S. EPA, 1991; Standard work day

TABLE H-4

EXPOSURE PARAMETERS FOR CONSTRUCTION WORKER SCENARIO

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

References

Department of Toxic Substances Control (DTSC), 1996, Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities (corrected and reprinted): Office of the Scientific Advisor, California Environmental Protection Agency (Cal/EPA), Sacramento, California.

DTSC, 1999, Preliminary Endangerment Assessment Guidance Manual, Sacramento, California.

U.S. Environmental Protection Agency (EPA), 1991, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors: Office of Emergency and Remedial Response, Washington, D.C.

U.S. EPA, 2002, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites: Office of Solid Waste and Emergency Response, December.

Abbreviations

cm^2 = centimeters squared
cm^2/day = centimeters squared per day
kg = kilograms
hrs/day = hours per day
m^3/hr = cubic meters per hour
m^3/kg = cubic meters per kilogram
mg/cm^2 = milligrams per centimeters squared
mg/day = milligrams per day

TABLE H-5

EXPOSURE PARAMETERS FOR ADULT AND CHILD RECREATIONAL USER SCENARIO

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Exposure Parameter	Units	Reasonable Maximum Exposure
Inhalation of Suspended Soil Particulates		
Inhalation Rate (IHR_a)	m^3/hr	Value: 1.2 (child) 1.6 (adult) Rationale: based on short-term "moderate" activities (Table 5-23); U.S. EPA, 1997
Particulate Emission Factor (PEF)	m^3/kg	Value: $8.7x10^8$ Rationale: U.S. EPA, 2002, calculated as indicated in Appendix B
Exposure Time (ET)	hours	Value: 2 Rationale: 95^{th} percentile, 24-hour cumulative minutes spent traveling on a bicycle, skateboard, roller skates minus approx. 30 minutes outside trail (Table 15-127); U.S EPA, 1997

References

Department of Toxic Substances Control (DTSC), 1996, Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities (corrected and reprinted), Office of the Scientific Advisor, California Environmental Protection Agency (Cal/EPA), Sacramento, California.

U.S. Environmental Protection Agency (U.S. EPA), 1991, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors: Office of Emergency and Remedial Response, Washington, D.C.

U.S. EPA, 1997, Exposure Factors Handbook, Volume 1: Office of Research and Development, Washington, D.C.

U.S. EPA, 2002 Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites: Office of Solid Waste and Emergency Response, December.

Abbreviations

cm^2/day = square centimeters per day
m^3/hour = cubic meters per hour
mg/day = milligrams per day
kg = kilograms
mg/cm^2 = milligrams per square centimeter

TABLE H-6

CARCINOGENIC AND NONCARCINOGENIC TOXICITY CRITERIA FOR ARSENIC

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

CAS No.	Chemical	Carcinogenic Slope Factors						Non-Carcinogenic Reference Doses					
		oral	dermal	Source	inhalation		Source	chronic oral	chronic dermal	Source	chronic inhalation		Source
		SFo	SFd		SFi	URF		RfDo	RfDd		RfDi	RfC	
		$(mg/kg\text{-}d)^{-1}$	$(mg/kg\text{-}d)^{-1}$		$(mg/kg\text{-}d)^{-1}$	$\mu g/m^3$		(mg/kg-d)	(mg/kg-d)		(mg/kg-d)	$\mu g/m^3$	
7440382	Arsenic	1.5	1.5	OEHHA	12	0.0033	OEHHA	0.0003	0.0003	IRIS	4.29E-06	0.015	OEHHA

Abbreviations
CAS No. = chemical abstract service number
IRIS = U.S. EPA, 2009, Integrated Risk Information System (IRIS) Data Base
mg/kg-day = milligrams per kilograms-day
$\mu g/m^3$ = micrograms per cubic meter
OEHHA = Cal-EPA, Office of Environmental Health Hazard Assessment, 2007, Toxicity Criteria Database, July.
RfC = Reference Concentration
RfD = Reference Dose
SF = Slope Factor
URF = Unit Risk Factor

TABLE H-7

BASELINE HAZARD AND RISK FOR FUTURE CONSTRUCTION WORKER

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Exposure Unit	Adjacent Land Use	Exposure Point Concentration (mg/kg)	Baseline Risk	Baseline Hazard Index
Sitewide	--	42.0	3E-06	0.6
South of Davenport	--	7.7	6E-07	0.1
East of Wilder State Park	--	20.0	2E-06	0.3
East of Watsonville	--	74.0	6E-06	1.0
Agricultural -- North	Agricultural	10.9	8E-07	0.2
Agricultural -- South	Agricultural	80.7	6E-06	1.1
Mission Industrial Land	Industrial	37.9	3E-06	0.5
Freight House	Industrial	29.4	2E-06	0.4
Industrial South	Industrial	59.3	5E-06	0.8
Residential -- Santa Cruz	Residential	56.9	4E-06	0.8
Residential -- Seascape	Residential	64.6	5E-06	0.9
Undeveloped	Undeveloped	61.2	5E-06	0.9

Symbol	Parameter	Value	Units
$RBSL_{Risk}$	Risk-Based Screening Level for Carcinogenic Risk	13.0	unitless
$RBSL_{Haz}$	Risk-Based Screening Level for Noncarcinogenic Hazard	71	unitless

Equations

$$\text{Hazard Index} = \frac{THQ \times EPC}{RBSL_{Haz}}$$

$$\text{Risk} = \frac{TR \times EPC}{RBSL_{Risk}}$$

TABLE H-8

BASELINE HAZARD AND RISK FOR FUTURE RECREATIONAL USER

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Exposure Unit	Adjacent Land Use	Exposure Point Concentration (mg/kg)	Baseline Risk	Baseline Hazard Index
Sitewide	--	42.0	2E-05	0.4
South of Davenport	--	7.7	4E-06	0.1
East of Wilder State Park	--	20.0	1E-05	0.2
East of Watsonville	--	74.0	4E-05	0.8
Agricultural -- North	Agricultural	10.9	6E-06	0.1
Agricultural -- South	Agricultural	80.7	5E-05	0.8
Mission Industrial Land	Industrial	37.9	2E-05	0.4
Freight House	Industrial	29.4	2E-05	0.3
Industrial South	Industrial	59.3	3E-05	0.6
Residential -- Santa Cruz	Residential	56.9	3E-05	0.6
Residential -- Seascape	Residential	64.6	4E-05	0.7
Undeveloped	Undeveloped	61.2	4E-05	0.6

Symbol	Parameter	Value	Units
$RBSL_{Risk}$	Risk-Based Screening Level for Carcinogenic Risk	1.75	unitless
$RBSL_{Haz}$	Risk-Based Screening Level for Noncarcinogenic Hazard	97	unitless

Equations

$$\text{Hazard Index} = \frac{THQ \times EPC}{RBSL_{Haz}}$$

$$\text{Risk} = \frac{TR \times EPC}{RBSL_{Risk}}$$

TABLE H-9

BACKGROUND HAZARD AND RISK FOR FUTURE CONSTRUCTION WORKER AND RECREATIONAL USER

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Receptor	$RBSL_{Risk}$	$RBSL_{Haz}$	Background Risk	Background Hazard
Future Construction Worker	12.97	71	1.E-06	0.20
Future Recreational User	1.75	97	8.E-06	0.15

Symbol	Parameter	Value	Units
BTV	Background Threshold Value	14.4	mg/kg

Equations

$$\text{Background Hazard} = \frac{THQ \times BTV}{RBSL_{Haz}}$$

$$\text{Background Risk} = \frac{TR \times BTV}{RBSL_{Risk}}$$

TABLE H-10

EXCESS LIFETIME CANCER RISK AND NONCARCINOGENIC HAZARD INDEX FOR FUTURE CONSTRUCTION WORKER AND RECREATIONAL USER

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Exposure Unit	Future Construction Worker		Future Recreational User	
	Excess Lifetime Cancer Risk	Noncarcinogenic Hazard Index	Excess Lifetime Cancer Risk	Noncarcinogenic Hazard Index
Sitewide	2E-06	0.4	2E-05	0.3
South of Davenport	NA	NA	NA	NA
East of Wilder State Park	4E-07	0.08	3E-06	0.06
East of Watsonville	5E-06	0.8	3E-05	0.6
Agricultural–North	NA	NA	NA	NA
Agricultural–South	5E-06	0.9	4E-05	0.7
Mission Industrial Land	2E-06	0.3	1E-05	0.2
Freight House	1E-06	0.2	9E-06	0.2
Industrial South	3E-06	0.6	3E-05	0.5
Residential–Santa Cruz	3E-06	0.6	2E-05	0.4
Residential–Seascape	4E-06	0.7	3E-05	0.5
Undeveloped	4E-06	0.7	3E-05	0.5

Note
NA = Not applicable because estimated risk is lower than background.

TABLE H-11

INCREMENTAL INCREASE IN RISK FOR FUTURE CONSTRUCTION WORKER AND RECREATIONAL USER

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

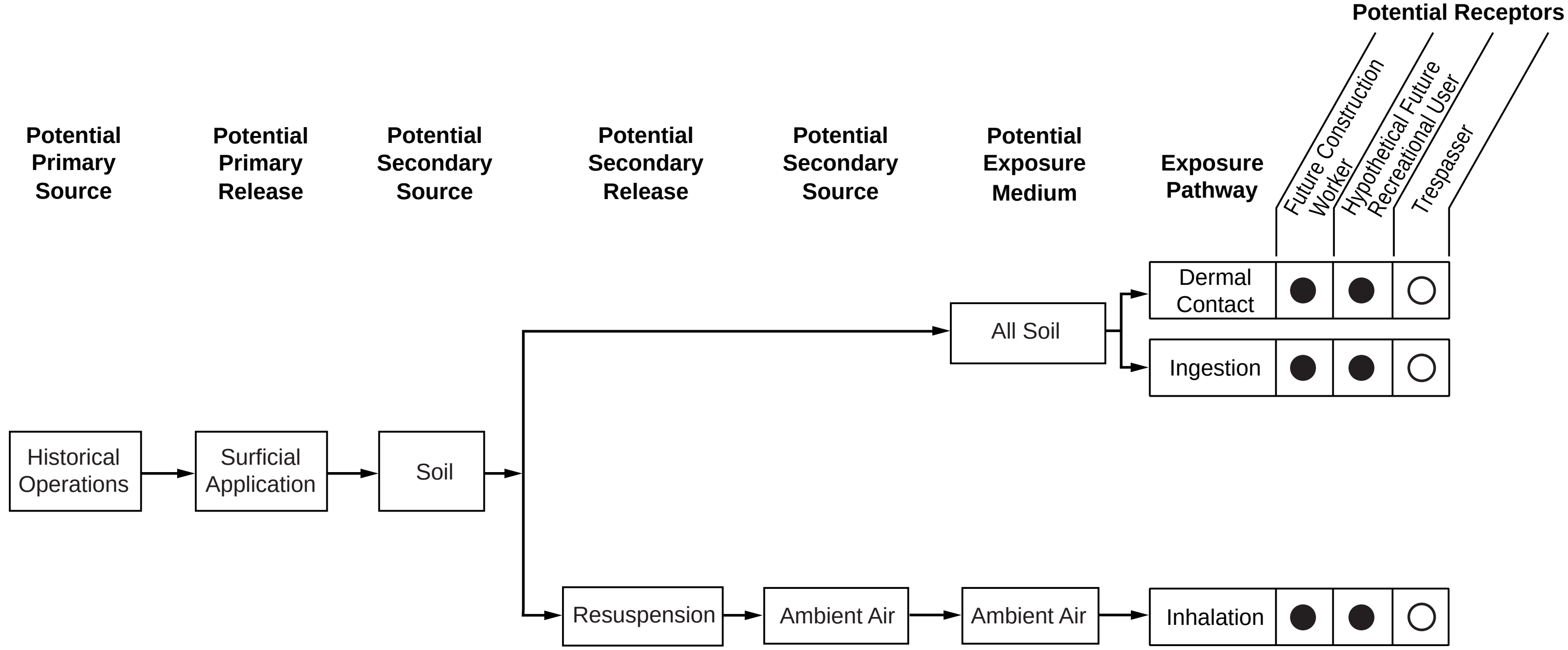
Exposure Unit	Adjacent Land Use	Exposure Point Concentration (mg/kg)	Incremental Risk
Sitewide	--	42.0	2.9
South of Davenport	--	7.7	--
East of Wilder State Park	--	20.0	1.4
East of Watsonville	--	74.0	5.1
Agricultural -- North	Agricultural	10.9	--
Agricultural -- South	Agricultural	80.7	5.6
Mission Industrial Land	Industrial	37.9	2.6
Freight House	Industrial	29.4	2.0
Industrial South	Industrial	59.3	4.1
Residential -- Santa Cruz	Residential	56.9	4.0
Residential -- Seascape	Residential	64.6	4.5
Undeveloped	Undeveloped	61.2	4.3

Equation

$$\text{Incremental Risk} = \frac{\text{Risk}_{\text{Exposure Unit}}}{\text{Risk}_{\text{Background}}}$$

FIGURE

S:\6200s\6257\task_9_fig_H-1_scm.ai



EXPLANATION

● Potentially complete exposure pathway.

○ Potentially complete exposure pathway but expected to be significantly less than the hypothetical future recreational user pathway. Therefore, this pathway is not evaluated.

SITE CONCEPTUAL MODEL
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

By: PS	Date: 6/30/09	Project No. 6257.000.0
AMEC Geomatrix		Figure H-1

ATTACHMENT H-1

ProUCL 4.00.04 Statistical Output

ATTACHMENT H-1a

ProUCL 4.00.04 STATISTICAL OUTPUT[1]

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

All concentrations presented in milligrams per kilogram (mg/kg)

Sitewide

General Statistics			
Number of Valid Data	150	Number of Detected Data	148
Number of Distinct Detected Data	104	Number of Non-Detect Data	2
		Percent Non-Detects	1.33%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	1.1	Minimum Detected	0.0953
Maximum Detected	240	Maximum Detected	5.481
Mean of Detected	28.35	Mean of Detected	2.569
SD of Detected	39.62	SD of Detected	1.267
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	1	Maximum Non-Detect	0
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.246	Lilliefors Test Statistic	0.0765
5% Lilliefors Critical Value	0.0728	5% Lilliefors Critical Value	0.0728
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	27.98	Mean	2.526
SD	39.48	SD	1.313
95% DL/2 (t) UCL	33.31	95% H-Stat (DL/2) UCL	37.48
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	27.67	Mean in Log Scale	2.524
SD	39.72	SD in Log Scale	1.317
95% MLE (t) UCL	33.03	Mean in Original Scale	27.97
95% MLE (Tiku) UCL	32.56	SD in Original Scale	39.48
		95% Percentile Bootstrap UCL	33.48
		95% BCA Bootstrap UCL	34.08
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.758	Data do not follow a Discernable Distribution (0.05)	
Theta Star	37.39		
nu star	224.4		
A-D Test Statistic	3.604	Nonparametric Statistics	
5% A-D Critical Value	0.795	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.795	Mean	27.98
5% K-S Critical Value	0.0801	SD	39.34
Data not Gamma Distributed at 5% Significance Level		SE of Mean	3.223
		95% KM (t) UCL	33.32
Assuming Gamma Distribution		95% KM (z) UCL	33.29
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	33.31
Minimum	1.00E-09	95% KM (bootstrap t) UCL	34.12
Maximum	240	95% KM (BCA) UCL	33.16
Mean	27.97	95% KM (Percentile Bootstrap) UCL	33.26
Median	10.5	95% KM (Chebyshev) UCL	42.03
SD	39.49	97.5% KM (Chebyshev) UCL	48.11
k star	0.572	99% KM (Chebyshev) UCL	60.06
Theta star	48.9		
Nu star	171.6	Potential UCLs to Use	
AppChi2	142.3	95% KM (Chebyshev) UCL	42.03
95% Gamma Approximate UCL	33.73		
95% Adjusted Gamma UCL	33.79		
Note: DL/2 is not a recommended method.			

Notes
1. Statistical output from ProUCL Version 4.00.04 (U.S. EPA, 2009a)

ATTACHMENT H-1b

ProUCL 4.00.04 STATISTICAL OUTPUT[1]

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

All concentrations presented in milligrams per kilogram (mg/kg)

Agricultural North

General Statistics			
Number of Valid Observations	6	Number of Distinct Observations	6
Raw Statistics		Log-transformed Statistics	
Minimum	4.7	Minimum of Log Data	1.548
Maximum	14	Maximum of Log Data	2.639
Mean	8.1	Mean of log Data	2.027
Median	7.15	SD of log Data	0.387
SD	3.345		
Coefficient of Variation	0.413		
Skewness	1.234		

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.901	Shapiro Wilk Test Statistic	0.965
Shapiro Wilk Critical Value	0.788	Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	10.85	95% H-UCL	12.37
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13.63
95% Adjusted-CLT UCL	11.08	97.5% Chebyshev (MVUE) UCL	16.03
95% Modified-t UCL	10.97	99% Chebyshev (MVUE) UCL	20.76
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	4.053	Data appear Normal at 5% Significance Level	
Theta Star	1.999		
MLE of Mean	8.1		
MLE of Standard Deviation	4.023		
nu star	48.63		
Approximate Chi Square Value (.05)	33.63	Nonparametric Statistics	
Adjusted Level of Significance	0.0122	95% CLT UCL	10.35
Adjusted Chi Square Value	29.19	95% Jackknife UCL	10.85
		95% Standard Bootstrap UCL	10.13
Anderson-Darling Test Statistic	0.269	95% Bootstrap-t UCL	12.41
Anderson-Darling 5% Critical Value	0.698	95% Hall's Bootstrap UCL	21.83
Kolmogorov-Smirnov Test Statistic	0.225	95% Percentile Bootstrap UCL	10.22
Kolmogorov-Smirnov 5% Critical Value	0.333	95% BCA Bootstrap UCL	10.63
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	14.05
		97.5% Chebyshev(Mean, Sd) UCL	16.63
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	21.69
95% Approximate Gamma UCL	11.72		
95% Adjusted Gamma UCL	13.5		
Potential UCL to Use		**Use 95% Student's-t UCL**	**10.85**

Notes
1. Statistical output from ProUCL Version 4.00.04 (U.S. EPA, 2009a)

ATTACHMENT H-1c

ProUCL 4.00.04 STATISTICAL OUTPUT[1]

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

All concentrations presented in milligrams per kilogram (mg/kg)

Agricultural South			
General Statistics			
Number of Valid Observations	12	Number of Distinct Observations	12
Raw Statistics		Log-transformed Statistics	
Minimum	6.1	Minimum of Log Data	1.808
Maximum	180	Maximum of Log Data	5.193
Mean	44.65	Mean of log Data	3.281
Median	37.5	SD of log Data	1.106
SD	48.93		
Coefficient of Variation	1.096		
Skewness	2.137		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.755	Shapiro Wilk Test Statistic	0.922
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	70.01	95% H-UCL	138.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	113.9
95% Adjusted-CLT UCL	77.19	97.5% Chebyshev (MVUE) UCL	143.5
95% Modified-t UCL	71.47	99% Chebyshev (MVUE) UCL	201.6
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.882	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	50.65		
MLE of Mean	44.65		
MLE of Standard Deviation	47.55		
nu star	21.16		
Approximate Chi Square Value (.05)	11.71	Nonparametric Statistics	
Adjusted Level of Significance	0.029	95% CLT UCL	67.88
Adjusted Chi Square Value	10.65	95% Jackknife UCL	70.01
		95% Standard Bootstrap UCL	67.54
Anderson-Darling Test Statistic	0.424	95% Bootstrap-t UCL	91.3
Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	173.7
Kolmogorov-Smirnov Test Statistic	0.185	95% Percentile Bootstrap UCL	69.23
Kolmogorov-Smirnov 5% Critical Value	0.252	95% BCA Bootstrap UCL	79.67
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	106.2
		97.5% Chebyshev(Mean, Sd) UCL	132.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	185.2
95% Approximate Gamma UCL	80.68		
95% Adjusted Gamma UCL	88.7		
Potential UCL to Use		**Use 95% Approximate Gamma UCL**	**80.68**

Notes

1. Statistical output from ProUCL Version 4.00.04 (U.S. EPA, 2009a)

ATTACHMENT H-1d

ProUCL 4.00.04 STATISTICAL OUTPUT[1]

Santa Cruz Branch Line

Santa Cruz and Monterey Counties, California

All concentrations presented in milligrams per kilogram (mg/kg)

Mission Industrial Lands

General Statistics			
Number of Valid Observations	24	Number of Distinct Observations	21
Raw Statistics		Log-transformed Statistics	
Minimum	1.1	Minimum of Log Data	0.0953
Maximum	53	Maximum of Log Data	3.97
Mean	8.575	Mean of log Data	1.376
Median	2.55	SD of log Data	1.093
SD	14.43		
Coefficient of Variation	1.683		
Skewness	2.555		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.536	Shapiro Wilk Test Statistic	0.833
Shapiro Wilk Critical Value	0.916	Shapiro Wilk Critical Value	0.916
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	13.62	95% H-UCL	13.22
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	14.7
95% Adjusted-CLT UCL	15.06	97.5% Chebyshev (MVUE) UCL	18.06
95% Modified-t UCL	13.88	99% Chebyshev (MVUE) UCL	24.67
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.703	Data do not follow a Discernable Distribution (0.05)	
Theta Star	12.2		
MLE of Mean	8.575		
MLE of Standard Deviation	10.23		
nu star	33.73		
Approximate Chi Square Value (.05)	21.45	Nonparametric Statistics	
Adjusted Level of Significance	0.0392	95% CLT UCL	13.42
Adjusted Chi Square Value	20.76	95% Jackknife UCL	13.62
		95% Standard Bootstrap UCL	13.11
Anderson-Darling Test Statistic	2.771	95% Bootstrap-t UCL	20.49
Anderson-Darling 5% Critical Value	0.782	95% Hall's Bootstrap UCL	15.38
Kolmogorov-Smirnov Test Statistic	0.279	95% Percentile Bootstrap UCL	13.55
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	15.09
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	21.41
		97.5% Chebyshev(Mean, Sd) UCL	26.97
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	37.88
95% Approximate Gamma UCL	13.49		
95% Adjusted Gamma UCL	13.93		
Potential UCL to Use		**Use 99% Chebyshev (Mean, Sd) UCL**	**37.88**

ATTACHMENT H-1e

ProUCL 4.00.04 STATISTICAL OUTPUT[1]
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

All concentrations presented in milligrams per kilogram (mg/kg)

Freight House

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
Raw Statistics		Log-transformed Statistics	
Minimum	2.9	Minimum of Log Data	1.065
Maximum	52	Maximum of Log Data	3.951
Mean	18.41	Mean of log Data	2.526
Median	14.5	SD of log Data	0.995
SD	16.43		
Coefficient of Variation	0.892		
Skewness	1.336		

Warning: There are only 8 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.875	Shapiro Wilk Test Statistic	0.965
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	29.42	95% H-UCL	74.11
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	48.57
95% Adjusted-CLT UCL	30.9	97.5% Chebyshev (MVUE) UCL	61.39
95% Modified-t UCL	29.88	99% Chebyshev (MVUE) UCL	86.59
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.981	Data appear Normal at 5% Significance Level	
Theta Star	18.77		
MLE of Mean	18.41		
MLE of Standard Deviation	18.59		
nu star	15.7		
Approximate Chi Square Value (.05)	7.75	Nonparametric Statistics	
Adjusted Level of Significance	0.0195	95% CLT UCL	27.97
Adjusted Chi Square Value	6.39	95% Jackknife UCL	29.42
		95% Standard Bootstrap UCL	27.4
Anderson-Darling Test Statistic	0.194	95% Bootstrap-t UCL	35.91
Anderson-Darling 5% Critical Value	0.729	95% Hall's Bootstrap UCL	72.43
Kolmogorov-Smirnov Test Statistic	0.145	95% Percentile Bootstrap UCL	28.06
Kolmogorov-Smirnov 5% Critical Value	0.299	95% BCA Bootstrap UCL	30.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	43.73
		97.5% Chebyshev(Mean, Sd) UCL	54.69
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	76.21
95% Approximate Gamma UCL	37.3		
95% Adjusted Gamma UCL	45.23		
Potential UCL to Use		**Use 95% Student's-t UCL**	**29.42**

<u>Notes</u>
1. Statistical output from ProUCL Version 4.00.04 (U.S. EPA, 2009a)

ATTACHMENT H-1f

ProUCL 4.00.04 STATISTICAL OUTPUT[1]
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

All concentrations presented in milligrams per kilogram (mg/kg)

Industrial South

General Statistics			
Number of Valid Data	26	Number of Detected Data	24
Number of Distinct Detected Data	21	Number of Non-Detect Data	2
		Percent Non-Detects	7.69%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	3	Minimum Detected	1.099
Maximum Detected	140	Maximum Detected	4.942
Mean of Detected	22.99	Mean of Detected	2.543
SD of Detected	31.62	SD of Detected	1.043
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	1	Maximum Non-Detect	0
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.629	Shapiro Wilk Test Statistic	0.924
5% Shapiro Wilk Critical Value	0.916	5% Shapiro Wilk Critical Value	0.916
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	21.26	Mean	2.294
SD	30.94	SD	1.332
95% DL/2 (t) UCL	31.62	95% H-Stat (DL/2) UCL	43.66
Maximum Likelihood Estimate (MLE) Method		Log ROS Method	
Mean	19.77	Mean in Log Scale	2.354
SD	32.08	SD in Log Scale	1.204
95% MLE (t) UCL	30.51	Mean in Original Scale	21.31
95% MLE (Tiku) UCL	29.81	SD in Original Scale	30.9
		95% Percentile Bootstrap UCL	32.11
		95% BCA Bootstrap UCL	35.26
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.883	Data appear Lognormal at 5% Significance Level	
Theta Star	26.04		
nu star	42.38		
A-D Test Statistic	1.298	Nonparametric Statistics	
5% A-D Critical Value	0.773	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.773	Mean	21.45
5% K-S Critical Value	0.183	SD	30.21
Data not Gamma Distributed at 5% Significance Level		SE of Mean	6.053
		95% KM (t) UCL	31.79
Assuming Gamma Distribution		95% KM (z) UCL	31.41
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	31.72
Minimum	1.00E-09	95% KM (bootstrap t) UCL	43.53
Maximum	140	95% KM (BCA) UCL	33.96
Mean	21.22	95% KM (Percentile Bootstrap) UCL	31.85
Median	11.6	95% KM (Chebyshev) UCL	47.83
SD	30.96	97.5% KM (Chebyshev) UCL	59.25
k star	0.291	99% KM (Chebyshev) UCL	81.67
Theta star	73		
Nu star	15.12	**Potential UCLs to Use**	
AppChi2	7.342	**97.5% KM (Chebyshev) UCL**	**59.25**
95% Gamma Approximate UCL	43.69		
95% Adjusted Gamma UCL	45.92		
Note: DL/2 is not a recommended method.			

Notes
1. Statistical output from ProUCL Version 4.00.04 (U.S. EPA, 2009a)

ATTACHMENT H-1g

ProUCL 4.00.04 STATISTICAL OUTPUT[1]

Santa Cruz Branch Line

Santa Cruz and Monterey Counties, California

All concentrations presented in milligrams per kilogram (mg/kg)

Residential -- Santa Cruz

General Statistics			
Number of Valid Observations	28	Number of Distinct Observations	25
Raw Statistics		Log-transformed Statistics	
Minimum	1.4	Minimum of Log Data	0.336
Maximum	190	Maximum of Log Data	5.247
Mean	36.95	Mean of log Data	2.755
Median	16	SD of log Data	1.42
SD	48.1		
Coefficient of Variation	1.302		
Skewness	1.802		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.741	Shapiro Wilk Test Statistic	0.964
Shapiro Wilk Critical Value	0.924	Shapiro Wilk Critical Value	0.924
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	52.44	95% H-UCL	98.25
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	98.65
95% Adjusted-CLT UCL	55.21	97.5% Chebyshev (MVUE) UCL	123.9
95% Modified-t UCL	52.95	99% Chebyshev (MVUE) UCL	173.5
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.654	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	56.49		
MLE of Mean	36.95		
MLE of Standard Deviation	45.69		
nu star	36.63		
Approximate Chi Square Value (.05)	23.78	Nonparametric Statistics	
Adjusted Level of Significance	0.0404	95% CLT UCL	51.91
Adjusted Chi Square Value	23.14	95% Jackknife UCL	52.44
		95% Standard Bootstrap UCL	51.57
Anderson-Darling Test Statistic	0.63	95% Bootstrap-t UCL	57.88
Anderson-Darling 5% Critical Value	0.789	95% Hall's Bootstrap UCL	56.16
Kolmogorov-Smirnov Test Statistic	0.156	95% Percentile Bootstrap UCL	52.28
Kolmogorov-Smirnov 5% Critical Value	0.172	95% BCA Bootstrap UCL	55.49
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	76.58
		97.5% Chebyshev(Mean, Sd) UCL	93.73
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	127.4
95% Approximate Gamma UCL	56.93		
95% Adjusted Gamma UCL	58.51		
Potential UCL to Use		**Use 95% Approximate Gamma UCL**	**56.93**

Notes

1. Statistical output from ProUCL Version 4.00.04 (U.S. EPA, 2009a)

ATTACHMENT H-1h

ProUCL 4.00.04 STATISTICAL OUTPUT[1]
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

All concentrations presented in milligrams per kilogram (mg/kg)

Residential--Seascape

General Statistics			
Number of Valid Data	14	Number of Detected Data	14
Number of Distinct Detected Data	12	Number of Non-Detect Data	0
Number of Missing Values	1	Percent Non-Detects	0.00%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	2	Minimum Detected	0.693
Maximum Detected	100	Maximum Detected	4.605
Mean of Detected	28.94	Mean of Detected	2.695
SD of Detected	30.62	SD of Detected	1.322
Minimum Non-Detect	N/A	Minimum Non-Detect	N/A
Maximum Non-Detect	N/A	Maximum Non-Detect	N/A
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.841	Shapiro Wilk Test Statistic	0.942
5% Shapiro Wilk Critical Value	0.874	5% Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	28.94	Mean	2.695
SD	30.62	SD	1.322
95% DL/2 (t) UCL	43.43	95% H-Stat (DL/2) UCL	121.6
Maximum Likelihood Estimate (MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.735	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	39.35		
nu star	20.59		
A-D Test Statistic	0.31	Nonparametric Statistics	
5% A-D Critical Value	0.765	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.765	Mean	28.94
5% K-S Critical Value	0.236	SD	29.51
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	8.184
		95% KM (t) UCL	43.43
Assuming Gamma Distribution		95% KM (z) UCL	42.4
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	43.43
Minimum	2	95% KM (bootstrap t) UCL	48.39
Maximum	100	95% KM (BCA) UCL	41.73
Mean	28.94	95% KM (Percentile Bootstrap) UCL	42.18
Median	18.5	95% KM (Chebyshev) UCL	64.61
SD	30.62	97.5% KM (Chebyshev) UCL	80.05
k star	0.735	99% KM (Chebyshev) UCL	110.4
Theta star	39.35		
Nu star	20.59	Potential UCLs to Use	
AppChi2	11.29	**95% KM (Chebyshev) UCL**	**64.61**
95% Gamma Approximate UCL	52.78		
95% Adjusted Gamma UCL	57.38		
Note: DL/2 is not a recommended method.			

Notes
1. Statistical output from ProUCL Version 4.00.04 (U.S. EPA, 2009a)

ATTACHMENT H-1i

ProUCL 4.00.04 STATISTICAL OUTPUT[1]

Santa Cruz Branch Line

Santa Cruz and Monterey Counties, California

All concentrations presented in milligrams per kilogram (mg/kg)

Undeveloped

General Statistics			
Number of Valid Data	42	Number of Detected Data	42
Number of Distinct Detected Data	38	Number of Non-Detect Data	0
Number of Missing Values	1	Percent Non-Detects	0.00%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	2	Minimum Detected	0.693
Maximum Detected	240	Maximum Detected	5.481
Mean of Detected	30.27	Mean of Detected	2.508
SD of Detected	45.95	SD of Detected	1.388
Minimum Non-Detect	N/A	Minimum Non-Detect	N/A
Maximum Non-Detect	N/A	Maximum Non-Detect	N/A
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.622	Shapiro Wilk Test Statistic	0.846
5% Shapiro Wilk Critical Value	0.942	5% Shapiro Wilk Critical Value	0.942
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	30.27	Mean	2.508
SD	45.95	SD	1.388
95% DL/2 (t) UCL	42.2	95% H-Stat (DL/2) UCL	59.26
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.641	Data do not follow a Discernable Distribution (0.05)	
Theta Star	47.2		
nu star	53.87		
A-D Test Statistic	1.646	Nonparametric Statistics	
5% A-D Critical Value	0.797	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.797	Mean	30.27
5% K-S Critical Value	0.143	SD	45.4
Data not Gamma Distributed at 5% Significance Level		SE of Mean	7.09
		95% KM (t) UCL	**42.2**
Assuming Gamma Distribution		95% KM (z) UCL	41.93
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	42.2
Minimum	2	95% KM (bootstrap t) UCL	48.25
Maximum	240	95% KM (BCA) UCL	43.65
Mean	30.27	95% KM (Percentile Bootstrap) UCL	42.23
Median	10	95% KM (Chebyshev) UCL	61.18
SD	45.95	97.5% KM (Chebyshev) UCL	74.55
k star	0.641	99% KM (Chebyshev) UCL	100.8
Theta star	47.2		
Nu star	53.87	Potential UCLs to Use	
AppChi2	38.01	**95% KM (Chebyshev) UCL**	**61.18**
95% Gamma Approximate UCL	42.91		
95% Adjusted Gamma UCL	43.45		
Note: DL/2 is not a recommended method.			

Notes

1. Statistical output from ProUCL Version 4.00.04 (U.S. EPA, 2009a)

ATTACHMENT H-2

Human Health Risk Calculations

ATTACHMENT H-2a

EQUATIONS USED IN SCREENING LEVEL CALCULATIONS
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

INCIDENTAL INGESTION OF SOIL

$$RBSL_{Hazard} = \frac{(THQ \times RfDo \times BW \times ATnc)}{(IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg)}$$

$$RBSL_{Risk} = \frac{(TR \times (1/SFo) \times BW \times ATca)}{(IRs \times ABSos \times EFig \times ED \times CFmg\text{-}kg)}$$

DERMAL CONTACT WITH SOIL

$$RBSL_{Hazard} = \frac{(THQ \times RfDo \times BW \times ATnc)}{(SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg)}$$

$$RBSL_{Risk} = \frac{(TR \times (1/SFo) \times BW \times ATca)}{(SAs \times SAF \times ABSds \times EFdc \times ED \times CFmg\text{-}kg)}$$

INHALATION OF RESUSPENDED SOIL PARTICULATES

$$RBSL_{Hazard} = \frac{(THQ \times RfDi \times BW \times PEF \times ATnc)}{(IHRaa \times ETaa \times ABSip \times EFaa \times ED)}$$

$$RBSL_{Risk} = \frac{(TR \times (1/SFo) \times BW \times PEF \times ATca)}{(HRaa \times ETaa \times ABSip \times EFaa \times ED)}$$

ATTACHMENT H-2b

EXPOSURE PARAMETERS

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Parameter	Symbol	Units	Construction Worker	Hypothetical Future Adult Recreational User	Hypothetical Future Child Recreational User
ALL PATHWAYS					
Exposure Frequency	EF	d/yr	250	78	78
Exposure Duration	ED	yr	1	24	6
Body Weight	BW	kg	70	70	15
Averaging Time-Non-cancer	ATnc	days	365	8,760	2,190
Averaging Time-Cancer	ATca	days	25,550	25,550	25,550
INCIDENTAL INGESTION OF SOIL					
Exposure Frequency	EFig	d/yr	250	78.0	78.0
Ingestion Rate	IRs	mg/d	330	100	200
DERMAL CONTACT WITH SOIL					
Exposure Frequency	EFdc	d/yr	250	78.0	78.0
Surface Area	SAs	cm^2	3,300	5,700	2,800
Soil-to-Skin Adherence Facto	SAF	mg/cm^2	0.3	0.07	0.2
INHALATION OF RESUSPENDED SOIL PARTICULATES					
Exposure Frequency	EFaa	d/yr	250	78.0	78.0
Inhalation Rate	IHRaa	m^3/hr	2.5	1.6	1.2
Exposure Time	ETaa	hr/d	8	2	2

ATTACHMENT H-2c

EQUATIONS USED IN SCREENING LEVEL CALCULATIONS

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

CAS No.	Chemical	Log Octanol Water Coefficient (Log Kow) (unitless)	Ref	Henry's Law Constant (H) (atm-m^3/mole)	Ref	Dimensionless Henry's Law Constant (H) (unitless)	Ref	Water Solubility (S) (mg/L)	Ref	Diffusivity in Air (Di) (cm^2/sec)	Ref	Diffusivity in Water (Dw) (cm^2/sec)	Ref	Organic Carbon Partition Coefficient (Koc) (L/kg)	Ref	Molecular Weight (MW) (g/mole)	Ref	Dermal Soil Absorption (ABSds) (unitless)	Ref	Permeability Constant (Kp) (cm/hr)	Ref
7440382	Arsenic	NA	--	NA	--	NA	--	NA	--	NA	--	NA	--	NA	--	75	1	0.03	2	0.001	2

References
(1) Merk Index, 1996.
(2) U.S. EPA, 2004, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part E, Supplemental guidance for Dermal Risk Assessment), Final.

Abbreviations
-- = Not applicable
atm-m^3/mole = atmospheres -cubic meters per mole
CAS No. = chemical abstract service number
cm/hr = centimeters per hour
cm^2/sec = squared cenitmeters per second
g/mole = grams per mole
L/kg = liters per kilogram
mg/L = milligrams per liter
NA = Not available

ATTACHMENT H-2d

RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL -- CONSTRUCTION WORKER

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

CAS No.	Chemical	CSF_o $(mg/kg\text{-}d)^{-1}$	CSFd $(mg/kg\text{-}d)^{-1}$	CSF_i $(mg/kg\text{-}d)^{-1}$	RfDo (mg/kg-d)	RfDd (mg/kg-d)	RfDi (mg/kg-d)	Absorption Factor ABS (--)	Molecular Weight (g/mole)	Construction Worker Cancer (mg/kg)	Construction Worker Noncancer (mg/kg)
7440382	Arsenic	1.50E+00	1.50E+00	1.20E+01	3.00E-04	3.00E-04	4.29E-06	0.03	75	1.3E+01	7.1E+01

Abbreviations
CAS No. = chemical abstract service number
na = not available
NC = noncarcinogenic
-- = not applicable

ATTACHMENT H-2e

RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL -- FUTURE ADULT RECREATIONAL USER

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

CAS No.	Chemical	CSF_o $(mg/kg\text{-}d)^{-1}$	CSFd $(mg/kg\text{-}d)^{-1}$	CSF_i $(mg/kg\text{-}d)^{-1}$	RfDo (mg/kg-d)	RfDd (mg/kg-d)	RfDi (mg/kg-d)	Absorption Factor ABS (--)	Molecular Weight (g/mole)	Adult Recreational User	
										Cancer (mg/kg)	Noncancer (mg/kg)
7440382	Arsenic	1.50E+00	1.50E+00	1.20E+01	3.00E-04	3.00E-04	4.29E-06	0.03	75	5.7E+00	8.8E+02

Abbreviations

CAS No. = chemical abstract service number
na = not available
NC = noncarcinogenic
-- = not applicable

ATTACHMENT H-2f

RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL -- FUTURE CHILD RECREATIONAL USER

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

CAS No.	**Chemical**	**CSF_o $(mg/kg\text{-}d)^{-1}$**	**CSFd $(mg/kg\text{-}d)^{-1}$**	**CSF_i $(mg/kg\text{-}d)^{-1}$**	**RfDo (mg/kg-d)**	**RfDd (mg/kg-d)**	**RfDi (mg/kg-d)**	**Absorption Factor ABS (--)**	**Molecular Weight (g/mole)**	**Child Recreational User**	
										Cancer (mg/kg)	**Noncancer (mg/kg)**
7440382	Arsenic	1.50E+00	1.50E+00	1.20E+01	3.00E-04	3.00E-04	4.29E-06	0.03	75	2.5E+00	9.7E+01

<u>Abbreviations</u>

CAS No. = chemical abstract service number
na = not available
NC = noncarcinogenic
-- = not applicable

ATTACHMENT H-2g

RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL -- FUTURE RECREATIONAL USER

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

CAS No.	Chemical	CSF_o $(mg/kg\text{-}d)^{-1}$	CSFd $(mg/kg\text{-}d)^{-1}$	CSF_i $(mg/kg\text{-}d)^{-1}$	RfDo (mg/kg-d)	RfDd (mg/kg-d)	RfDi (mg/kg-d)	Absorption Factor ABS (--)	Molecular Weight (g/mole)	Child & Adult Recreational User Cancer (mg/kg)	Child & Adult Recreational User Noncancer (mg/kg)
7440382	Arsenic	1.50E+00	1.50E+00	1.20E+01	3.00E-04	3.00E-04	4.29E-06	0.03	75	1.7E+00	9.7E+01

Abbreviations
CAS No. = chemical abstract service number
na = not available
NC = noncarcinogenic
-- = not applicable

ATTACHMENT H-2h

SUMMARY OF RISK-BASED SCREENING LEVELS

Santa Cruz Branch Line

Santa Cruz and Monterey Counties, California

Concentrations presented in milligrams per kilogram (mg/kg)

Scenario	Risk-Based Screening Level--Cancer	Risk-Based Screening Level--Noncancer Hazard
Construction Worker	13.0	71
Recreational User	1.75	97