PORT OF OAKLAND

May 8, 2003

Mr. Barney Chan
Hazardous Materials Specialist
Alameda County Health Care Services Agency
1131 Harbor Bay Parkway, 2nd Floor
Alameda, California 94502

Re: Final Revised Sections of the Human Health Risk Assessment - Future Port of Oakland Field Support Services Complex - 2225 and 2277 Seventh Street, Oakland, California

Dear Mr. Chan:

Please find enclosed for your review and approval, the subject final revised sections of the *Human Health Risk Assessment* (HHRA) – Future Port of Oakland Field Support Services Complex (PFSSC) prepared by Iris Environmental on behalf of the Port of Oakland (Port) for 2225 and 2277 Seventh Street in Oakland, California. These final HHRA sections integrate the revisions and clarifications requested by Dr. Roger Brewer of the Regional Water Quality Control Board (RWQCB) after his review of the draft HHRA and during follow up meetings at the RWQCB office on January 27, and April 15, 2003. The final HHRA is being submitted in accordance with Alameda County Health Care Services Agency (ACHCSA) requirements for construction of the PFSSC.

Please provide your review and approval as soon as possible because ground breaking for building construction is planned for next week. We propose the following workflow to expedite distribution of this final HHRA:

- Iris Environmental prepares final HHRA sections and submits one copy to the Port. These final HHRA sections will be a set of replacement sections to incorporate into the draft HHRA binder.

- The Port submits the final HHRA sections (attached herein) to ACHCSA, with a cover letter requesting your review and approval.

- ACHCSA issues a final HHRA approval letter to the Port. Iris Environmental then prepares distribution copies of the final HHRA replacement package, incorporating the approval letter to all designated recipients, with instructions for section replacement in the distributed binders.

We trust this approach is acceptable to you. If you have any questions regarding these final replacement sections to the HHRA, or the proposed workflow, please contact me at (510) 627-1134.

Sincerely,

Jeffrey L. Rubin, CPSS, REA
Port Associate Environmental Scientist
Environmental Health and Safety Compliance

Enclosure: noted

Cc (w/o encl.): Mikhail Korsunsky (Port Engineering Dept.)
Roger Brewer (Regional Water Quality Control Board)
Rachel Hess (Innovative Technical Solutions, Inc.)
Jeff Jones (Port Environmental Health & Safety Dept.)
Roberta Schoenholz (Port Environmental Health & Safety Dept.)
Chris Alger (Iris Environmental)

IRIS ENVIRONMENTAL

Via Federal Express

May 6, 2003

Mr. Jeffrey Rubin
Associate Port Environmental Scientist
Port of Oakland EH&SC Department
530 Water Street
Oakland, California, 94607

Re: Final *Human Health Risk Assessment* for Future Port of Oakland Field Support Services Complex, 2225 and 2277 Seventh St., Oakland, California

Dear Mr. Rubin:

Iris Environmental is submitting for your use the final Port Human Health Risk Assessment – Future Port of Oakland Field Support Services Complex (PFSSC) report (HHRA) for 2225 and 2277 Seventh Street in Oakland, California. The final HHRA integrates the revisions and clarifications requested by Dr. Roger Brewer of the Regional Water Quality Control Board (RWQCB) Toxics Cleanup Division subsequent to his initial review of the draft HHRA and subsequently during meetings at the RWQCB office on January 27, and April 15, 2003.

It is our understanding that the final HHRA will be provided to Mr. Barney Chan of the Alameda County Health Care Services Agency for review and approval. The final HHRA package is designed to replace sections of the binder containing the draft HHRA.

Please feel free to contact Chris Alger at (510) 834-4747, ext. 21, with any questions or comments.

Sincerely,
Iris Environmental

Christopher S. Alger, C.E.G., Ch.G.
Principal Engineering Geologist

ATTACHMENT: Final Sections of HHRA (text, tables, and Appendix B)

TEXT

FINAL
HUMAN HEALTH RISK ASSESSMENT FOR THE FUTURE PORT OF OAKLAND FIELD SUPPORT SERVICES COMPLEX 2225 and 2277 SEVENTH STREET OAKLAND, CALIFORNIA

Prepared for:

Port of Oakland
Oakland, California

Prepared by:

IRIS ENVIRONMENTAL
Oakland, California

May 2003
Project No. 02-201-B

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LIST OF ACRONYMS

ACHCSA:	Alameda County Health Care Services Agency
ASTM:	American Society for Testing and Materials
BART:	Bay Area Rapid Transit
Cal/EPA:	California Environmental Protection Agency
CDI:	chronic daily intake
COPC:	chemical of potential concern
CSF:	cancer slope factor
CSM:	conceptual site model
DTSC:	Department of Toxic Substances Control
EPA/USEPA:	United States Environmental Protection Agency
ESA:	Environmental Site Assessment
FISCO:	Fleet Industrial Supply Center Oakland
HEAST:	Health Effects Assessment Summary Tables
HHRA:	human health risk assessment
HI:	hazard index
IRIS:	EPA's Integrated Risk Information System
JITR:	Port of Oakland Joint Intermodal Transport Railway
LBNL:	Lawrence Berkeley National Laboratory
LEL:	lower explosive limit
NOEL:	no observed effects level
OEHHA:	Cal/EPA Office of Environmental Health Hazard Assessment
PCB:	polychlorinated biphenyl
REL:	reference exposure level
RfD/RfC:	reference dose/reference concentration
SVOC:	semi-volatile organic compound
TPH:	total petroleum hydrocarbons
TPPH:	total purgeable petroleum hydrocarbons
TRT:	Three Rivers Trucking Company
UST:	underground storage tank
VOC:	volatile organic compound

EXECUTIVE SUMMARY

Iris Environmental prepared this baseline human health risk assessment (HHRA) on behalf of the Port of Oakland ("the Port"), to support the design, engineering, construction, and safe future use of the proposed Field Support Services Complex ("the Complex") on the subject Site ("the Site"). This HHRA focuses on the construction and future use of the Complex. As such, the HHRA was designed with the express purpose of providing a highly conservative technical analysis of the human health impacts associated with on-site exposures resulting from these activities. The Site is approximately 12 acres in size and is located at 2225 and 2227 Seventh Street, immediately west of Maritime Street and south of the adjacent Bay Area Rapid Transit (BART) right-of-way, on Port property in Oakland, California (Figure 1). Approximately eight acres of the Site are designated for construction of the Complex.

The proposed project involves the demolition of two existing structures and one-quarter of a third structure, the excavation of existing building footings and demolition debris, the importation of clean fill, and the construction of a new Field Support Services Complex.

The purpose of this risk evaluation is to determine whether the residual chemicals at the Site could adversely impact human health during development (construction) and throughout the proposed future use of the Site. Specifically, this report assesses the human health risks associated with possible exposures to Port employees from chemicals detected in soils, soil gas, and groundwater during the March 2002 Phase II investigation of the Site (Iris Environmental, 2002a). As exposure to these chemicals of potential concern (COPCs) could potentially occur both during Site development and future use of the Complex, the health risks associated with the development and future land use phases are both evaluated.

Three different populations of Port workers were evaluated for each land use phase. During the development phase, it was assumed that the populations that may be exposed to COPCs included:

- On-Site construction workers involved in the development.

Following development, when the Complex is in use, it was assumed that the populations who could become exposed to chemicals present at the Site after the development is complete included:

- On-Site commercial workers (e.g., Port employees working in and around the proposed structure) who will be using the Complex (structure and grounds); and

- On-Site intrusive workers (e.g., Port utility workers installing, repairing, or removing utility lines in trenches at the Site). Exposure of Port utility workers to COPCs is assumed to be similar to on-Site construction workers.

In order to assess the positive impact of proposed mitigation measures being incorporated into the development, the Site was first evaluated under worst-case baseline conditions (the "baseline evaluation"), where specific design elements that will be incorporated into the Site development are not included. These specific design elements include the planned passive soil venting systems that will be placed beneath the proposed building and the asphalt cap that will completely cover the Site. The Site was then evaluated under the proposed Site development

conditions (the "Site development evaluation") reflective of and consistent with the aforementioned design elements. Note that these design elements will only affect the evaluation of the commercial worker scenario.

All COPCs are evaluated based on their potential to cause cancer or chronic noncancer health effects in human populations under the development and future land use exposure scenarios. Select volatile organic compounds (VOCs) were also evaluated for potential explosive hazards. Furthermore, the generation of methane at the Site was evaluated as an additional transport mechanism that may potentially enhance chemical transport of VOCs.

In preparing this HHRA, Iris Environmental used standard risk assessment techniques and regulatory assumptions recommended by the United States Environmental Protection Agency (USEPA) and the California Environmental Protection Agency (Cal/EPA), as well as conservative modeling approaches. Given the multiple conservative assumptions, the potential health risks presented in this analysis are likely overestimates of the actual risks that may be associated with the proposed development project. Risk assessment results for the three receptor populations identified in Section 3.2 are summarized in the table and bullets on the following page.

Baseline Evaluation Results				
Exposure Scenarios	Cancer Risk (1)	Noncancer HI (2)	Cumulative Explosive Hazard Ratio (3)	Odor Nuisance (4)
Development Phase				
On-Site Construction Worker (Intrusive)	9.21×10^{-06} (5)	4.21	0.004	5.41
Future Land Use Phase				
On-Site Commercial Worker	2.72×10^{-5}	0.35	0.00011	0.11
On-Site Intrusive Worker	3.83×10^{-6}	0.03	0.0002	0.48
Site Development Evaluation Results				
Future Land Use Phase				
On-Site Commercial Worker	8.49×10^{-6}	0.16	0.00011	0.10

Note:

(1) Cancer Risk is defined as the incremental probability that an individual will develop cancer over the course of a lifetime as a result of exposure to the potential carcinogen. The USEPA defines the upper range of acceptable cancer risks to be between 1 per 10,000 (1E-04, or 10^{-4}) and 1 per 1,000,000 (1E-06, or 10^{-6}). (The USEPA "acceptable risk range" is the upper range of probabilities for cancer risk which USEPA applies to federally regulated sites.) The maximum risk level generally considered acceptable by Cal/EPA DTSC and regulatory agencies such as the RWQCB is 1 in 100,000 (1E-5, or 10^{-5}).

(2) Noncancer HI (Hazard Index) is the parameter used to evaluate the potential for adverse noncancer health effects. The HI represents a ratio of the projected exposure to an "acceptable" level of exposure; the USEPA defines the acceptable Noncancer Hazard Index as 1.0 or less (i.e., the projected exposure is below the "acceptable" exposure).

(3) Cumulative explosive hazard ratio is the parameter used to evaluate potential levels of combustible gases/vapors. It is the sum of ratios of the predicted combustible gas concentrations to the chosen hazard thresholds. Explosive hazard thresholds are not regulated by USEPA or Cal/EPA DTSC.

(4) Odor nuisance is established by the 50% odor recognition level published by the Massachusetts Department of Environmental Protection (MADEP). A value greater than 1 indicates a likelihood that a majority of exposed populations will detect nuisance odors.

(5) 9.21×10^{-6} is scientific notation approximately equivalent to the fraction 1/108,600 ($9.21 \times 10^{-6}/1 = 1/108,600$; a calculated incremental cancer risk of 1 per 108,600 can thus be interpreted).

1. Baseline incremental cancer risks estimated for on-Site construction workers during development and on-Site commercial and intrusive workers during future use, respectively, are 9.21×10^{-06}, 2.72×10^{-05}, and 3.83×10^{-06}. These risks are all within USEPA's acceptable risk range of 1×10^{-4} to 1×10^{-6}. Note that risks associated with risk levels below 1×10^{-6} are also "acceptable"; indeed, these risks are considered insignificant. The risks for construction workers are below 1×10^{-5}, a risk level generally considered acceptable by Cal/EPA DTSC for commercial land-use scenarios. Incorporating planned Site development design elements

such as passive vapor controls and the Site-wide asphalt cover into the risk analysis results in cancer risks below 1 x 10^{-5} for future on-site commercial workers as well.

2. Exposures to noncancer agents result in noncancer HIs within health guidelines (i.e., less than one) for the on-Site commercial worker and intrusive worker. The noncancer HI for the on-Site construction worker is above the health guideline. For construction workers, exposures will be mitigated through standard health and safety practices that will be documented within the Health and Safety Plan and an appropriate Risk Management Plan (RMP);

3. The predicted worst-case steady state on-Site concentrations of explosive vapors are below the respective lower explosive limits (LEL) with a safety factor of ten. While actual explosive hazard to the on-Site intrusive and construction worker is likely low, potential hazards as instantaneous/acute exposure to in-site levels of flammable gases will be mitigated by an appropriate RMP; and,

4. Nuisance odor evaluation indicates that on-Site construction workers may experience undesirable odors. The Health and Safety Plan and the RMP will be developed to address potential odor issues.

1.0 INTRODUCTION AND OBJECTIVES

Iris Environmental prepared this human health risk assessment on behalf of the Port of Oakland ("the Port"), in support of the design, engineering, construction, and future use of the proposed Field Support Services Complex and associated grounds ("the Complex" and "the Site," respectively). The Site is approximately 12 acres in size and is located at 2225 and 2227 Seventh Street, immediately west of Maritime Street and south of the adjacent Bay Area Rapid Transit (BART) right-of-way, on Port property in Oakland, California (Figure 1). Approximately eight of the 12 acres are designated for the Complex.

The proposed project involves the demolition of two existing structures and one-quarter of one structure, the excavation of existing building footings and demolition debris, the importation of clean fill, and the construction of a new Complex, to be used by the Port for field services and associated support activities.

The purpose of this risk evaluation is to determine whether the residual chemicals at the Site could adversely impact human health during development and proposed future use of the Site. Specifically, this report assesses the human health risks associated with possible exposures to Port employees from chemicals detected in soils, soil gas, and groundwater during the March 2002 Phase II investigation of the Site (Iris Environmental, 2002a). As exposure to these chemicals of potential concern (COPCs) could potentially occur both during Site development and future use of the Complex, the health risks associated with the development and future land use phases are both evaluated.

The Site was also evaluated under worst-case baseline conditions (the "baseline evaluation"), where specific design elements that will be incorporated into the Site development are not included. These specific design elements include the planned passive soil venting systems that will be placed beneath all constructed buildings and the asphalt cap that will completely cover the Site. The Site was then evaluated under actual Site development conditions (the "Site development evaluation") reflective of and consistent with the aforementioned design elements. Note that these design elements will only affect the evaluation of the commercial worker scenario.

All COPCs are evaluated based on their potential to cause cancer or chronic noncancer health effects in human populations under the development and future land use exposure scenarios. We also evaluated select volatile organic compounds (VOCs) for potential explosive hazards. Furthermore, the generation of methane at the Site was evaluated as an additional transport mechanism that may potentially enhance chemical transport of VOCs.

The methodology used in this HHRA is consistent with risk assessment guidelines provided by the United States Environmental Protection Agency's (USEPA) *"Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final"* (USEPA 1989) and by the California Environmental Protection Agency (Cal/EPA), Department of Toxic Substances Control's (DTSC) "*Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities*" (Cal/EPA 1992). As described by USEPA, a human health risk assessment estimates the potential for adverse health effects to occur as a result of exposure to COPCs. According to the USEPA (1989), and as summarized

below, there are four basic steps in the quantitative human health risk assessment process: (1) data collection and analysis, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization. These steps are summarized briefly as follows:

- Data Collection and Analysis: For this HHRA, environmental sampling data from the 2002 Phase II ESA were reviewed to identify COPCs and their concentrations at the Site;
- Exposure Assessment: Site physical features were evaluated to develop a conceptual Site model which identifies the pathways by which potential receptors could potentially be exposed to Site-specific constituents. The magnitude of the potential human exposures was estimated;
- Toxicity Assessment: This phase of the risk assessment presents the relationship between the magnitude of exposure and potential adverse effects (dose-response assessment). As a part of the toxicity assessment, toxicity values were determined or derived and were then used to estimate the likelihood of adverse effects which potentially could occur at different exposure levels; and,
- Risk Characterization: The exposure and toxicity assessments were combined to characterize and quantify the potential for adverse health effects as a result of potential Site-specific exposures. The risk characterization estimates the likelihood that the estimated potential exposures to COPCs at the Site will result in either cancer or other noncancer adverse health effects.

The remaining sections of this report are as follows: Section 2.0 provides descriptions of the Site and the proposed project, and summarizes sampling activities that have been conducted at the Site. Section 3.0 identifies the populations that may potentially be exposed to Site COPCs, and the pathways by which potential exposures may occur. Section 4.0 identifies the COPCs that have been included in this HHRA. Section 5.0 presents the methodology for estimating representative exposure concentrations for chemicals present in soil, soil gas, and groundwater. Section 6.0 presents the toxicity values and explosive limits used in the calculation of the cancer risks, noncancer hazard indices, and explosive hazards. Section 7.0 presents the methodology used to calculate the cancer risks, noncancer hazard indices, and explosive hazards and summarizes the results of the HHRA. The references used in this report are presented in Section 8.0. There are four Appendices that accompany the report. Appendix A presents the data collected during the Phase II ESA, from which a representative subset was selected to characterize the representative concentrations present in the Site media. Appendix B presents the modeling used by Iris Environmental to estimate the mass flux emissions of COPCs from the Site and the corresponding predicted air concentrations to which the various human populations may be exposed, and Appendix C discusses the uncertainties inherent in the health risk assessment. The output from LEADSPREAD, the Cal/EPA DTSC-developed model used to evaluate potential health effects from exposure to lead, is presented in Appendix D.

2.0 SITE CHARACTERIZATION

This section provides a brief description of the Site layout and other physical features, as well as a summary of the development and proposed future land use of the Site. This information is used as the basis for identifying the exposure pathways that are relevant at the Site. In addition, previous and recent Site investigation activities are discussed below.

2.1 Site Location

The Site is approximately 12 acres in size and is located at 2225 and 2227 Seventh Street, immediately west of Maritime Street and south of the adjacent Bay Area Rapid Transit (BART) right-of-way, on Port property in Oakland, California (Figure 1). Access to the Site is from Maritime Street.

2.2 Site Description

The Site is generally surrounded by railroad, trucking, ocean shipping, and other facilities used for freight transportation. The Site is bound by the Port's Joint Intermodal Transport Railway (JITR) and the Bay Area Rapid Transit (BART) right-of-way to the north (just south of Seventh Street), Maritime Street to the east, and Port-owned (but former Navy Fleet Industrial Supply Center Oakland [FISCO]) property to the south and west, as shown on Figure 2. Thus, the human populations present in areas surrounding the Site are industrial/commercial workers; there is no nearby residential land use. As part of the Port's Vision 2000 expansion plan, the areas to the south and west have been raised approximately three to five feet relative to the Site with fill dredged from the Oakland estuary.

The Site is currently paved and relatively flat. The current description of the Site encompasses three Port-owned buildings (Figure 2) that are scheduled for demolition or modification prior to development of the Complex:

- Port Building C-401 is located at 2277 Seventh Street, in the northern portion of the Site. The building is approximately 44,000 square feet. Approximately 75% of the structure is a raised, open-walled transloading platform now leased by Three Rivers Trucking Company (TRT). Approximately 25% of the structure is office space and vehicle maintenance bays which will be demolished;

- Port Building C-407 is located at 2277 Seventh Street in the center of the Site. The building is approximately 19,000 square feet, and is currently vacant. The building contains an unused truck wash, several open truck bays, and a warehouse area with offices on a mezzanine level; and

- Port Building C-406 is located at 2225 Seventh Street on the eastern side of the Site. The building is approximately 28,000 square feet. The northern two-thirds are unused and damaged by fire (loading dock and former multi-floor office space), and the southern third was used until recently as a loading dock by TRT.

The history of these buildings and past Site use is presented in Section 2.4.

2.3 Planned Development and Future Use

The planned development and proposed future use of the Site includes the demolition of Building C-406 and Building C-407, demolition of the eastern one-quarter of Building C-401, and the removal of demolished structure footings and excavation of the asphalt pavement. Following demolition, the overall grade at the Site will be raised through the importation of one to two feet of clean fill. Construction of the Complex will encompass an eight acre portion of the Site, located on the eastern portion of the Site. The conceptual layout of the Complex is illustrated by the Port Development Plan presented in Figure 3. Development of the Complex will last approximately 6 months (120 construction days). A brief description of the development activities (obtained from the Port) is summarized below.

2.3.1 Demolition

Buildings C-406 and C-407 will be completely demolished, and the eastern one-quarter of Building C-401 (the enclosed office portion of the structure) will be demolished. All debris will be transported off-Site for disposal. The footings of all demolished structures will be removed and transported off-Site for disposal. The monitoring well free-product recovery system has recently been relocated to avoid potential damage during demolition.

2.3.2 Excavation of Pavement and Importation of Fill

Approximately eight acres of pavement will be removed to prepare the Site for imported fill and regrading. The exposed surface and building footing excavations will be covered with clean imported fill and re-graded to provide adequate drainage. The overall effect will be to raise the average height of the Site approximately one and one-half feet.

2.3.3 Construction

Approximately eight acres of the Site will be dedicated to the Complex. The proposed size of the structure is 61,000 square feet. A passive soil vapor venting system with a permeable sand and gravel layer below the structure footprint will allow for enhanced control of volatile subsurface chemicals. The rest of the Site will then be completely paved over with asphalt.

2.4 Site History

All information contained in the Site History section of this report was obtained from the Phase I ESA (Iris Environmental, 2002b). Complete references and further information may be found in the Phase I ESA.

2.4.1 Pre-demolition Building History

Prior to demolition activities, the Site includes three buildings that are owned by the Port of Oakland (Figure 2). These buildings are evident on a 1989 aerial photograph, but were likely constructed at least 25 years ago. Aerial photographs dated 1949 and 1959 indicate that railroad tracks and freight storage were located on the Site. Aerial photos between 1959 and 1989 were unavailable. Descriptions of these buildings are included below for reference.

2.4.1.1 C-401 (2277 Seventh Street)

Building C-401 was vacant and unused until recently, when TRT moved into the western portion of the building. The building was last occupied by Pacific Container Company (PCC), and was occupied by SeaLand prior to PCC. The building was occupied by Shippers Imperial prior to SeaLand.

The eastern end of building C-401 was formerly used for truck repair and has several service bays with roll-up doors. Office space is also located in the eastern end of the building. The western portion of the building has an elevated floor, corrugated steel roof, and no walls, and was formerly used as a loading dock.

Four underground storage tanks (USTs) were removed from the area adjacent to the south side of Building C-401 in 1993, as shown on Figure 2. An active product recovery system is located adjacent to the south side of the building. The system was installed in 1996 to collect free product from an active skimmer in one groundwater monitoring well (MW-3 at 2277 Seventh Street) and a passive skimmer installed in one groundwater monitoring well (MW-1 at 2277 Seventh Street). The monitoring wells are used to extract free product associated with releases from the former USTs. Alameda County Health Care Services Agency (ACHCSA) is currently the lead regulatory agency for the Site.

2.4.1.2 C-406 (2225 Seventh Street)

The Port reacquired the lot and building from lessee Dongary Investments in June 1999 after it had been damaged by fire in late 1997 or early 1998. The northern two-thirds of Building C-406 were damaged in the fire, including the two-story office space portion near the center of the building.

2.4.1.3 C-407 (2277 Seventh Street)

Building C-407 is separated into three distinct sections by one fixed and one temporary wall. The middle and western sections were vacated in early 2002 by a hotel operator which used the building to store furniture and durable goods. The eastern portion of Building C-407 was formerly used as a truck washing and maintenance facility. A drive-through truck wash is located in the eastern end of the building. The washing facility has been out of use for at least four years. A vehicle maintenance pit, which is currently covered by plywood, is located inside the eastern portion of the building. The maintenance pit is approximately four feet wide, 40 feet long, and 5 feet deep.

The building was formerly subleased from Dongary Investments to SeaLand and became part of the operations at 2277 Seventh Street. A total of nine USTs were removed from the area adjacent to the northeast and east sides of Building C-407 in 1990 and 1992. Alameda County Health Care Services Agency (ACHCSA) is currently the lead regulatory agency for the Site.

Currently, the road located adjacent to the Site to the east is Maritime Street. A vacant lot is located west of the Site, but a bridge (the BART/JITR "flyover") and roadway (former extension

of Maritime Street) extended along the west side of the Site until their demolition was completed in July 2000. Maritime Street and Middle Harbor Road were rerouted as part of the Port's Vision 2000 plan, and the flyover bridge and roadway were removed at that time.

2.4.2 Underground Storage Tanks and Free-Phase Product

A total of nine USTs were removed from an area adjacent to Building C-407 in 1990 and 1992, including a "nest" of seven diesel tanks and two oil tanks. Free product diesel has been recovered from an active pumping system located adjacent to Building C-401 since the excavation of the tanks. Quarterly monitoring is currently conducted by Harding ESE. Alameda County Health Care Services Agency (ACHCSA) is currently the lead regulatory agency for the Site.

Four USTs were removed from the area adjacent to the south side of Building C-401 in September 1993. Holes from corrosion were noted in some of the excavated tanks, and free product was noted on the surface of groundwater during excavations and investigations (Uribe, 1994). Previous soil and groundwater investigations have identified the presence of a diesel fuel plume containing free product between Buildings C-407 and C-401 (see Figure 4).

A recovery system connected to monitoring wells is part of ongoing mitigation efforts. A quarterly groundwater monitoring report from late 2001 (Harding ESE, 2001) noted measurable free product in the two wells used for product recovery at the 2277 Seventh Street area. The active skimmer in one well (MW-3) had removed in excess of 7,000 gallons of product between December 1997 and mid-2001, and product thickness in the same well in the first seven months of 2001 ranged from 1.25 to 1.50 feet. The quarterly monitoring report also indicated measurable quantities (in at least one well) of the following compounds: total petroleum hydrocarbons (TPH) as gasoline, TPH as diesel, benzene, toluene, ethylbenzene, xylenes, and methyl tertiary butyl ether (MTBE).

An expanded free product recovery system is proposed to replace the existing system. Seven recovery wells equipped with pneumatic, self-controlled free product skimmer pumps and eight replacement groundwater monitoring wells are proposed for the redeveloped Site in order to continue the mitigation and Site monitoring program (ITSI, 2002).

Data obtained from monitoring wells associated with the recovery system have been supplemented by data obtained during the Phase II ESA (Iris Environmental, 2002a). When free product was encountered during the Phase II ESA, Innovative Technical Solutions, Inc. (ITSI) collected product samples and logged findings. Results are found in the *Additional Site Characterization and Remedial Action Plan for 2225 and 2277 Seventh Street, Oakland, California* (ITSI, 2002). ITSI identified the plume as consisting generally of medium range boiling point petroleum hydrocarbons, such as diesel or kerosene. Migration of free product appears to have been retarded by low permeability sediments in the plume region (ITSI, 2002). A figure in ITSI 2002 (duplicated as Figure 4) indicates a region of free product at least three inches thick between Building C-401 and Building C-407. An area of trace plume thickness extends from the area adjacent to the south side of Building C-401 to the area near the southeast corner of Building C-407 and the northern half of Building C-406 (see Figure 4).

2.5 Geology and Hydrogeology

The geology and hydrology of the Site was most recently characterized during the Phase II ESA (Iris Environmental, 2002a), and the information presented below was obtained from the Phase II ESA.

2.5.1 Underlying Geologic Materials

Until recently, the entire Site was covered either with asphalt pavement or buildings. The asphalt pavement was typically an inch or two thick with several inches to a foot of underlying base rock. Soil materials encountered beneath the base rock consisted of various types of imported fill materials placed over Bay Mud-type soils. The Site was known to have been constructed on hydraulically placed dredge spoils, and these materials were encountered in each of the 46 borings. An additional fill material was encountered in several borings above the dredged materials. This upper fill material was a heterogeneous, interlayered mix of gravel, sand, and silt that often contained demolition debris (bricks, wood fragments, glass, and slag-like waste).

Bay Mud was encountered at the Site at depths ranging from approximately 8.5 feet below ground surface (bgs), in boring MFC-13 located south of Building C-401 in the central portion of the Site, to 11 feet bgs in the boring MFC-45, located near the southeastern-most property boundary. The coloration of the Bay Mud varies from olive gray to greenish gray. Muds and clays generally have low permeabilities, theoretically restricting vertical groundwater migration and limiting horizontal migration. For the purposes of this risk assessment, we have assumed for the baseline evaluation that the soils at the Site may be conservatively represented by loamy sand.

Site soil total porosity, soil water-filled porosity, soil bulk density, and soil organic carbon fraction were assumed to be the same as the site-specific values developed for the adjacent Berths 23 and 24 site (Treadwell & Rollo 2002).

2.5.2 Hydrogeological Setting

Based on a review of the 1993 Oakland West USGS topographic map, ground elevation at the Site is less than ten feet above mean sea level. The topography of the Site is generally flat. The Site was developed in the 1930s using hydraulically-placed dredge sediments. The nearest surface water, which is located approximately one-half mile northwest of the Site, is the Oakland Outer Harbor, which is part of the San Francisco Bay. The Oakland Middle Harbor and Inner Harbor Channel are also located approximately one-half mile west and south of the Site, respectively.

Groundwater was typically encountered during Phase II drilling activities from 4.5 feet bgs to 13.0 feet bgs. Groundwater was notably depressed in areas under the building footprints. Groundwater was not encountered at several boring locations (MFC-10, MFC-24, MFC-30, MFC-32 and MFC-42). In areas where temporary wells were installed, it was noted that the general recharge of groundwater was slow and it was often difficult to collect enough groundwater for the entire analytical bottle set. Additional information on groundwater

elevations at the time of drilling is noted on the boring logs found in the Phase II ESA. For the purposes of this risk assessment, the depth to groundwater was determined based on site specific data: to estimate the flux of COPCs from groundwater to the surface, an average depth of groundwater across the Site of 8.75 feet was used; to estimate the flux from groundwater to the Complex, the average groundwater depth below the Complex (7 feet) was used.

Storm water runoff at the facility is currently discharged to storm drains located in the paved areas on the Site. Storm drains discharge to the San Francisco Bay.

2.6 Site Investigation Activities

The Site has been the subject of multiple soil and groundwater investigations over the past decade. Investigation of the Site in the 1990s followed the removal of 13 underground storage tanks (USTs) from 1990 to 1993. These investigations focused exclusively on total petroleum hydrocarbons and do not address the Site as a whole, or address other potential COPCs. Therefore, these investigations are inadequate for use in this risk assessment: they are briefly discussed below. To assess the COPCs that may be present at the Site and to thoroughly understand the lateral and vertical extent of said COPCs across the Site, Iris Environmental and the Port in 2002 implemented an expanded environmental Site assessment, or Phase II (Iris Environmental, 2002a). This Phase II is discussed in detail below.

2.6.1 Previous Investigations (1993-2002)

Iris Environmental identified a number of investigations and reports and used the following select documents for investigating the extent of TPH in Site soils and groundwater following the excavation of the USTs and the discovery of associated releases:

- Ramcon Engineering and Environmental Contracting (1993), *Soil and Groundwater Site Assessment: Dongary Investments—Oakland*;
- Uribe & Associates (1994), *Report of Additional Investigation and Groundwater Monitoring Well Installation and Sampling at 2277 Seventh Street, Oakland, California*; and
- Harding ESE (2001), *Third Quarter 2001 Quarterly Groundwater Monitoring and Product Recovery Report, 2277 and 2225 Seventh Street.*

These reports address activities and Site conditions directly related to the USTs removed from the Site and potential impacts to the Site from leaks associated with these tanks. Laboratory analysis of samples collected during this effort was limited to total petroleum hydrocarbons (TPH). Free-phase hydrocarbons in soil and dissolved-phase hydrocarbons (primarily as diesel fuel-grade petroleum hydrocarbons, but with some gasoline-grade petroleum hydrocarbons) were identified in soil and groundwater at the Site in these investigations, and a monitoring and extraction system was designed and implemented to address TPH impacts at the Site. The investigations were focused on hydrocarbon impacts in the vicinity of the former USTs. In order to further characterize the hydrocarbon impacts, the following investigation listed below was conducted in early 2002:

- Innovative Technical Solutions, Inc. [ITSI] (2002), *Additional Site Characterization and Remedial Action Plan, 2225 and 2277 Seventh Street, Oakland, California.*

The ITSI report focused on identification of the condition and extent of the free-phase and dissolved-phase petroleum hydrocarbon plumes and fuel fingerprinting of product samples. Again, sample collection was limited to the vicinity of the former USTs and laboratory analysis of samples collected during this effort was limited to TPH.

2.6.2 Rational for Focused Investigation

Upon review of the Site investigations mentioned above, it was determined that the analytic data was inadequate for a complete baseline HHRA, as the dataset was based solely on petroleum-related investigations and TPH analyses, did not attempt to characterize other potential chemicals of concern, and did not adequately investigate other areas of the Site away from the TPH releases. Therefore, the ACHCSA-approved Phase II ESA Workplan (Iris Environmental, 2002c) was developed with the following objectives:

- evaluation of Site media for a comprehensive set of hazardous chemicals, including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), total petroleum hydrocarbons (TPH), and metals;

- definition of the lateral and vertical extent of the existing hydrocarbon plume in both soil and groundwater; and

- characterization of media likely to be encountered during Site development and during future Site use, to support risk assessment for redevelopment planning.

By meeting these objectives, the dataset collected during the Phase II ESA is the only dataset that includes a comprehensive list of COPCs and adequately characterizes all parts of the Site. Therefore, the data from the 2002 Iris Environmental Phase II ESA was the only dataset that could be used to estimate chemical concentrations for the purpose of exposure modeling and human health risk assessment. A complete summary of the data collected as a part of this Phase II ESA, illustrating the extent and breadth of the sampling conducted, is presented below.

2.6.3 Summary of Phase II Sampling (2002)

Subsurface data for the Phase II ESA (Iris Environmental, 2002a) were collected during a single sampling event conducted from March 25 through March 28, 2002. A total of 46 borings were drilled as part of the program. Locations of borings are presented on Figure 2. During the investigation, an on-Site mobile laboratory was used to analyze selected samples to provide real time data on sample concentrations of VOCs and TPH. The sample collection locations could then be adjusted as necessary to refine the field investigation. An off-Site laboratory was used for the remaining analyses. Chemical analyses included TPH, and VOCs, as well as SVOCs, metals, and fixed gases (including methane). As polychlorinated biphenyls (PCBs) were not previously detected at the Site, they were not included in the Phase II list of analytes. No history of pesticide use or storage was identified in the Phase I ESA, and therefore pesticides were not considered in Phase II ESA analyses.

Table 2-1 provides an overall summary of all sample collection and chemical analyses from the Phase II ESA. Table 4-2, presented in Section 4.0 of this report, presents a detailed summary

and breakdown of the results of analytical testing of samples collected during the Phase II sampling event.

In this section, the recent Phase II Site investigation activities undertaken at the Site are presented. This includes soil sampling, groundwater sampling, and soil gas sampling. Each section discusses the locations of sampling, the number of samples collected, and the laboratory methods used to analyze the samples.

2.6.3.1 Soil Sampling

Between one and three soil samples were collected from each of the 46 boring locations advanced during the Phase II investigation for laboratory analysis. In general, a shallow soil sample was collected from a depth of approximately 0.5 feet below ground surface (bgs), an intermediate sample was collected from approximately 2.5 feet bgs, and a deeper sample was collected from approximately 5.5 feet bgs. Samples analyzed for SVOCs were vertically composited at each sample location for analysis due to cost considerations. Additional soil duplicate samples were collected for quality control analyses. Soil samples collected from saturated materials were not submitted for chemical analyses.

Soil samples collected during this investigation were tested for various chemical compounds as summarized in Table 2-1. Soil samples from each boring were analyzed for TPH as gasoline, diesel, kerosene, jet fuel, and motor oil (TPHg/d/k/j/mo, respectively) by EPA Method 8015M; VOCs by EPA Method 8260/8260B; SVOCs by EPA Method 8270; and Title 26 Metals by EPA Methods 6010, 6020, 7471, and 7196A. Selected samples were also analyzed for organic lead by the California Leaking Underground Storage Tank (LUFT) Method. Select soil samples were tested for TPHg using EPA Method 8260G by Mobile Chem Laboratory. Phase II ESA soil chemical data tables are presented in Appendix A.

2.6.3.2 Groundwater Sampling

Grab groundwater samples were collected through temporary PVC well casings set into twenty-five selected boreholes immediately after soil sample collection. Water sample locations were distributed across the Site and groundwater sampling was subject to the ability to drill to groundwater and collect a sufficient amount of water. The temporary wells were constructed using factory cleaned, two inch diameter PVC casing with machine cut slots. Each temporary well was allowed to equilibrate for a minimum of forty-five minutes prior to sampling. The upper water column was observed for evidence of free product prior to sampling. If free product thickness greater than a sheen was present, a free product sample was collected by ITSI. The groundwater samples were collected from the temporary wells using a pre-cleaned, PVC disposable bailer. Groundwater was transferred directly from the bailer into sampling containers provided by the laboratory.

Groundwater samples collected during this investigation were tested for various chemical compounds as summarized in Table 2-1. Groundwater samples were analyzed for TPHg, TPHd, TPHk, TPHj, and TPHmo by EPA Method 8015M; VOCs by EPA Method 8260/8260B; SVOCs by EPA Method 8270; and organic lead by the CA LUFT Method. Phase II ESA groundwater chemical data tables are presented in Appendix A.

2.6.3.3 Soil Gas Sampling

Twenty-four soil gas samples were collected from selected boring locations for chemical analyses. Soil gas was collected at a depth of approximately 4.0 feet bgs in both Tedlar sample bags and Summa canisters. Each soil gas sample set was collected directly through Teflon™ tubing routed down a 1-inch diameter drill rod and connected to a sealed, retractable tip. The drill rod was advanced to approximately 4.0 feet bgs and retracted a short distance to open the tip and expose the soil interface. A calculated volume of air was then purged from the tubing and borehole space using a vacuum pump. Tedlar bag samples were collected using a differential pressure chamber connected to the vacuum pump. The Tedlar bag was placed in the chamber, connected to the sample tubing, and opened. As the chamber is evacuated and pressure dropped below ambient soil pressure levels, soil gas flowed into the bag. After filling the Tedlar sample bag, the sample tubing was closed and transferred to an evacuated Summa canister for additional sampling. Samples collected in Tedlar sample bags and Summa canisters were transported under chain-of-custody protocol to STL San Francisco for chemical analysis.

Soil gas samples collected during this investigation were tested for various chemical compounds as summarized in Table 2-1. Soil gas samples were analyzed for VOCs by EPA Method 8260; methane and fixed gases by ASTM Method D1946; and total purgeable petroleum hydrocarbons (TPPH) (gasoline) by Standard Method TO-3. Phase II ESA soil gas chemical data tables are presented in Appendix A.

2.6.4 Nature and Extent of Chemical Impacts

As summarized in the Phase II, results of the soil, groundwater, and soil gas sampling conducted identified a pattern of chemical impacts that are consistent with past Site use and known petroleum hydrocarbon releases from USTs. Free product distribution patterns characterized by ITSI (2002) and included on Figure 4 are consistent with gradient-driven groundwater transport of separate-phase petroleum hydrocarbon releases from known UST locations. Distributions of TPHg in soil gas, TPHg and TPHd in groundwater, and TPHd and TPHmo in soil suggest a broader pattern of petroleum hydrocarbon releases or migration than is evidenced by the free product distribution pattern. This broader pattern may be the result of fluctuating groundwater flow directions and elevation over time that expanded the distribution of dissolved phase hydrocarbons beyond the free product plume area.

Low level concentrations and inconsistent distributions of VOCs and SVOCs observed in the sampling results did not identify a clear source area for the detected chemicals. The areal extent of VOC and SVOC detections in soil and groundwater samples does coincide roughly with the TPH detection pattern in soil and groundwater, although no systematic area of elevated concentrations was identified.

TPHg and methane detections in soil gas were relatively consistent to the pattern of free product. Soil gas patterns followed the observed deflection of the free product plume westward along the southern edge of Building C-401, suggesting that geologic and possibly building foundation controls have an effect on chemical migration in this area.

3.0 IDENTIFICATION OF POTENTIALLY EXPOSED POPULATIONS AND EXPOSURE PATHWAYS

To determine whether the levels of constituents present at the Site could pose a risk to human health, it is necessary to identify both the populations that may be present in the area and the pathways through which potential exposures may occur. The identification of the potentially exposed populations is based upon the human activities and land use patterns at and around the Site. Once the potentially exposed populations are identified, the complete pathways by which the individuals may be exposed to chemicals present at the Site must be determined.

An exposure pathway is defined as "the course a chemical or pollutant takes from the source to the organism exposed" (USEPA 1988). An exposure route is "the way a chemical or pollutant enters an organism after contact" (USEPA 1988). A complete exposure pathway requires four key elements: on-Site chemical sources; release mechanism and transport pathway; an exposure point for contact (i.e., fill, air, or water); and human exposure routes (i.e., oral, dermal, inhalation). An exposure pathway is not complete unless all four elements are present. Conceptual Site Models (CSMs) are used to show the relationship between chemical sources, exposure pathways, and potential receptors for a Site. These source-pathway-receptor relationships provide the basis for the quantitative exposure assessment. Only complete source-pathway-receptor relationships are included in this HHRA.

As we have evaluated the Site under both under worst-case baseline conditions and actual Site development conditions, the exposure pathways for the commercial worker scenario will vary. As the Site development will include an asphalt cover for the Site, the particulate inhalation and dermal exposure pathways for the commercial worker scenario will be altered. These changes will be noted in Section 3.3.2 below.

3.1 Chemical Sources and Potential Release Mechanisms

Hydrocarbons known to have been released to soil and groundwater from former underground storage tanks represent the primary source of COPCs that have been encountered during Site investigations. Spills and leaks related to the former underground storage tanks are the primary known potential release mechanisms for TPH related COPCs at the Site. Suspected handling of chemicals by previous Site users may be the source of other, non-TPH related COPCs. Once released into the air, soil gas, soil, or groundwater, COPCs may be transported via potential secondary release mechanisms into exposure media such as soil, ambient air, indoor air, surface water, and groundwater.

As the Site will first undergo development and then be used as a service Complex, future activities at the Site may be divided into two parts: 1) Site construction activities; and 2) future land use. During Site construction activities, there is one receptor population of concern: on-Site construction workers. During future land use, there are two receptor populations of concern: on-Site intrusive workers (who could be involved in periodic subsurface repair activities) and on-Site commercial workers (Port employees). The respective source-pathway-receptor relationships for each period are summarized in the CSM (Figure 5), and are summarized below.

3.1.1 Site Construction Activities

The potential mechanisms through which chemicals can be released during the construction at the Site include the following:

- Wind erosion of soil and atmospheric dispersion of particulate-bound COPCs (dust) into ambient air;
- Volatilization and atmospheric dispersion of COPCs in soil, soil gas, and groundwater into ambient air;
- Leaching and groundwater transport of COPCs to groundwater and surface water; and
- Runoff of precipitation that has come into contact with soil, allowing transport of COPCs to nearby surface water.

The mechanisms listed above represent the theoretically complete mechanisms through which COPCs at the Site can be released and transported from one environmental medium to another. A discussion of each of these transport mechanisms, including those that are considered incomplete, is incorporated into Section 3.3, below.

3.1.2 Future Land Use

The potential baseline mechanisms through which chemicals may be released following the construction of the Complex include the following (in the absence of any controls such as a Site-wide surface cap or passive subsurface vapor barriers):

- Wind erosion of soil and atmospheric dispersion of particulate-bound COPCs (dust) into ambient air;
- Volatilization and atmospheric dispersion of COPCs in soil, soil gas, and groundwater into ambient air;
- Volatilization of COPCs in soil, soil gas, and groundwater into the indoor air of on-Site structures;
- Infiltration or percolation of COPCs in soil vertically into underlying groundwater and lateral migration into surface water; and
- Runoff of precipitation that has come into contact with soil, allowing transport of COPCs to nearby surface water.

The mechanisms listed above represent the theoretically complete mechanisms through which COPCs at the Site can be released and transported from one environmental medium to another. A discussion of each of these transport mechanisms, including those that are considered incomplete, is incorporated into Section 3.3, below.

3.2 Potentially Exposed Populations

During the development of the Complex, demolition, excavation, grading, and construction activities will be performed on-Site. The populations that may be exposed to COPCs during the development process include:

- On-Site construction workers involved in the development. All workers are conservatively modeled as workers potentially exposed to subsurface conditions and in contact with all environmental media.

Following development, the Complex built on the Site will be used. Accordingly, the populations who could become exposed to chemicals present at the Site after the development is complete include:

- On-Site commercial workers (e.g., Port employees working in and around the proposed structure) who will be using the Complex (structure and grounds); and

- On-Site intrusive workers (e.g., Port utility workers installing, repairing, or removing utility lines in trenches at the Site). Exposure of Port utility workers to COPCs is assumed to be similar to on-Site construction workers, as discussed above.

3.3 Exposure Pathways

The following section identifies the potentially complete exposure pathways through which various populations could be exposed to COPCs detected at the Site. The section also provides the rationale for excluding certain exposure pathways from further consideration. All exposure pathways included in the HHRA are identified in Figure 5, the Conceptual Site Model for the Site.

3.3.1 Complete Exposure Pathways

Complete exposure pathways included in this HHRA were considered respective to the two parts of the proposed project mentioned above: Site Construction Activities and Future Land Use.

3.3.1.1 Site Construction Activities

On-Site construction workers involved in the development of the Site will potentially be exposed to COPCs present in the soil, soil gas, and groundwater via the following complete pathways:

- Inhalation of ambient air vapors resulting from the volatilization and dispersion of COPCs present in soil, soil gas, and groundwater;

- Inhalation of airborne particulates resulting from dust emissions and dispersion of COPCs present in soil;

- Ingestion of COPCs present in surface and subsurface soil;

- Dermal contact with COPCs present in surface and subsurface soil; and,
- Dermal contact with COPCs present in groundwater.

3.3.1.2 Future Land Use

During future land use, on-Site commercial workers and on-Site intrusive workers (e.g., Port utility repair worker) may potentially be exposed to COPCs present in soil, soil gas, and groundwater via the following complete pathways:

- Ingestion of COPCs present in surface and subsurface soil;
- Dermal contact with COPCs present in surface and subsurface soil;
- Inhalation of ambient/indoor air vapors resulting from the volatilization and dispersion of COPCs present in the soil, soil gas, and groundwater; and
- Inhalation of airborne particulates resulting from dust emissions and dispersion of COPCs present in soil.

3.3.2 Incomplete Exposure Pathways

Baseline exposure pathways considered incomplete were not included in the risk evaluation. Development and future land use exposure pathways considered incomplete are discussed below:

- Ingestion of groundwater: Excavation at the Site is anticipated to be limited to depths required for the removal of building footings and installation of subgrade utilities. Compliance with a Health and Safety Plan during demolition and construction is likely to limit exposure to groundwater, and ingestion of groundwater is therefore unlikely. Ingestion is also unlikely for on-Site intrusive workers, as proposed utility lines are located above groundwater level.
- Ingestion of and dermal contact with surface water: During construction, engineering controls will be implemented to reduce standing water and encourage drainage of any precipitation. Surface drains and proper grading will ensure that users of the Complex will not encounter surface water. The nearest naturally-occurring surface water is approximately one-half mile away, and is unlikely to be impacted by COPCs at the Site.
- Use of Potable Water: Groundwater beneath the Site is highly impacted with TPH-related chemicals and will likely not be used as a potable water source for the proposed service Complex.

The inclusion of Site development design elements will cause the following additional exposure pathways to be considered incomplete for the commercial worker scenario:

- Dermal contact with soil, inhalation of soil particulate, and ingestion of soil. Site development includes the construction of a Site-wide asphalt cover. This cover will

prevent Port commercial workers from contacting, inhaling, or ingesting Site soils in the Site development evaluation.

3.4 Exposure Assumptions

Intake of a chemical is dependent on various exposure assumptions including exposure duration, inhalation rate, body weight, and averaging time. The baseline route-specific exposure assumptions used to estimate exposure to COPCs in the soil, soil gas, and groundwater at the Site are presented in Table 3-1. The changes to the exposure assumptions for the commercial worker as a result of planned Site development design elements are presented in Table 3-2. Note that all other scenarios are unchanged. These are the specific exposure assumptions that are used in the calculation of the intake of a chemical, as discussed in Section 7.2. Default exposure assumptions are obtained from Cal/EPA and USEPA guidance documents, wherever possible or applicable.

To determine whether short-term exposures to COPCs at the Site during the development phase of the Site could adversely impact human health, Iris Environmental has conservatively estimated that complete development of the Site will take 6 months (120 work days) and that the construction worker could be exposed throughout this time period.

To determine whether long-term exposures to COPCs at the Site after development could adversely impact human health, Iris Environmental has estimated the lifetime exposure for on-Site commercial workers using default parameters. The on-Site commercial worker was assumed to work at the Site for 250 days per year for a 25-year period. As it is highly unlikely that any individual would work at the Site for a 25-year period, exposures and risks estimated for the future on-Site commercial worker are expected to be significantly lower than presented in this analysis. To estimate exposures that could be incurred by a future intrusive worker who may be involved in limited subsurface repair activities, Iris Environmental has assumed a 2-day per year exposure frequency. To account for the possibility that the same repair worker could be assigned to the Site and return on an annual basis, we have assumed that the intrusive worker could be exposed 2 days per year, for a 25-year exposure period.

4.0 SELECTION OF CHEMICALS FOR INCLUSION IN THE RISK EVALUATION

The purpose of this section is to identify COPCs at the Site to be included in the HHRA. All Site-related data collected during previous and recent Site investigations as discussed in Section 2.6 were qualitatively evaluated for use in the HHRA. As previous Site investigations focused on TPH-related impacts and the recent Phase II ESA was conducted to provide an adequate dataset of all potential chemicals of concern on-Site for the purpose of conducting a risk assessment, only Phase II ESA data was used in this HHRA. The selection of COPCs to be included in the quantitative evaluation was based on guidance provided by USEPA (1989) and Cal/EPA (1997). Analytical data collected as part of the Phase II ESA was compiled, and Site-wide statistics for each chemical were calculated and summarized (e.g., frequency of detection, maximum detected concentration, mean concentration). The summary of chemicals detected across the Site is presented in Table 4-1.

All chemicals ever detected in soils, soil gas, and groundwater were initially included in the quantitative evaluation. Consistent with general risk assessment guidance, the only chemicals excluded from the quantitative evaluation are metals that were detected at levels within regional background levels. Regional background levels of metals in "Colluvium & Fill" soils, as published by Lawrence Berkeley National Laboratory (LBNL) in 1995, were compared to metal concentration levels at the Site. Based on these criteria, the 95% Upper Confidence Limit (95% UCL) of the mean concentration of six of the detected metals were below the LBNL 95% UCL background levels: antimony, chromium, mercury, nickel, selenium, and thallium. These metals were not selected as COPCs for evaluation in the HHRA. See Table 4-2 for the comparison of Site-specific levels to background levels published by LBNL.

Even if a compound was only detected once, it was conservatively included in the risk assessment. The selection of chemicals is summarized in the rightmost column of Table 4-1. As indicated by Tables 2-1 and 4-1:

- Out of a possible 154 compounds, 56 were detected in soil, soil gas, or groundwater and selected for use in the HHRA; of these:
    - 27 were VOCs (17 in soil, 19 in groundwater, and 14 in soil gas):
    - 11 were SVOCs (11 in soil and five in groundwater):
    - two were total petroleum hydrocarbons;
    - nine were metals; and
    - additionally, methane was considered in soil gas.

Consistent with DTSC risk assessment guidance (Cal/EPA 1994), risks associated with the presence of TPH are assessed by evaluating the significance of individual chemical constituents within the TPH mixture.

5.0 ESTIMATION OF REPRESENTATIVE EXPOSURE CONCENTRATIONS

The purpose of this section is to estimate the representative concentrations of COPCs in soil, soil gas, and groundwater to which human populations may be exposed. As described in preceding sections, on-Site construction workers during development and on-Site commercial and intrusive workers during the proposed future land use scenario (the "Receptors") could potentially be exposed to COPCs identified in the environmental media (i.e., soil, soil gas, and groundwater; i.e., "the Source") at the Site. An estimate of the potential total exposure to COPCs requires that the exposures resulting from each pathway be estimated and included in a calculation of total exposure.

Developing a Source-Receptor relationship requires estimating representative concentrations of the COPCs in the soil, soil gas, and groundwater and then conducting fate and transport modeling to estimate the concentrations of COPCs that may be present in the air where the Receptors are located. To provide a conservative estimate of potential health risks posed by COPCs at the Site under the development and future land use scenarios, Iris Environmental estimated potential exposures under baseline conditions, with the assumption that the Site is developed without the benefit of the various specific engineering design elements that will mitigate exposure (i.e., the baseline conditions do not incorporate the reduction in exposures that will result from the passive venting system that is a component of the building design and the asphalt cover that will preclude daily direct contact with soils) Exposures were then estimated by incorporating the specific engineering design elements that will minimize exposures, specifically the passive soil venting system and the asphalt cap that will cover all soils at the Site.

The remaining parts of this section discuss the methods used to estimate the representative COPC concentrations to which the Receptors may be exposed based on the existing analytic data and the predicted emissions from the Source. A detailed discussion of the modeling approaches used in this risk assessment is presented in Appendix B.

5.1 Estimation of COPC Concentrations in Soil, Soil Gas, and Groundwater

The list of COPCs which may be encountered in each medium (soil, soil gas, and groundwater) was determined using the sampling results presented above in Section 4.0. A comprehensive summary of all sampling for chemicals in various media, and the COPCs selected for evaluation in the HHRA, are presented in Table 4-1.

USEPA recommends the use of the 95% upper confidence limit (UCL) of the arithmetic mean concentration as the representative exposure point concentration (EPC; USEPA 1989). For the purposes of this risk assessment, Iris Environmental utilized the 95% UCL of chemical concentrations based on Phase II ESA analytical results, except in instances where the 95% UCL was greater than the maximum detected concentration. Consistent with USEPA guidance, the maximum detected concentration was used as the representative EPC where the 95% UCL was greater than the maximum. The representative EPCs for soil, soil gas, and groundwater used in the HHRA are presented in Table 4-1. Use of Site-wide data was deemed a conservative approach, as the dataset was inclusive and representative of Site conditions. As the Complex will be constructed on only a fraction of the Site and away from the main source area, it will be

situated on soils which are likely to have a subset of chemicals at lower concentrations than used in the assessment. We have conservatively included many chemical source areas that are not below the planned building footprint, or are below only a fraction of the building footprint; moreover, in many cases we have included chemical concentrations greater then those found below the building footprint in our calculation of EPCs. Therefore, we believe that use of the 95% UCL of Site-wide data maximizes the number of chemicals in the evaluation and allows for a conservative assessment of total possible risk.

Where possible, only discrete samples for soil (by boring location and depth) were used in the risk assessment. This was not possible for SVOC samples, which were depth-composited in the field for cost-effective laboratory analysis. Some soil samples were analyzed for on-Site feedback purposes by Mobile Chem Laboratory, as indicated in Section 2.6.3. On-Site laboratory results were selected as representative of a particular sample location if the detected level of a particular chemical was higher than that reported by the off-Site laboratory; conversely, for results reported as non-detect by both laboratories, the sample result with the lower detection limit was selected as representative of the particular sample location. No duplicate sample results or co-located sample results were selected for use in the risk assessment to ensure unbiased chemical characterization.

5.2 Estimation of Air Concentrations Resulting from the Emissions from Soil, Soil Gas, and Groundwater

Various models were used to estimate on-Site indoor and outdoor ambient air concentrations associated with the emission and dispersion of COPCs in soil, soil gas, and groundwater. The estimation of the COPC concentrations at on-Site receptors consisted of two steps: (i) the estimation of emission rates of COPCs into air; and, (ii) the estimation of the dispersion these emissions into trenches and indoor environments. The trench and indoor air concentrations were calculated by multiplying the volatilization flux by the dispersion factor.

A table summarizing the models used for each scenario and the associated input concentration is presented below. Further description of all Models used to determine air concentrations is included in Appendix B. The physicochemical properties of the COPCs used in these models are presented in Table 5-1. The Site data properties are presented in Table 5-2. Table 5-3 presents the air concentrations associated with the baseline modeling and Table 5-4 presents the ambient air concentrations associated with the engineering control modeling.

Population	Exposure Pathway/Media	Input Concentration(s)	Model
On-Site Construction Worker; On-Site Intrusive Worker	Soil Particulate	Soil	Dust
	Ambient Air	Soil, soil gas, groundwater	Trench
On-Site Commercial Worker	Soil Particulate	Soil	Dust
	Indoor Ambient Air	Soil, soil gas, groundwater	Johnson & Ettinger

As discussed in Appendix B, Iris Environmental incorporated pressurized methane flow that results in enhanced migration of other COPCs through the soil column. Methane concentrations at the Site are likely the result of the use of hydrocarbons as a food substrate by subsurface microorganisms. As the microorganisms consume the hydrocarbons as food, methane is released as a byproduct. The generation of methane builds up the local gas pressure, resulting in a pressure gradient between the source of the TPH and the surface. This pressure gradient causes methane, and other collocated gases, to be "pushed" to surface at a rate greater that expected from the diffusion gradient. Therefore, we have conservatively incorporated this additional transport pathway in our baseline modeling.

6.0 TOXICITY ASSESSMENT

The following section has two primary objectives. The first objective is to present the toxicity values that will be used in subsequent sections to quantify potential health impacts associated with the predicted chemical exposures. The second objective is to briefly discuss the basis for these values.

The toxicity assessment, also referred to as the dose-response assessment, characterizes the relationship between the magnitude of exposure to a chemical and the potential for adverse health effects to occur as a result of that exposure. Guidance from Cal/EPA and USEPA requires that risk assessments evaluate two different categories of toxic effects: carcinogenic and noncarcinogenic. Different methods are used to estimate the potential for carcinogenic and noncarcinogenic health effects to occur. Some chemicals that produce carcinogenic effects may also be associated with noncarcinogenic effects. Most regulatory agencies consider carcinogens, such as benzene, to pose a risk for cancer at all exposure levels (i.e., a "no-threshold" assumption); that is, any increase in dose is associated with an increase in the probability of developing cancer over the course of a lifetime. Noncarcinogens, in contrast, are thought to produce adverse health effects only when some minimum exposure level is exceeded (i.e., a threshold dose).

In this HHRA, the possibility for the potential exposures occurring during the development and post-development use of the Site to result in cancer or noncancer health effects was evaluated. Additionally, the potential for exposures resulting releases during Site development to result in explosive hazards under the on-Site construction scenario was evaluated. The specific sources of toxicity information used for this analysis correspond to Cal/EPA's and USEPA's recommended toxicity sources, as described further in the remaining sections.

The remaining sections present the specific toxicity values that will be used to quantify the potential for carcinogenic and noncarcinogenic health effects to result from predicted exposures. Additionally, this section describes the specific method that is recommended by Cal/EPA to evaluate potential adverse health effects from exposure to lead. Finally, this section concludes with a description of the threshold concentrations that will be used in Section 7.0 to assess the potential for the predicted exposures to pose an unacceptable explosive hazard.

6.1 Toxicity Assessment for Carcinogenic Effects

Current health risk assessment practice for carcinogens is based on the assumption that, for most substances, there is no threshold dose below which carcinogenic effects do not occur. This current "no-threshold" assumption for carcinogenic effects is based on an assumption that the carcinogenic processes are the same at high and low doses. This approach has generally been adopted by regulatory agencies as a conservative practice to protect public health. The "no-threshold" assumption is used in this risk assessment for evaluating carcinogenic effects. Although the magnitude of the risk declines with decreasing exposure, the risk is believed to be zero only at zero exposure.

Cancer slope factors (CSFs) are used to quantify the response potency of a potential carcinogen. The CSF represents the excess lifetime cancer risk due to a continuous, constant lifetime

exposure to a specified level of a carcinogen. CSFs are generally reported as excess incremental cancer risk per milligram of chemical per kilogram body weight per day $(mg/kg/day)^{-1}$. The Cal/EPA and USEPA have published a list of CSFs recommended for use in risk assessments. The Cal/EPA-recommended CSFs are maintained on the Cal/EPA Office of Environmental Health Hazard Assessment's (OEHHA) on-line toxicity criteria database (Cal/EPA 2002). The USEPA-recommended CSFs are maintained on the USEPA's *Integrated Risk Information System* on-line database (USEPA, 2002). Consistent with Cal/EPA risk assessment guidance, the OEHHA CSFs are used, when available USEPA CSFs are used when OEHHA CSFs are not available. The CSFs used to evaluate the potential carcinogenicity of COPCs are presented in Table 6-1.

6.2 Toxicity Assessment for Noncarcinogenic Effects

The toxicity assessment for noncarcinogenic effects requires the derivation of an exposure level below which no adverse health effects in humans are expected to occur. USEPA refers to these levels as reference doses (RfDs) for oral exposure and reference concentrations (RfCs) for inhalation exposure (USEPA, 1989). The noncancer RfD represents a dose, given in milligrams of chemical per kilogram of body weight per day, that would not be expected to cause adverse noncancer health effects in potentially exposed populations. The noncancer RfD, reported in units of mg/kg/day, is often referred to as the "acceptable dose." The noncancer Reference Concentration (RfC) represents the airborne concentration (in units of micrograms per cubic meter [$\mu g/m^3$]) that would not be expected to cause adverse noncancer health effects in populations exposed through the inhalation pathway. OEHHA refers to these "acceptable air concentrations" as Reference Exposure Levels (RELs). As the inhalation RfCs/RELs are derived from inhalation toxicity studies, they are used for evaluating inhalation exposures, when available, and are converted to corresponding inhaled doses (inhalation RfDs) using USEPA standard conversion assumptions. As recommended by USEPA, inhalation RfCs/RELs are converted to inhaled doses (inhalation RfDs) by assuming a breathing rate of 20 m^3/day, and a body weight of 70 kilograms (i.e., RfC/REL ($\mu g/m^3$) x (20 m^3/day) x (1/70 kg) x (1 mg/1000 μg) = RfD (mg/kg/day)). If inhalation RfCs/RELs were not available, then RfDs obtained from an oral study (oral RfDs) were extrapolated and applied to the inhalation in this evaluation (i.e., the inhalation RfD was assumed to be equivalent to the oral RfD, under the toxicological assumption that the chemical could produce the same type of noncancer effects via the inhalation route as observed through the oral route of exposure).

As recommended by USEPA (USEPA, 1989), RfDs are obtained from the *Integrated Risk Information System* (IRIS) (USEPA, 2002) or from the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997). As recommended by DTSC, noncancer RELs, (in units of $\mu g/m^3$), obtained from OEHHA's on-line toxicity database (Cal/EPA, 2002), are used for evaluating noncancer effects from inhalation exposures, where available. If OEHHA-RELs are not available, RfCs are obtained from the IRIS (USEPA, 2002) or from HEAST (USEPA, 1997). All noncarcinogenic toxicity values used in this risk assessment are presented in Table 6-1.

6.3 Toxicity Assessment for Lead

The traditional RfD approach to the evaluation of chemicals is not applied to lead because most human health effects data are based on blood lead concentrations, rather than external dose

(Cal/EPA, 1992). Blood lead concentration is an integrated measure of internal dose, reflecting total exposure from Site-related and background sources. A clear no observed effects level (NOEL) has not been established for such lead-related endpoints as birth weight, gestation period, heme synthesis and neurobehavioral development in children and fetuses, and blood pressure in middle-aged men. Dose-response curves for these endpoints appear to extend down to 10 micrograms/deciliter (µg/dL) or less (ATSDR, 1993). The DTSC has developed a methodology for evaluating exposure and the potential for adverse health effects resulting from exposure to lead in the environment (Cal/EPA, 1992). The methodology results in a blood lead concentration of concern for the protection of human health and presents an algorithm for estimating blood lead concentrations in children and adults based on a multi-pathway analysis.

DTSC has provided a spreadsheet (LEADSPREAD) based on its guidance for evaluating lead toxicity (Cal/EPA, 1993). Per DTSC risk assessment guidance, the updated version spreadsheet model, LEADSPREAD Version 7, has been used in this HHRA. As recommended by DTSC, the estimated 99th percentile blood lead concentration for the given exposure scenarios in the spreadsheet are used to screen against the target endpoint of 10 ug (lead)/dL (blood). The default parameters for the construction and intrusive worker in the DTSC LEADSPREAD model have been modified to reflect the exposure assumptions depicted in Table 3-1. The results of the blood lead concentration calculations are presented in Appendix D and are discussed in Section 7.0 (Risk Characterization).

6.4 Assessment of Acute Hazards

Explosive hazard thresholds are used to evaluate potential explosive hazards from hydrocarbons detected at the Site. The results of this screening evaluation will be used to determine if explosive hazard control measures will need to be implemented during Site development. Methane was detected in soil gas at high concentrations, and diesel and gasoline were detected in soil and water. These hydrocarbons may cause an explosive hazard, particularly in confined spaces. The available explosive threshold for methane used in this screening evaluation is 1.25% by volume of air. Note that this threshold incorporates a safety factor of four. The explosive threshold selected for gasoline in this evaluation was 0.35% by volume of air. The explosive threshold selected for No. 1 grade diesel fuel in this evaluation was 0.875% by volume in air. Explosive thresholds selected in this evaluation incorporate a safety factor of ten (i.e., the explosive threshold selected is 10% of the lower explosive limit [LEL]), and LEL sources are noted in tables 7-10 and 7-11.

Odor thresholds are used to evaluate potential nuisance from vapors detected at the Site. Of particular concern are TPH compounds. 50% odor thresholds are based on MADEP values (MADEP 2002).

7.0 RISK CHARACTERIZATION

7.1 Introduction

Risk characterization is the final step of a risk assessment; the exposure and toxicity assessments are combined to produce an estimate of risk and a characterization of the uncertainties in the estimated risks. This section presents the results of the HHRA. A discussion of the uncertainties inherent in all risk assessments, including this one, is presented in Appendix C.

The risk posed by chemicals is directly related to the amount of exposure that an individual has to the chemicals. The amount of exposure that the identified potential receptor populations will incur is Site-specific, and is a function of the following elements:

- the initial maximum concentration of chemicals in the soil, soil gas, and groundwater;
- the ability of COPC to migrate from the soil, soil gas, and groundwater into the ambient outdoor and/or indoor environment;
- the influence of Site-specific development plans, such as a Site-wide asphalt cover and vapor controls (e.g., subgrade venting system) beneath buildings used by Port commercial workers, on the potential exposures to COPCs incurred by Site receptors;
- the predicted airborne concentration in the ambient and indoor air after atmospheric dispersion of the chemicals from all sources (i.e., chemicals in the soil, soil gas, and groundwater) has occurred; and
- the amount of time that a potential receptor may be present and exposed to the combined chemical concentrations from the soil, soil gas, and groundwater.

Each of the elements listed above was integrated into an exposure model using standard regulatory guidelines for risk assessment. This exposure information is then combined with the toxicity values to estimate the likelihood that the predicted exposures will result in adverse health effects. The overall goal of the State and Federal agencies is to protect public health. Consequently, the risk assessment relies on a series of health protective assumptions that typically overestimate the potential for exposure and risk. For example, health protective assumptions were used to estimate the movement of chemicals from one environmental medium (i.e., soil, soil gas, and groundwater) to another (i.e., outdoor or indoor air). The assumptions in the baseline exposure model are designed to provide a conservative (i.e., high) estimate of an individual's exposure to chemicals. Similarly, the techniques used by the agencies to develop carcinogenic and noncarcinogenic toxicity values rely on a series of health protective assumptions. The combination of conservative assumptions used in the exposure and toxicity assessment ensures that the likelihood of underestimating the health risks is low.

The methodology used to evaluate the likelihood that potential chronic exposures will result in cancer or noncancer health effects is described in the following section.

7.2 Methodology

Estimating chronic risks (cancer risks and noncancer hazard indices) for exposures to chemicals in soil, soil gas, and groundwater requires information regarding chemical concentrations in the various media, the level of intake of the chemical, and the relationship between intake of the chemical and its toxicity as a function of human exposure to the chemical. The methodology used to derive the cancer risks and noncancer hazard indices for the selected chemicals of concern is based on guidance provided in the regulatory documents listed below.

- U.S. Environmental Protection Agency (USEPA). 1989. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A). Interim Final.* Office of Emergency and Remedial Response. EPA/540/1-89/002. Washington, D.C. December.

- U.S. Environmental Protection Agency (USEPA). 1991b. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Supplemental Guidance. Standard Default Exposure Factors.* Office of Emergency and Remedial Response. March 25.

- California Environmental Protection Agency (Cal/EPA). 1992. *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities.* Department of Toxic Substances Control. July.

The potential risk associated with a measured concentration of a chemical in a medium is estimated using the following equations that describe the relationship between estimated intake of Site constituents, toxicity of specific chemicals, and overall risk for carcinogenic and noncarcinogenic health effects. For carcinogenic effects, the relationship is given by the following equation (USEPA, 1989):

$$\text{Cancer Risk} = \text{CDI} \times \text{CSF}$$

Where:

Cancer Risk	=	Cancer risk; the probability of an individual developing cancer as a result of exposure to a particular cumulative dose of a potential carcinogen (unitless);
CDI	=	Chronic Daily Intake of a chemical (mg chemical/kg body weight-day);
CSF	=	Cancer Slope Factor; the toxicity value which indicates the upper limit on lifetime incremental cancer risk per unit of dose of chemical (mg chemical/kg body weight-day)$^{-1}$.

The relationship for a noncarcinogenic chemical is given by the following equation (USEPA, 1989):

$$\text{Hazard Quotient} = \text{CDI/RfD}$$
$$\text{Hazard Index} = \sum \text{Hazard Quotient}$$

Where:

Hazard Quotient	=	Hazard Quotient; an expression of the potential for a chemical to cause noncarcinogenic effects, which relates the allowable amount of a chemical (reference dose [RfD]) to the estimated Site-specific intake (unitless);
Hazard Index	=	Hazard Index; the sum of the chemical-specific Hazard Quotients, which represents the cumulative potential for predicted exposures to result in noncarcinogenic effects (unitless);
CDI	=	Chronic Daily Intake of a chemical (mg chemical/kg body weight-day);
RfD	=	Reference dose; the toxicity value indicating the threshold amount of chemical contacted below which no adverse health effects are expected (mg chemical/kg body weight-day).

Intake is dependent on the exposure concentration and contact rate. The equations and used to calculate the chronic daily intake for each chemical via the identified complete exposure pathways under the development and future land use scenarios are presented in Table 7-1. These equations are used to derive the cancer risks and noncancer hazard indices associated with exposure to chemicals at the Site. State and Federal agencies have established acceptable incremental cancer risk levels to be within the range of one-in-ten thousand (1×10^{-4}) and one-in-one million (1×10^{-6}); that is, they consider a calculated excess cancer risk within this range of numbers to be acceptable. Regulatory agencies consider the one-in-one million risk level to be an insignificant risk, and terms such as "negligible risk" and "safe dose" have been used to characterize the one-in-one million risk level. As a risk management policy, the Cal/EPA DTSC generally requires risks to be closer to the 1×10^{-5} end of the target range for commercial scenarios, consistent with California Code of Regulations (CCR, Title 22) use of 1×10^{-5} risk target in estimating No Significant Risk Levels for Proposition 65 listed carcinogenic chemicals. The CDIs for carcinogens, calculated under baseline conditions, are presented in Table 7-2. The CDIs for carcinogens, calculated under Site development conditions, are presented in Table 7-3.

For noncancer health hazards, an HI of one (1) is identified as the target level of concern. Chemical exposures that yield hazard indices of less than 1 are not expected to result in adverse noncancer health effects (USEPA, 1989). The CDIs for noncarcinogens, calculated under baseline conditions, are presented in Table 7-4. The CDIs calculated for noncarcinogens, calculated under Site development plans are presented in Table 7-5.

7.3 Risk Assessment Results

The probability that populations will develop cancer or suffer noncancerous adverse health effects from exposure to chemicals associated with the Site was determined by combining the toxicity values for each chemical (presented in Section 6.0) with the quantitative estimates of exposure (discussed in Sections 3.0 and 5.0). Cancer risks and noncancer hazard indices were calculated for exposure to chemicals present in soil, soil gas, and groundwater.

A discussion of the potential cancer risks and noncancer hazard indices associated with the development phase and the proposed future land use of the Site are described below, in Sections 7.3.1 and 7.3.2, respectively.

7.3.1 During Development

Development phase health risks for the on-Site construction worker, calculated as cancer risk, noncancer hazard indices, and lead exposure, are included below.

7.3.1.1 Cancer Risk Estimates

As indicated in Table 7-6, the total incremental cancer risk for the on-Site construction worker involved in the development of the Site is estimated to be 9.21×10^{-6}, which is within the acceptable incremental cancer risk range of 1×10^{-4} and 1×10^{-6} and within the 1×10^{-5} cancer risk level commonly considered by Cal/EPA DTSC as the "acceptable" risk level for commercial land-use scenarios. Approximately 71% of the predicted cancer risk for the on-Site construction worker is attributable to inhalation of vapors which have migrated up from groundwater and 23% is attributable to the soil ingestion pathway. Further, approximately 59% of the total cancer risk for on-Site construction workers is attributable to vinyl chloride and 27% is attributable to arsenic. In sum, the chemical exposures that could occur during the development of the Site would not be expected to result in unacceptable cancer risks for workers involved in the development of the Site. The predicted cancer risks associated with the development phase of the project are within levels that are often considered acceptable by USEPA and below the risk level often considered by Cal/EPA DTSC, particularly for industrial/commercial exposure scenarios. It is important to note that although 59% of the risk is attributable to vinyl chloride, this compound was detected in only 3 out of a total of 37 groundwater samples and 2 out of 23 soil gas samples. Thus, it does not appear to be widespread throughout the Site and basing our risk estimates on this compound is likely conservative.

7.3.1.2 Noncancer Hazard Indices

As indicated in Table 7-7, the estimated cumulative noncancer HIs for exposure to chemicals present in the soil, soil gas, and groundwater is 4.21 for on-Site construction worker during Site development. The estimated cumulative noncancer HI for on-Site construction workers is above the target HI of 1, indicating that exposures to construction workers may result in adverse health effects in the absence of health and safety practices. 51% of the noncancer HI for the construction worker is attributable to gasoline vapors. This is likely a conservative assessment, as the EPC of gasoline vapors is skewed by one hit of 28,000 ppmv at MFC-16; the RMP will address this location and proper protocol for ensuring worker safety in the vicinity.

7.3.1.3 Lead

As previously described, the reference dose approach used for assessing potential noncarcinogenic effects is not used to evaluate exposure to lead. Rather, the DTSC has developed specific guidance for evaluating exposure and the potential for adverse health effects resulting from exposure to lead in the environment using a model based on absorbed doses and estimated blood-lead concentrations. The guidance is implemented using a spreadsheet, obtained from DTSC, in which a multi-pathway algorithm is used for estimating blood-lead concentrations in children and adults.

Appendix D presents the output from LEADSPREAD. Using the representative EPC of lead detected in soil (57.4 mg/kg), the 99th percentile blood lead level associated with construction worker exposures to lead from the Site and from the Site via all exposure pathways and from background sources in air, food, and drinking water is 3.8 ug/dl. This level is well below the target concentration of 10 ug/dl, developed to be protective of children's health (Cal/EPA, 1992). The results from LEADSPREAD for on-Site construction workers are presented in Table D-1.

7.3.2 Future Land Use

Future land use phase health risks for the on-Site commercial worker and on-Site intrusive worker, calculated as cancer risk, noncancer hazard indices, and lead exposures, are included below.

7.3.2.1 Cancer Risk Estimates

On-Site Commercial Worker

As indicated in Table 7-6, the total incremental baseline cancer risk predicted for the on-Site commercial workers during future land use of the Site is complete is estimated to be 2.72×10^{-5}, a level that is within USEPA's established acceptable incremental cancer risk range of 1×10^{-4} and 1×10^{-6}, but above the 1×10^{-5} risk level commonly considered as the "acceptable" risk level by Cal/EPA DTSC for commercial land-use scenarios. Approximately 41% of the predicted cancer risk for the future on-Site commercial worker is attributable to the soil ingestion pathway and 37% is attributable to vapors which have migrated up from groundwater. Approximately 57% of the total cancer risk for on-Site commercial workers is attributable to arsenic in soils.

As shown in Table 7-8, the incorporation of planned Site development design features (i.e., passive vapor venting system and asphalt cover across the Site) results in a predicted cancer risk of 8.49×10^{-6}, a level that is well within USEPA's established acceptable incremental cancer risk range of 1×10^{-4} and 1×10^{-6}, and below the 1×10^{-5} risk level commonly considered as the "acceptable" risk level by Cal/EPA DTSC for commercial land-use scenarios. With controls, approximately 87% of the predicted cancer risk for the future on-Site commercial worker is attributable to vapors which have migrated up from groundwater and accumulated in indoor air. Approximately 74% of the total cancer risk for on-Site commercial workers is attributable to vinyl chloride.

On-Site Intrusive Worker

As indicated in Table 7-6, the total incremental cancer risk for the on-Site intrusive worker involved in repeated annual subsurface maintenance activities at the Site is estimated to be 3.83×10^{-6}, which is well within USEPA's acceptable incremental cancer risk range of 1×10^{-4} and 1×10^{-6}, and below the 1×10^{-5} risk level commonly considered as the "acceptable" risk level by Cal/EPA DTSC for commercial land-use scenarios. Approximately 71% of the predicted cancer risk for the on-Site intrusive worker is attributable to the inhalation of vapors which have migrated to the trench from groundwater, and 23% is attributable to the soil ingestion pathway. Further, approximately 59% of the total cancer risk for on-Site intrusive workers is attributable to vinyl chloride and 27% is attributable to arsenic.

7.3.2.2 Noncancer Hazard Indices

On-Site Commercial Worker

As indicated in Table 7-7, the estimated cumulative noncancer HI for exposure to chemicals present in the soil, soil gas, and groundwater is 0.35 for the on-Site commercial worker. The estimated cumulative noncancer HI is below the target HI of 1, indicating that exposures to commercial workers would not be expected to result in any adverse noncancer health effects. Approximately 27% of the noncancer HI for the on-Site commercial worker is attributable to vapors which have migrated from soil gas, 23% of the noncancer HI for the on-Site commercial worker is attributable to vapors which have migrated from groundwater, and 21% of the noncancer HI is due to soil ingestion pathway. 38% of the cumulative noncancer HI for the on-Site commercial worker is attributable to arsenic and 27% is attributable to gasoline.

As shown in Table 7-9, the incorporation of planned Site development design features (i.e., passive vapor venting system and asphalt cover across the Site) results in a predicted noncancer HI of 0.16 indicating that exposures to commercial workers would not be expected to result in any adverse noncancer health effects. Approximately 52% of the noncancer HI for the on-Site commercial worker in the development model is from the soil vapor inhalation pathway, all of it from gasoline vapors.

On-Site Intrusive Worker

As indicated in Table 7-7, the estimated cumulative noncancer HI for exposure to chemicals present in the soil, soil gas, and groundwater is 0.03 for the on-Site intrusive worker. This estimated cumulative noncancer HI is below the target HI of 1, indicating that the chemical exposures for on-Site intrusive workers that could occur during the proposed future land use would not be expected to result in adverse noncancer health effects. Approximately 63% of the noncancer HI for the on-Site intrusive worker is attributable to vapors which have migrated from groundwater and 17% of the noncancer HI for the on-Site intrusive worker is attributable to the soil ingestion pathway. Approximately 28% percent of the cumulative noncancer HI for the on-Site intrusive worker is attributable to arsenic in soils; contributions from groundwater vapors are attributable to an array of chemicals.

7.3.2.3 Lead

Exposure to soils for the on-Site intrusive worker and the on-Site commercial worker (after incorporations of Site development design elements) will be less than that for on-Site construction workers. Thus, the output from LEADSPREAD model used for the on-Site construction worker is considered protective for both the on-Site intrusive worker and the on-Site commercial worker. As the projected blood-lead level fro the on-Site construction worker was estimated to be 3.8 ug/dl, a level well below the target concentration of 10 ug/dl. Accordingly, the predicted blood-lead levels for the on-Site intrusive worker and the on-Site commercial worker will be below 3.8 ug/dl. Therefore, the levels of lead present at the Site are well below levels that would result in unacceptable blood lead concentrations in either future on-Site intrusive workers or future on-Site commercial workers.

7.4 Explosive Hazard and Odor Estimates

As indicted in Table 7-10, the predicted cumulative combustible gas concentrations are below the respective lower explosive limits (LEL) with a safety factor of ten for the compounds which pose the greatest risk. Nonetheless, while exceedances of the actual LEL are unlikely, the Health and Safety Plan for the development of the Site should consider the explosive potential of vapors encountered during construction activities at the Site. As indicated by Table 7-11, Site development conditions further reduce estimates for the indoor air explosive hazard.

Tables 7-10 and 7-11 also indicate the estimated results of odor threshold evaluation of TPH data. Results indicate that in the absence of controls, on-Site construction workers may be exposed to nuisance odors. Finally, we note that predicted elevated levels of diesel gases may suggest the potential for odorous sulfur compounds (in addition to TPH odors) during construction activities. Monitoring for hydrogen sulfide is recommended.

7.5 Summary and Conclusions

A HHRA was conducted to ensure that development and use of the Site as a proposed service Complex can occur in a manner that is protective of human health. A baseline HHRA was conducted, to evaluate potential health risks under the assumption that the Site is developed without the benefit of the various specific design elements that will, from a practical standpoint, mitigate exposure (i.e., the baseline conditions do not incorporate the reduction in exposures that will result from the passive vapor venting system that is a component of the building design and the asphalt cover that will preclude daily direct contact with soils). Risks were also calculated assuming the inclusion of planned Site development design elements that will minimize exposures, specifically the passive vapor venting system and the asphalt cap that will cover all soils at the Site.

Under both scenarios, the risk assessment was intended to be very conservative, resulting in projected estimates of risk that are likely significantly higher than the actual risks that may be posed by the Site. The human receptors that could potentially be impacted throughout the development and use of the Site were identified and included in the evaluation. Further, all chemicals detected in recent sampling activities were included in the evaluation; under the assumption the 95% UCL represents the concentration to which human populations may be exposed. The models that were used to predict the movement of chemicals from one environmental media to another were very conservative, and tend to overestimate human exposures. The goal of the baseline approach is to identify those uses, activities, and chemical sources that have the potential to contribute most significantly to human health impacts. The identification of the most significant contributors to risk will facilitate the future development of the Site and will ensure that human health is protected throughout the entire Site development process.

As described in the preceding sections, the baseline risk assessment results indicate that absent mitigation, risks to on-Site commercial workers during future use of the Site may be slightly greater than levels typically considered acceptable by regulatory agencies such as Cal/EPA DTSC. The projected risks are dominated by potential exposures resulting from the inhalation of vapors and the ingestion of soil.

However, based on the actual development plans that will be implemented at the Site, which will include the incorporation of vapor controls (e.g., a subgrade venting system) beneath the building and the covering of all exposed soils with an asphalt cover, risks to future commercial workers at the Site will be below (i.e., lower than) levels that would be considered acceptable by regulatory agencies.

The baseline risk assessment results indicate that absent mitigation, noncancer risks to on-Site construction workers during development of the Site are above the level typically considered acceptable by regulatory agencies such as Cal/EPA DTSC. The projected risks are dominated by potential exposures resulting from the inhalation of vapors and the ingestion of soil, in particular by gasoline vapors. Appropriate measures for protection of health and safety at the Site in general, and in particular the area in which gasoline vapors were detected at elevated concentrations, will be addressed by the Site Health and Safety and Risk Management Plans, which will be prepared by the Port. Construction workers involved in the duration of the Site development should undertake all activities in accordance with the Site-specific Health and Safety Plan that meets the requirements of all relevant rules and regulations. Similarly, risks to future on-Site intrusive workers who may be engaged in ongoing, albeit periodic, subsurface repair activities are below levels that would be considered acceptable by regulatory agencies such as Cal/EPA DTSC. Accordingly, the risk assessment supports that the development of the Site, as currently planned by the Port and with the appropriate implementation of safety measures during construction, will result in a Site that is safe and appropriate for the intended commercial/industrial use.

8.0 REFERENCES

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APPENDIX A

PHASE II ESA SAMPLE DATA TABLES

APPENDIX B

MODELING METHODOLOGIES

APPENDIX C

UNCERTAINTIES IN THE RISK ASSESSMENT

APPENDIX D

VERSION 7 DTSC LEADSPREAD OUTPUT

TABLES

TABLE 2-1: SAMPLING AND CHEMICAL ANALYSIS SUMMARY
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Method	Soil Analyses Selected for HHRA								Groundwater Analyses Selected for HHRA						Soil Gas Analyses Selected for HHRA			Total data selected for use in the HHRA
	8015M/ 8260G Gasoline [b]	8015TEH TPHd [c]	8015M TPHj/k/mo [c]	8260 VOCs [d]	8260B VOCs [d]	8021B BTEX [e]	8270C SVOCs [f]	6010/ 6020/ 7471 Metals [g]	8015M/ 8260G Gasoline [b]	8015M TPHd [c]	8015M TPHj/k/mo [c]	8260 VOCs [d]	8260B VOCs [d]	8270C SVOCs [f]	8260B VOCs [d]	TO-3 Gasoline [h]	ASTM D1946 Methane [h]	
No. of samples considered [a]	112	113	107	varies [i]		41	45	107	36	33	31	varies [i]		13	23	23	23	231
No. of compounds considered	1	1	3	41	67	4	65	18	1	1	3	41	67	65	66	1	1	154
No. of compounds detected	1	1	1	17		4	11	15	1	1	1	19		5	14	1	1	56

Notes:

[a] Number of samples includes discrete soil samples from borings, groundwater samples, and soil gas samples. Composite soil sample results were used only for SVOCs. Duplicate samples were not included in the dataset used for site characterization.

[b] "Gasoline" indicates Total Volatile Hydrocarbons as gasoline by EPA Method 8015 modified for both soil and groundwater samples and Volatile Organic Compounds as Gasoline by EPA Method 8260B. Soil gas samples were analyzed by EPA Method TO-3.

[c] "TPHd/j/k/mo" indicates Total Petroleum Hydrocarbons as diesel, jet fuel, kerosene, and motor oil, by EPA Method 8015 modified (Total Extractable Hydrocarbons). Samples were treated with a silica gel column clean-up prior to analysis. Mobile Chem Lab samples only analyzed for Total Extractable Hydrocarbons in the diesel range.

[d] "VOCs" indicates halogenated volatile compounds by EPA Method 8260 and/or 8260B.

[e] "BTEX" indicates benzene, toluene, ethylbenzene, and xylenes by EPA Method 8021B.

[f] "SVOCs" indicates semi-volatile organic compounds by EPA Method 8270.

[g] "Metals" indicates Title 26 Metals (Ag, As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, Sb, Se, Ti, V, Zn) by EPA Method 6010/6020/7471 and Cr VI by EPA Method 7196A. Organic Lead was additionally analyzed by CA Leaking Underground Storage Tank (LUFT) Method. Organic Lead was not detected in any of the soil samples (12 samples) or grab groundwater samples (13 samples).

[h] "Methane" indicates CH4 by ASTM method D1946.

[i] 42 compounds and are listed on Method 8260 reporting from Mobile Chem Lab and 66 compounds are listed on Method 8260B reporting from STL San Francisco, and the list of chemicals evaluated in 8260B analysis did not include the entire list of chemicals evaluated in 8260 analysis. Each lab received a different number of samples. Because of the different analyte lists, the number of soil samples for each VOC was either 23, 66, or 71. The number of water samples for each VOC was 18, 21, or 37.

Reference:

Iris Environmental. 2002a. *Phase II Environmental Site Assessment, Future Port Field Support Services Complex, 2225 & 2277 Seventh Street, Port of Oakland, Oakland, California.* Oakland, California. June 11.

TABLE 3-1: BASELINE EXPOSURE ASSUMPTIONS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Parameter	Symbol	Scenario			Units
		Development Phase	Future Land Use		
		On-Site Construction Workers	On-Site Commercial Workers	On-Site Intrusive Workers	
Inhalation of Soil Particulates					
Breathing Rate [a]	BR	20	20	20	m^3/day
Transfer Coefficient [b]	TFp	5.0E-07	5.0E-08	5.0E-07	$(mg/m^3)/(mg/kg)$
Dermal Contact with Soil					
Surface Area [c]	SA	3300	5700	3300	cm^2/day
Adherence Factor [d]	AF	0.2	0.07	0.2	mg/cm^2
Absorption Factor-PAHs	ABS-PAH	See Chemical Properties Table (Table 5-1)			unitless
Absorption Factor-Metals	ABS-Met				unitless
Absorption Factor-Arsenic	ABS-As				unitless
Absorption Factor-Cadmium	ABS-Cd				unitless
Absorption Factor-Organics	ABS-Org				unitless
Conversion Factor	CF	1.0E-06	1.0E-06	1.0E-06	kg/mg
Dermal Contact with Groundwater					
Surface Area [c]	SA	3,300	NA	3300	cm^2/day
Chemical Specific Dermal Permeablility Coefficient	Kp	See Chemical Properties Table (Table 5-1)			cm^2/hr
Conversion Factor	CF	1.0E-03	NA	1.0E-03	L/cm^3
Ingestion of Soil					
Ingestion Rate [e]	IR	480	50	480	mg/day
Conversion Factor	CF	1.0E-06	1.0E-06	1.0E-06	kg/mg
Inhalation of Vapors					
Breathing Rate [a]	BR	20	20	20	m^3/day
Population-Specific Intake Parameters					
Exposure Time		8	8	8	hrs/day
Exposure Frequency	EF	120	250	2	day/yr
Exposure Duration	ED	1	25	25	yr
Body Weight	BW	70	70	70	kg
Averaging Time-Carcinogens	ATc	25,550	25550	25550	day
Averaging Time-Noncarcinogens	ATnc	365	9,125	9,125	day

Notes:

[a] Recommended breathing rates for adults (20 m^3/day) (Cal/EPA 1992; Cal/EPA 1994).

[b] A soil-to-air transfer coefficient is calculated by assuming an airborne dust level of 50µg/m^3 for commercial workers, which corresponds to the National Ambient Air Quality Standard (Cal/EPA 1994). For construction and intrusive workers, corresponds to a level of 500 µg/m^3.

[c] Corresponds to the area of exposed skin in each respective population. For commercial workers, corresponds to head, hands, forearms and lower legs (Cal/EPA 2000). For construction and intrusive workers, corresponds to head, hands, and forearms.

[d] Soil adherence factors recommended by Cal/EPA (2000).

[e] Ingestion rate for commercial workers as recommended by Cal/EPA (1992). A soil ingestion rate of 480 mg/day is used for intrusive and outdoor workers (USEPA 1997).

Sources:

California Environmental Protection Agency (Cal/EPA). 1994. *Preliminary Endangerment Assessment Guidance Manual.* Department of Toxic Substances Control (DTSC). January.

California Environmental Protection Agency (Cal/EPA). 2000. *Draft: Guidance for the Dermal Exposure Pathway.* Memorandum from Department of Toxic Substances Control (DTSC). January 7.

California Environmental Protection Agency (Cal/EPA). 1992. *Supplemental Guidance for Human Health Multimedia Risk Assessment of Hazardous Waste Sites and Permitted Facilities.* Sacramento, CA. July.

EPA. 1997. *Volume I-General Factors, Exposure Factors Handbook* Washington, D.C. August.

TABLE 3-2: SITE DEVELOPMENT EXPOSURE ASSUMPTIONS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Parameter	Symbol	Scenario	Units
		Future Land Use	
		On-Site Commercial Workers	
Inhalation of Vapors			
Breathing Rate [a]	BR	20	m^3/day
Population-Specific Intake Parameters			
Exposure Time		8	hrs/day
Exposure Frequency	EF	250	day/yr
Exposure Duration	ED	25	yr
Body Weight	BW	70	kg
Averaging Time-Carcinogens	ATc	25550	day
Averaging Time-Noncarcinogens	ATnc	9,125	day
Exposure Duration	ED	788,760,000	s

Notes:

NA = Not applicable, incomplete exposure pathway.

[a] Recommended breathing rates for adults (20 m^3/day) (Cal/EPA 1992; Cal/EPA 1994).

Sources:

California Environmental Protection Agency (Cal/EPA). 1994. *Preliminary Endangerment Assessment Guidance Manual.* Department of Toxic Substances Control (DTSC). January.

California Environmental Protection Agency (Cal/EPA). 1992. *Supplemental Guidance for Human Health Multimedia Risk Assessment of Hazardous Waste Sites and Permitted Facilities.* Sacramento, CA. July.

California Environmental Protection Agency (Cal/EPA). 2000. *Draft: Guidance for the Dermal Exposure Pathway.* Memorandum from Department of Toxic Substances Control (DTSC). January 7.

TABLE 4-1: Summary of Chemicals Included in the Risk Assessment
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Sample Matrix	Chemical	On-Site Detection Frequency (Detections/Samples Analyzed)	Range of On-Site Concentrations [a] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	95% UCL of On-Site Concentrations [b] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	LBNL 1995 Background Concentrations [c] (mg/kg)	Included in Risk Assessment [d]
	Volatile Organic Compounds					
Soil	1,1,1,2-Tetrachloroethane	0/66	ND	ND	--	No
Soil	1,1,1-Trichloroethane	0/71	ND	ND	--	No
Soil	1,1,2,2-Tetrachloroethane	0/71	ND	ND	--	No
Soil	1,1,2-Trichloroethane	0/71	ND	ND	--	No
Soil	1,1-Dichloroethane	0/71	ND	ND	--	No
Soil	1,1-Dichloroethene	1/71	ND - 0.0081	0.00217	--	**Yes**
Soil	1,1-Dichloropropene	0/66	ND	ND	--	No
Soil	1,2,3-Trichlorobenzene	0/66	ND	ND	--	No
Soil	1,2,4-Trichlorobenzene	0/66	ND	ND	--	No
Soil	1,2,4-Trimethylbenzene	1/66	ND - 0.019	0.00328	--	**Yes**
Soil	1,2-Dibromo-3-chloropropane	0/66	ND	ND	--	No
Soil	1,2-Dibromoethane	0/66	ND	ND	--	No
Soil	1,2-Dichlorobenzene	0/66	ND	ND	--	No
Soil	1,2-Dichloroethane	0/71	ND	ND	--	No
Soil	1,2-Dichloropropane	0/71	ND	ND	--	No
Soil	1,3,5-Trimethylbenzene	1/66	ND - 0.0057	0.00281	--	**Yes**
Soil	1,3-Dichlorobenzene	0/66	ND	ND	--	No
Soil	1,3-Dichloropropane	0/66	ND	ND	--	No
Soil	1,4-Dichlorobenzene	0/66	ND	ND	--	No
Soil	2,2-Dichloropropane	0/66	ND	ND	--	No
Soil	2-Butanone(MEK)	0/71	ND	ND	--	No
Soil	2-Chloroethylvinyl ether	0/66	ND	ND	--	No
Soil	2-Chlorotoluene	0/66	ND	ND	--	No
Soil	2-Hexanone	0/71	ND	ND	--	No
Soil	4-Chlorotoluene	0/66	ND	ND	--	No
Soil	4-Methyl-2-pentanone (MIBK)	0/71	ND	ND	--	No
Soil	Acetone	3/71	ND - 0.21	0.0263	--	**Yes**
Soil	Benzene	2/112	ND - 0.01	0.00239	--	**Yes**
Soil	Bromobenzene	0/66	ND	ND	--	No
Soil	Bromochloromethane	0/66	ND	ND	--	No
Soil	Bromodichloromethane	0/71	ND	ND	--	No
Soil	Bromoform	0/71	ND	ND	--	No
Soil	Bromomethane	0/71	ND	ND	--	No
Soil	Carbon disulfide	0/71	ND	ND	--	No
Soil	Carbon tetrachloride	0/71	ND	ND	--	No
Soil	Chlorobenzene	1/71	ND - 0.0078	0.00216	--	**Yes**
Soil	Chloroethane	0/71	ND	ND	--	No
Soil	Chloroform	0/71	ND	ND	--	No
Soil	Chloromethane	0/71	ND	ND	--	No
Soil	cis-1,2-Dichloroethene	0/71	ND	ND	--	No
Soil	cis-1,3-Dichloropropene	0/71	ND	ND	--	No
Soil	Dibromochloromethane	0/71	ND	ND	--	No
Soil	Dibromomethane	0/66	ND	ND	--	No
Soil	Dichlorodifluoromethane	0/66	ND	ND	--	No
Soil	di-Isopropyl Ether (DIPE)	0/23	ND	ND	--	No
Soil	Ethanol	0/23	ND	ND	--	No
Soil	Ethyl tert-Butyl Ether (ETBE)	0/23	ND	ND	--	No
Soil	Ethylbenzene	1/112	ND - 0.0055	0.00226	--	**Yes**
Soil	Hexachlorobutadiene	0/66	ND	ND	--	No
Soil	Isopropylbenzene	2/66	ND - 0.098	0.00642	--	**Yes**
Soil	Methylene chloride	0/71	ND	ND	--	No
Soil	MTBE	2/71	ND - 0.023	0.00286	--	**Yes**
Soil	Naphthalene	3/66	ND - 3.5	0.150	--	**Yes**
Soil	n-Butylbenzene	2/66	ND - 0.17	0.00932	--	**Yes**

TABLE 4-1: Summary of Chemicals Included in the Risk Assessment
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Sample Matrix	Chemical	On-Site Detection Frequency (Detections/Samples Analyzed)	Range of On-Site Concentrations [a] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	95% UCL of On-Site Concentrations [b] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	LBNL 1995 Background Concentrations [c] (mg/kg)	Included in Risk Assessment [d]
	Volatile Organic Compounds (cont'd)					
Soil	n-Propylbenzene	1/66	ND - 0.17	0.00927	--	**Yes**
Soil	p-Isopropyltoluene	0/66	ND	ND	--	No
Soil	sec-Butylbenzene	2/66	ND - 0.12	0.00755	--	**Yes**
Soil	Styrene	0/71	ND	ND	--	No
Soil	tert-Amyl Ethyl Ether (TAME)	0/23	ND	ND	--	No
Soil	tert-Butylbenzene	0/66	ND	ND	--	No
Soil	Tertiary Butanol (TBA)	0/23	ND	ND	--	No
Soil	Tetrachloroethene	2/71	ND - 0.011	0.00236	--	**Yes**
Soil	Toluene	7/112	ND - 0.018	0.00263	--	**Yes**
Soil	trans-1,2-Dichloroethene	0/71	ND	ND	--	No
Soil	trans-1,3-Dichloropropene	0/71	ND	ND	--	No
Soil	Trichloroethene	1/71	ND - 0.0079	0.00216	--	**Yes**
Soil	Trichlorofluoromethane	0/66	ND	ND	--	No
Soil	Trichlorotrifluoroethane	0/66	ND	ND	--	No
Soil	Vinyl acetate	0/71	ND	ND	--	No
Soil	Vinyl chloride	0/71	ND	ND	--	No
Soil	Xylene(s)	3/112	ND - 0.026	0.00296	--	**Yes**
	Total Petroleum Hydrocarbons [e]					
Soil	Diesel	79/113	ND - 5700	186	--	**Yes**
Soil	Gasoline	6/112	ND - 310	7.89	--	**Yes**
Soil	Kerosene	0/107	ND	ND	--	No
Soil	Jet A	0/107	ND	ND	--	No
Soil	Motor Oil	49/107	ND - 3800	325	--	**Yes**
	Semi-volatile Organic Compounds					
Soil	1,3-Dichlorobenzene	0/45	ND	ND	--	No
Soil	1,4-Dichlorobenzene	0/45	ND	ND	--	No
Soil	2,4,5-Trichlorophenol	0/45	ND	ND	--	No
Soil	2,4,6-Trichlorophenol	0/45	ND	ND	--	No
Soil	2,4-Dichlorophenol	0/45	ND	ND	--	No
Soil	2,4-Dimethylphenol	0/45	ND	ND	--	No
Soil	2,4-Dinitrophenol	0/45	ND	ND	--	No
Soil	2,4-Dinitrotoluene	0/45	ND	ND	--	No
Soil	2,6-Dinitrotoluene	0/45	ND	ND	--	No
Soil	2-Chloronaphthalene	0/45	ND	ND	--	No
Soil	2-Chlorophenol	0/45	ND	ND	--	No
Soil	2-Methyl-4,6-dinitrophenol	0/45	ND	ND	--	No
Soil	2-Methylnaphthalene	3/45	ND - 18	1.39	--	**Yes**
Soil	2-Methylphenol	0/45	ND	ND	--	No
Soil	2-Nitroaniline	0/45	ND	ND	--	No
Soil	2-Nitrophenol	0/45	ND	ND	--	No
Soil	3,3-Dichlorobenzidine	0/45	ND	ND	--	No
Soil	3-Nitroaniline	0/45	ND	ND	--	No
Soil	4-Bromophenyl phenyl ether	0/45	ND	ND	--	No
Soil	4-Chloro-3-methylphenol	0/45	ND	ND	--	No
Soil	4-Chloroaniline	0/45	ND	ND	--	No
Soil	4-Chlorophenyl phenyl ether	0/45	ND	ND	--	No
Soil	4-Methylphenol	0/45	ND	ND	--	No
Soil	4-Nitroaniline	0/45	ND	ND	--	No
Soil	4-Nitrophenol	0/45	ND	ND	--	No
Soil	Acenaphthene	1/45	ND - 14	1.09	--	**Yes**
Soil	Acenaphthylene	0/45	ND	ND	--	No
Soil	Anthracene	2/45	ND - 12	0.975	--	**Yes**
Soil	Benzo(a)anthracene	1/45	ND - 4	0.514	--	**Yes**

TABLE 4-1: Summary of Chemicals Included in the Risk Assessment
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Sample Matrix	Chemical	On-Site Detection Frequency (Detections/Samples Analyzed)	Range of On-Site Concentrations [a] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	95% UCL of On-Site Concentrations [b] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	LBNL 1995 Background Concentrations [c] (mg/kg)	Included in Risk Assessment [d]
	Semi-volatile Organic Compounds (cont'd)					
Soil	Benzo(a)pyrene	0/45	ND	ND	--	No
Soil	Benzo(b)fluoranthene	0/45	ND	ND	--	No
Soil	Benzo(g,h,i)perylene	0/45	ND	ND	--	No
Soil	Benzo(k)fluoranthene	0/45	ND	ND	--	No
Soil	Benzoic acid	0/45	ND	ND	--	No
Soil	Benzyl alcohol	0/45	ND	ND	--	No
Soil	Bis(2-chloroethoxy) methane	0/45	ND	ND	--	No
Soil	Bis(2-chloroethyl)ether	0/45	ND	ND	--	No
Soil	Bis(2-chloroisopropyl) ether	0/45	ND	ND	--	No
Soil	bis(2-Ethylhexyl) phthalate	0/45	ND	ND	--	No
Soil	Butyl benzyl phthalate	0/45	ND	ND	--	No
Soil	Chrysene	1/45	ND - 2.9	0.456	--	**Yes**
Soil	Dibenzo(a,h)anthracene	0/45	ND	ND	--	No
Soil	Dibenzofuran	2/45	ND - 8.5	0.770	--	**Yes**
Soil	Diethyl phthalate	0/45	ND	ND	--	No
Soil	Dimethyl phthalate	0/45	ND	ND	--	No
Soil	Di-n-butyl phthalate	0/45	ND	ND	--	No
Soil	Di-n-octyl phthalate	0/45	ND	ND	--	No
Soil	Fluoranthene	1/45	ND - 15	1.15	--	**Yes**
Soil	Fluorene	3/45	ND - 12	0.991	--	**Yes**
Soil	Hexachlorobenzene	0/45	ND	ND	--	No
Soil	Hexachlorobutadiene	0/45	ND	ND	--	No
Soil	Hexachlorocyclopentadiene	0/45	ND	ND	--	No
Soil	Hexachloroethane	0/45	ND	ND	--	No
Soil	Indeno(1,2,3-c,d)pyrene	0/45	ND	ND	--	No
Soil	Isophorone	0/45	ND	ND	--	No
Soil	Naphthalene	3/45	ND - 5.9	0.633	--	**Yes**
Soil	Nitrobenzene	0/45	ND	ND	--	No
Soil	N-Nitroso-di-n-propylamine	0/45	ND	ND	--	No
Soil	N-Nitrosodiphenylamine	0/45	ND	ND	--	No
Soil	Pentachlorophenol	0/45	ND	ND	--	No
Soil	Phenanthrene	4/45	ND - 36	2.44	--	**Yes**
Soil	Phenol	0/45	ND	ND	--	No
Soil	Pyrene	2/45	ND - 15	1.15	--	**Yes**
	Metals					
Soil	Antimony	17/107	ND - 22	2.32	3	No
Soil	Arsenic	105/107	ND - 880	41.9	7.3	**Yes**
Soil	Barium	107/107	2 - 180	60.7	147	No
Soil	Beryllium	0/107	ND	ND	0.5	No
Soil	Cadmium	107/107	0.55 - 14	2.45	0.5	**Yes**
Soil	Chromium	107/107	1.2 - 50	25.0	55	No
Soil	Chromium (Hexavalent)	0/107	ND	ND	--	No
Soil	Cobalt	107/107	2.3 - 14	6.58	17	No
Soil	Copper	107/107	2.5 - 380	47.7	32	**Yes**
Soil	Lead	107/107	1.1 - 680	57.4	14	**Yes**
Soil	Mercury	56/107	ND - 0.58	0.119	0.2	No
Soil	Molybdenum	4/107	ND - 2	0.568	55	No
Soil	Nickel	107/107	1.3 - 220	32.0	64	No
Soil	Selenium	4/107	ND - 2.5	1.09	2	No
Soil	Silver	0/107	ND	ND	0.6	No
Soil	Thallium	2/107	ND - 1.2	0.526	11	No
Soil	Vanadium	107/107	8.1 - 84	27.4	54	No
Soil	Zinc	107/107	7.1 - 600	63.6	60	**Yes**

TABLE 4-1: Summary of Chemicals Included in the Risk Assessment
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Sample Matrix	Chemical	On-Site Detection Frequency (Detections/Samples Analyzed)	Range of On-Site Concentrations [a] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	95% UCL of On-Site Concentrations [b] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	LBNL 1995 Background Concentrations [c] (mg/kg)	Included in Risk Assessment [d]
	Volatile Organic Compounds				--	
Water	Carbon tetrachloride	0/37	ND	ND	--	No
Water	Ethanol	0/18	ND	ND	--	No
Water	Acetone	0/37	ND	ND	--	No
Water	Chloroform	0/37	ND	ND	--	No
Water	Benzene	6/37	ND - 0.078	0.00896	--	**Yes**
Water	1,1,1-Trichloroethane	0/37	ND	ND	--	No
Water	Bromomethane	0/37	ND	ND	--	No
Water	Chloromethane	0/37	ND	ND	--	No
Water	Dibromomethane	0/21	ND	ND	--	No
Water	Bromochloromethane	0/21	ND	ND	--	No
Water	Chloroethane	1/37	ND - 0.011	0.00284	--	**Yes**
Water	Vinyl chloride	3/37	ND - 0.18	0.0152	--	**Yes**
Water	Methylene chloride	0/37	ND	ND	--	No
Water	Carbon disulfide	0/37	ND	ND	--	No
Water	Bromoform	0/37	ND	ND	--	No
Water	Bromodichloromethane	0/37	ND	ND	--	No
Water	1,1-Dichloroethane	3/37	ND - 0.0097	0.00172	--	**Yes**
Water	1,1-Dichloroethene	1/37	ND - 0.00097	0.00132	--	**Yes**
Water	Tertiary Butanol (TBA)	0/18	ND	ND	--	No
Water	Trichlorofluoromethane	0/21	ND	ND	--	No
Water	Dichlorodifluoromethane	0/21	ND	ND	--	No
Water	Trichlorotrifluoroethane	0/21	ND	ND	--	No
Water	1,2-Dichloropropane	2/37	ND - 0.2	0.0170	--	**Yes**
Water	2-Butanone(MEK)	0/37	ND	ND	--	No
Water	1,1,2-Trichloroethane	0/37	ND	ND	--	No
Water	Trichloroethene	5/37	ND - 0.029	0.00343	--	**Yes**
Water	1,1,2,2-Tetrachloroethane	0/37	ND	ND	--	No
Water	1,2,3-Trichlorobenzene	0/21	ND	ND	--	No
Water	Hexachlorobutadiene	0/21	ND	ND	--	No
Water	Naphthalene	9/21	ND - 0.35	0.117	--	**Yes**
Water	2-Chlorotoluene	0/21	ND	ND	--	No
Water	1,2-Dichlorobenzene	0/21	ND	ND	--	No
Water	1,2,4-Trimethylbenzene	3/21	ND - 0.05	0.00750	--	**Yes**
Water	1,2-Dibromo-3-chloropropane	0/21	ND	ND	--	No
Water	tert-Butylbenzene	0/21	ND	ND	--	No
Water	Isopropylbenzene	5/21	ND - 0.022	0.00608	--	**Yes**
Water	p-Isopropyltoluene	0/21	ND	ND	--	No
Water	Ethylbenzene	4/37	ND - 0.046	0.00565	--	**Yes**
Water	Styrene	0/37	ND	ND	--	No
Water	n-Propylbenzene	4/21	ND - 0.029	0.00946	--	**Yes**
Water	n-Butylbenzene	4/21	ND - 0.019	0.00652	--	**Yes**
Water	4-Chlorotoluene	0/21	ND	ND	--	No
Water	1,4-Dichlorobenzene	0/21	ND	ND	--	No
Water	1,2-Dibromoethane	0/21	ND	ND	--	No
Water	1,2-Dichloroethane	1/37	ND - 0.011	0.00193	--	**Yes**
Water	Vinyl acetate	0/37	ND	ND	--	No
Water	4-Methyl-2-pentanone (MIBK)	0/37	ND	ND	--	No
Water	di-Isopropyl Ether (DIPE)	1/18	ND - 0.0026	0.00124	--	**Yes**
Water	1,3,5-Trimethylbenzene	1/21	ND - 0.002	0.00207	--	**Yes**
Water	Bromobenzene	0/21	ND	ND	--	No
Water	Toluene	1/37	ND - 0.0012	0.00132	--	**Yes**
Water	Chlorobenzene	0/37	ND	ND	--	No
Water	2-Chloroethylvinyl ether	0/21	ND	ND	--	No

TABLE 4-1: Summary of Chemicals Included in the Risk Assessment
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Sample Matrix	Chemical	On-Site Detection Frequency (Detections/Samples Analyzed)	Range of On-Site Concentrations [a] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	95% UCL of On-Site Concentrations [b] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	LBNL 1995 Background Concentrations [c] (mg/kg)	Included in Risk Assessment [d]
	Volatile Organic Compounds (cont'd)				--	
Water	1,2,4-Trichlorobenzene	0/21	ND	ND	--	No
Water	Dibromochloromethane	0/37	ND	ND	--	No
Water	Tetrachloroethene	2/37	ND - 0.013	0.00191	--	**Yes**
Water	sec-Butylbenzene	5/21	ND - 0.015	0.00626	--	**Yes**
Water	1,3-Dichloropropane	0/21	ND	ND	--	No
Water	cis-1,2-Dichloroethene	8/37	ND - 0.65	0.0626	--	**Yes**
Water	trans-1,2-Dichloroethene	3/37	ND - 0.13	0.0108	--	**Yes**
Water	1,3-Dichlorobenzene	0/21	ND	ND	--	No
Water	1,1-Dichloropropene	0/21	ND	ND	--	No
Water	2-Hexanone	0/37	ND	ND	--	No
Water	2,2-Dichloropropane	0/21	ND	ND	--	No
Water	1,1,1,2-Tetrachloroethane	0/21	ND	ND	--	No
Water	Ethyl tert-Butyl Ether (ETBE)	0/18	ND	ND	--	No
Water	tert-Amyl Ethyl Ether (TAME)	0/18	ND	ND	--	No
Water	Xylene(s)	2/37	ND - 0.011	0.00296	--	**Yes**
Water	MTBE	2/37	ND - 0.13	0.0174	--	**Yes**
Water	cis-1,3-Dichloropropene	0/37	ND	ND	--	No
Water	trans-1,3-Dichloropropene	0/37	ND	ND	--	No
	Total Petroleum Hydrocarbons[e]					
Water	Gasoline	11/36	ND - 4.6	0.617	--	**Yes**
Water	Diesel	16/33	ND - 600	66.9	--	**Yes**
Water	Kerosene	0/31	ND	ND	--	No
Water	Jet A	0/31	ND	ND	--	No
Water	Motor Oil	7/31	ND - 7.1	5.70		**Yes**
	Semi-volatile Organic Compounds					
Water	Benzo(a)pyrene	0/13	ND	ND	--	No
Water	2,4-Dinitrophenol	0/13	ND	ND	--	No
Water	Dibenzo(a,h)anthracene	0/13	ND	ND	--	No
Water	Benzo(a)anthracene	0/13	ND	ND	--	No
Water	4-Chloro-3-methylphenol	0/13	ND	ND	--	No
Water	Benzoic acid	0/13	ND	ND	--	No
Water	Hexachloroethane	0/13	ND	ND	--	No
Water	Hexachlorocyclopentadiene	0/13	ND	ND	--	No
Water	Isophorone	0/13	ND	ND	--	No
Water	Acenaphthene	0/13	ND	ND	--	No
Water	Diethyl phthalate	0/13	ND	ND	--	No
Water	Di-n-butyl phthalate	0/13	ND	ND	--	No
Water	Phenanthrene	6/13	ND - 0.18	0.0856	--	**Yes**
Water	Butyl benzyl phthalate	0/13	ND	ND	--	No
Water	N-Nitrosodiphenylamine	0/13	ND	ND	--	No
Water	Fluorene	6/13	ND - 0.081	0.0394	--	**Yes**
Water	Hexachlorobutadiene	0/13	ND	ND	--	No
Water	Pentachlorophenol	0/13	ND	ND	--	No
Water	2,4,6-Trichlorophenol	0/13	ND	ND	--	No
Water	2-Nitroaniline	0/13	ND	ND	--	No
Water	2-Nitrophenol	0/13	ND	ND	--	No
Water	Naphthalene	5/13	ND - 0.39	0.167	--	**Yes**
Water	2-Methylnaphthalene	6/13	ND - 0.76	0.335	--	**Yes**
Water	2-Chloronaphthalene	0/13	ND	ND	--	No
Water	3,3-Dichlorobenzidine	0/13	ND	ND	--	No
Water	2-Methylphenol	0/13	ND	ND	--	No
Water	1,2-Dichlorobenzene	0/13	ND	ND	--	No
Water	2-Chlorophenol	0/13	ND	ND	--	No

TABLE 4-1: Summary of Chemicals Included in the Risk Assessment
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Sample Matrix	Chemical	On-Site Detection Frequency (Detections/Samples Analyzed)	Range of On-Site Concentrations [a] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	95% UCL of On-Site Concentrations [b] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	LBNL 1995 Background Concentrations [c] (mg/kg)	Included in Risk Assessment [d]
	Semi-volatile Organic Compounds (cont'd)					
Water	2,4,5-Trichlorophenol	0/13	ND	ND	--	No
Water	Nitrobenzene	0/13	ND	ND	--	No
Water	3-Nitroaniline	0/13	ND	ND	--	No
Water	4-Nitroaniline	0/13	ND	ND	--	No
Water	4-Nitrophenol	0/13	ND	ND	--	No
Water	Benzyl alcohol	0/13	ND	ND	--	No
Water	4-Bromophenyl phenyl ether	0/13	ND	ND	--	No
Water	2,4-Dimethylphenol	0/13	ND	ND	--	No
Water	4-Methylphenol	0/13	ND	ND	--	No
Water	1,4-Dichlorobenzene	0/13	ND	ND	--	No
Water	4-Chloroaniline	0/13	ND	ND	--	No
Water	Phenol	0/13	ND	ND	--	No
Water	Bis(2-chloroethyl)ether	0/13	ND	ND	--	No
Water	Bis(2-chloroethoxy) methane	0/13	ND	ND	--	No
Water	bis(2-Ethylhexyl) phthalate	0/13	ND	ND	--	No
Water	Di-n-octyl phthalate	0/13	ND	ND	--	No
Water	Hexachlorobenzene	0/13	ND	ND	--	No
Water	Anthracene	0/13	ND	ND	--	No
Water	1,2,4-Trichlorobenzene	0/13	ND	ND	--	No
Water	2,4-Dichlorophenol	0/13	ND	ND	--	No
Water	2,4-Dinitrotoluene	0/13	ND	ND	--	No
Water	Pyrene	0/13	ND	ND	--	No
Water	Dimethyl phthalate	0/13	ND	ND	--	No
Water	Dibenzofuran	1/13	ND - 0.0046	0.00609	--	**Yes**
Water	Benzo(g,h,i)perylene	0/13	ND	ND	--	No
Water	Indeno(1,2,3-c,d)pyrene	0/13	ND	ND	--	No
Water	Benzo(b)fluoranthene	0/13	ND	ND	--	No
Water	Fluoranthene	0/13	ND	ND	--	No
Water	Benzo(k)fluoranthene	0/13	ND	ND	--	No
Water	Acenaphthylene	0/13	ND	ND	--	No
Water	Chrysene	0/13	ND	ND	--	No
Water	2-Methyl-4,6-dinitrophenol	0/13	ND	ND	--	No
Water	1,3-Dichlorobenzene	0/13	ND	ND	--	No
Water	2,6-Dinitrotoluene	0/13	ND	ND	--	No
Water	N-Nitroso-di-n-propylamine	0/13	ND	ND	--	No
Water	4-Chlorophenyl phenyl ether	0/13	ND	ND	--	No
Water	Bis(2-chloroisopropyl) ether	0/13	ND	ND	--	No
	Volatile Organic Compounds					
Air	Ethylbenzene	2/23	ND - 0.0071	0.00152	--	**Yes**
Air	Styrene	0/23	ND	ND	--	No
Air	cis-1,3-Dichloropropene	0/23	ND	ND	--	No
Air	trans-1,3-Dichloropropene	0/23	ND	ND	--	No
Air	n-Propylbenzene	1/23	ND - 0.0021	0.000844	--	**Yes**
Air	n-Butylbenzene	0/23	ND	ND	--	No
Air	4-Chlorotoluene	0/23	ND	ND	--	No
Air	1,4-Dichlorobenzene	0/23	ND	ND	--	No
Air	1,2-Dibromoethane	0/23	ND	ND	--	No
Air	1,2-Dichloroethane	0/23	ND	ND	--	No
Air	Vinyl acetate	0/23	ND	ND	--	No
Air	4-Methyl-2-pentanone (MIBK)	0/23	ND	ND	--	No
Air	1,3,5-Trimethylbenzene	0/23	ND	ND	--	No
Air	Bromobenzene	0/23	ND	ND	--	No
Air	Toluene	1/23	ND - 0.00054	0.000383	--	**Yes**

TABLE 4-1: Summary of Chemicals Included in the Risk Assessment
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Sample Matrix	Chemical	On-Site Detection Frequency (Detections/Samples Analyzed)	Range of On-Site Concentrations [a] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	95% UCL of On-Site Concentrations [b] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	LBNL 1995 Background Concentrations [c] (mg/kg)	Included in Risk Assessment [d]
	Volatile Organic Compounds (cont'd)					
Air	Chlorobenzene	0/23	ND	ND	--	No
Air	2-Chloroethylvinyl ether	0/23	ND	ND	--	No
Air	1,2,4-Trichlorobenzene	0/23	ND	ND	--	No
Air	Dibromochloromethane	0/23	ND	ND	--	No
Air	Tetrachloroethene	0/23	ND	ND	--	No
Air	Xylene(s)	3/23	ND - 0.014	0.00215	--	**Yes**
Air	sec-Butylbenzene	1/23	ND - 0.0012	0.000773	--	**Yes**
Air	1,3-Dichloropropane	0/23	ND	ND	--	No
Air	cis-1,2-Dichloroethene	1/23	ND - 0.0014	0.000454	--	**Yes**
Air	trans-1,2-Dichloroethene	0/23	ND	ND	--	No
Air	MTBE	1/23	ND - 0.021	0.00528	--	**Yes**
Air	1,3-Dichlorobenzene	0/23	ND	ND	--	No
Air	Carbon tetrachloride	0/23	ND	ND	--	No
Air	1,1-Dichloropropene	0/23	ND	ND	--	No
Air	2-Hexanone	0/23	ND	ND	--	No
Air	2,2-Dichloropropane	0/23	ND	ND	--	No
Air	1,1,1,2-Tetrachloroethane	0/23	ND	ND	--	No
Air	Acetone	0/23	ND	ND	--	No
Air	Chloroform	0/23	ND	ND	--	No
Air	Benzene	7/23	ND - 0.17	0.0209	--	**Yes**
Air	1,1,1-Trichloroethane	0/23	ND	ND	--	No
Air	Bromomethane	0/23	ND	ND	--	No
Air	Chloromethane	0/23	ND	ND	--	No
Air	Dibromomethane	0/23	ND	ND	--	No
Air	Bromochloromethane	0/23	ND	ND	--	No
Air	Chloroethane	0/23	ND	ND	--	No
Air	Vinyl chloride	2/23	ND - 0.0073	0.00137	--	**Yes**
Air	Methylene chloride	0/23	ND	ND	--	No
Air	Carbon disulfide	0/23	ND	ND	--	No
Air	Bromoform	0/23	ND	ND	--	No
Air	Bromodichloromethane	0/23	ND	ND	--	No
Air	1,1-Dichloroethane	0/23	ND	ND	--	No
Air	1,1-Dichloroethene	0/23	ND	ND	--	No
Air	Trichlorofluoromethane	1/23	ND - 0.0014	0.000787	--	**Yes**
Air	Dichlorodifluoromethane	0/23	ND	ND	--	No
Air	Trichlorotrifluoroethane	1/23	ND - 0.0021	0.000844	--	**Yes**
Air	1,2-Dichloropropane	0/23	ND	ND	--	No
Air	2-Butanone(MEK)	0/23	ND	ND	--	No
Air	1,1,2-Trichloroethane	0/23	ND	ND	--	No
Air	Trichloroethene	1/23	ND - 0.0016	0.000475	--	**Yes**
Air	1,1,2,2-Tetrachloroethane	0/23	ND	ND	--	No
Air	1,2,3-Trichlorobenzene	0/23	ND	ND	--	No
Air	Hexachlorobutadiene	0/23	ND	ND	--	No
Air	Naphthalene	0/23	ND	ND	--	No
Air	2-Chlorotoluene	0/23	ND	ND	--	No
Air	1,2-Dichlorobenzene	0/23	ND	ND	--	No
Air	1,2,4-Trimethylbenzene	2/23	ND - 0.00057	0.000400	--	**Yes**
Air	1,2-Dibromo-3-chloropropane	0/23	ND	ND	--	No
Air	tert-Butylbenzene	0/23	ND	ND	--	No
Air	Isopropylbenzene	1/23	ND - 0.0022	0.000538	--	**Yes**
Air	p-Isopropyltoluene	0/23	ND	ND	--	No

TABLE 4-1: Summary of Chemicals Included in the Risk Assessment
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Sample Matrix	Chemical	On-Site Detection Frequency (Detections/Samples Analyzed)	Range of On-Site Concentrations [a] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	95% UCL of On-Site Concentrations [b] (mg/kg for soil; mg/L for groundwater; mg/L for soil gas)	LBNL 1995 Background Concentrations [c] (mg/kg)	Included in Risk Assessment [d]
Air	Methane	21/23	ND - 520.1079	218	--	**Yes**
Air	TPH-Gasoline	15/23	ND - 114.1	14.3	--	**Yes**

Notes:

[a] The range of concentrations of all on-site samples (at all depths) collected during the March 2002 Phase II ESA by Iris Environmental.

[b] Corresponds to the 95% Upper Confidence Level (UCL) of the arithmetic mean calculated by assuming that chemicals reported as non-detect (ND) are present at one-half the analytical detection limit as recommended by the USEPA (1989). Field duplicate samples were considered for quality assurance purposes only, and are not included in the calculations.

[c] See Section 4.0 of the report and Table 4-2. As listed in Lawrence Berkeley National Laboratory (LBNL) Environmental Restoration Program, Universi of California, Berkeley. 1995. *Protocol for Determining Background Concentrations of Metals in Soil at Lawrence Berkeley National Laboratory*. Berkeley, California. August.

[d] Chemicals were included in the risk assessment if they were detected, with the exception of metals. Only metals deetected in soil above background concentrations were included in the risk assessment. If the 95% UCL is greater than the maximum detected concentration, the maximum detected concentration is used for screening purposes.

[e] TPH evaluated using detected individual related constituents.

TABLE 4-2: COMPARISON OF DETECTION LEVELS OF METALS IN SOIL TO BACKGROUND CONCENTRATIONS
Future Port of Oakland Field Services Complex
2225 and 2277 Seventh Street
Oakland, California

Chemical	Colluvium & Fill Background (LBNL, 1995)		Phase II ESA (Iris Environmental, 2002)	95% UCL Within Background?
	95% UCL Concentration (in ppm [mg/kg])	95% UTL Concentration (in ppm [mg/kg])	95% UCL Concentration (mg/kg)[a]	
Antimony	3.0	5.9	2.32	**Yes**
Arsenic	7.3	14.0	41.9	No
Barium	147	359	60.7	NA
Beryllium	0.5	0.9	ND	NA
Cadmium	0.5	1.5	2.45	No
Chromium	55	91	25.0	**Yes**
Chromium (Hexavalent)	--	--	ND	NA
Cobalt	17	22	6.58	NA
Copper	32	60	47.7	No
Lead	14	15	57.4	No
Mercury	0.2	0.3	0.119	**Yes**
Molybdenum	1.4	3.2	25.0	NA
Nickel	64	120	32.0	**Yes**
Selenium	2.0	5.6	1.09	**Yes**
Silver	0.6	1.7	ND	NA
Thallium	11	43	0.526	**Yes**
Vanadium	54	78	27.4	NA
Zinc	60	92	63.6	No

References:

Iris Environmental. 2002. *Phase II Environmental Site Assessment, Future Port Field Support Services Complex, 2225 & 2277 Seventh Street, Port of Oakland, Oakland, California*. Oakland, California. June 11.

Lawrence Berkeley National Laboratory (LBNL) Environmental Restoration Program, University of California, Berkeley. 1995. *Protocol for Determining Background Concentrations of Metals in Soil at Lawrence Berkeley National Laboratory*. Berkeley, California. August. **This document incorrectly presents its own statistical evaluation. The 95% UCL (upper confidence limit) of the mean presented as background data was calculated using the mean and standard deviation presented by LBNL in the document, however, and presented along with LBNL's 95% UTL (upper tolerance limit).

Notes:

[a] Corresponds to the 95% Upper Confidence Level (UCL) of the arithmetic mean calculated by assuming that chemicals reported as non-detect (ND) are present at one-half the analytical detection limit as recommended by the USEPA (1989). Field duplicate samples were considered for quality assurance purposes only, and are not included in the calculations.

-- = No data available.

NA = Not applicable.

ND = Not detected.

TABLE 5-1: PHYSICOCHEMICAL PROPERTIES OF THE CHEMICALS OF POTENTIAL CONCERN
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Chemical	VOC?	Diffusivity in air, Da (cm^2/s)	Source	Diffusivity in water, Dw (cm^2/s)	Source	Henry's law constant at reference temperature, H (atm-m^3/mol)	Source	Henry's law constant reference temperature, TR (oC)	Source	Enthalpy of vaporization at the normal boiling point, DHv,b (cal/mol)	Source	Normal boiling point, TB (oK)	Source	Critical temperature, TC (oK)	Source	Organic carbon partition coefficient, Koc (cm^3/g)	Source	Pure component water solubility, S (mg/L)	Source	MW	ABS	Source	Kp (cm/hr)	Source
Volatile Organic Compounds																								
1,1-Dichloroethane	Y	7.42E-02	1	1.05E-05	1	5.61E-03	1	2.50E+01	1	6.90E+03	1	3.31E+02	1	5.23E+02	1	3.16E+01	1	5.06E+03	1	99	0.1	6	0.0089	7
1,1-Dichloroethylene	Y	9.00E-02	1	1.04E-05	1	2.61E-02	1	2.50E+01	1	6.25E+03	1	3.05E+02	1	5.76E+02	1	5.89E+01	1	2.25E+03	1	97	0.1	6	0.0159	7
1,2,4-Trimethylbenzene	Y	7.50E-02	2	7.10E-06	2	5.70E-03	2	2.50E+01	4	NA	NA	4.42E+02	4	NA	NA	3.72E+03	2	5.70E+01	2	120.2	0.1	6	0.1331	7
1,2-Dichloroethane	Y	1.04E-01	1	9.90E-06	1	9.78E-04	1	2.50E+01	1	7.64E+03	1	3.57E+02	1	5.61E+02	1	1.74E+01	1	8.52E+03	1	99	0.1	6	0.0053	6
1,2-Dichloropropane	Y	7.82E-02	1	8.73E-06	1	2.80E-03	1	2.50E+01	1	7.59E+03	1	3.70E+02	1	5.72E+02	1	4.37E+01	1	2.80E+03	1	113	0.1	6	0.01	6
1,3,5-Trimethylbenzene	Y	7.50E-02	2	7.10E-06	2	7.71E-03	2	2.50E+01	4	NA	NA	4.38E+02	4	NA	NA	8.19E+02	2	4.80E+01	2	120.2	0.1	6	0.0944	7
Acetone	Y	1.24E-01	1	1.14E-05	1	3.88E-05	1	2.50E+01	1	6.96E+03	1	3.29E+02	1	5.08E+02	1	5.75E-01	1	1.00E+06	1	58	0.1	6	0.0006	7
Benzene	Y	8.80E-02	1	9.80E-06	1	5.56E-03	1	2.50E+01	1	7.34E+03	1	3.53E+02	1	5.62E+02	1	5.89E+01	1	1.75E+03	1	78.1	0.1	6	0.021	6
Chlorobenzene	Y	7.30E-02	1	8.70E-06	1	3.71E-03	1	2.50E+01	1	8.41E+03	1	4.05E+02	1	6.32E+02	1	2.19E+02	1	4.72E+02	1	113	0.1	6	0.041	6
Chloroethane	Y	1.04E-01	2	1.15E-05	2	1.10E-02	2	NA	NA	NA	NA	NA	NA	NA	NA	1.47E+01	2	5.70E+03	2	65	0.1	6	0.008	6
cis-1,2-Dichloroethylene	Y	7.36E-02	1	1.13E-05	1	4.07E-03	1	2.50E+01	1	7.19E+03	1	3.34E+02	1	5.44E+02	1	3.55E+01	1	3.50E+03	1	97	0.1	6	0.01	6b
Di-isopropyl ether	Y	7.36E-02	4	NA	NA	2.28E-03	4	2.50E+01	4	NA	NA	3.42E+02	4	NA	NA	1.31E+01	4	8.80E+03	4	102.2	0	0	0.0054	7
Ethylbenzene	Y	7.50E-02	1	7.80E-06	1	7.88E-03	1	2.50E+01	1	8.50E+03	1	4.09E+02	1	6.17E+02	1	3.63E+02	1	1.69E+02	1	106.2	0.1	6	0.074	6
Freon 113	Y	2.88E-02	2	8.07E-06	2	5.21E-01	2	NA	NA	NA	NA	NA	NA	NA	NA	1.60E+02	2	1.10E+03	2	187.4	0.1	6	0.024	7
Isopropylbenzene (Cumene)	Y	7.50E-02	2	7.10E-06	2	1.20E+00	2	NA	NA	NA	NA	NA	NA	NA	NA	2.20E+02	2	6.10E+01	2	120	0.1	6	0.1402	7
Methane	Y	2.10E-01	4	NA	NA	6.58E-01	4	2.50E+01	4	NA	NA	1.12E+02	4	NA	NA	4.81E+00	4	2.20E+01	4	16.04	0.1	6	0.009	7
Methyl tert-butyl ether	Y	8.10E-02	1	9.41E-05	1	5.87E-04	1	2.50E+01	1	6.68E+03	1	3.28E+02	1	4.97E+02	1	1.17E+01	1	4.80E+04	1	88.15	0.1	6	0.0026	7
Naphthalene	Y	5.90E-02	1	7.50E-06	1	4.83E-04	1	2.50E+01	1	1.04E+04	1	4.91E+02	1	7.48E+02	1	2.00E+03	1	3.10E+01	1	128.2	0.15	6	0.0694	7
n-Butylbenzene	Y	7.50E-02	2	7.80E-06	2	1.31E-02	2	NA	NA	NA	NA	NA	NA	NA	NA	2.83E+03	2	1.38E+01	2	134.2	0.1	6	0.3724	7
N-propylbenzene	Y	6.81E-02	4	NA	NA	1.05E-02	4	2.50E+01	4	NA	NA	4.32E+02	4	NA	NA	2.03E+03	4	5.22E+01	4	120.2	0.1	6	0.1468	7
sec-Butylbenzene	Y	7.50E-02	2	7.80E-06	2	1.87E-02	2	NA	NA	NA	NA	NA	NA	NA	NA	2.15E+03	2	1.70E+01	2	134.2	0.1	6	0.5081	7
Tetrachloroethylene	Y	7.20E-02	1	8.20E-06	1	1.84E-02	1	2.50E+01	1	8.29E+03	1	3.94E+02	1	6.20E+02	1	1.55E+02	1	2.00E+02	1	165.8	0.1	6	0.048	6
Toluene	Y	8.70E-02	1	8.60E-06	1	6.63E-03	1	2.50E+01	1	7.93E+03	1	3.84E+02	1	5.92E+02	1	1.82E+02	1	5.26E+02	1	92	0.1	6	0.045	6
trans-1,2-Dichloroethylene	Y	7.07E-02	1	1.19E-05	1	9.39E-03	1	2.50E+01	1	6.72E+03	1	3.21E+02	1	5.17E+02	1	5.25E+01	1	6.30E+03	1	97	0.1	6	0.0077	8
Trichloroethylene	Y	7.90E-02	1	9.10E-06	1	1.03E-02	1	2.50E+01	1	7.51E+03	1	3.60E+02	1	5.44E+02	1	1.66E+02	1	1.10E+03	1	131	0.1	6	0.016	6
Trichlorofluoromethane	Y	8.70E-02	2	1.30E-05	2	9.70E-02	2	NA	NA	NA	NA	NA	NA	NA	NA	1.60E+02	2	1.10E+03	2	137.4	0.1	6	0.017	6
Vinyl chloride (chloroethene)	Y	1.06E-01	1	1.23E-05	1	2.71E-02	1	2.50E+01	1	5.25E+03	1	2.59E+02	1	4.32E+02	1	1.86E+01	1	2.76E+03	1	98	0.1	6	0.0073	6
Xylenes	Y	7.00E-02	2	7.80E-06	2	7.34E-03	2	NA	NA	NA	NA	NA	NA	NA	NA	1.96E+02	2	1.61E+02	2	106.2	0.1	6	0.08	6a
Semi-Volatile Compounds																								
2-methylnaphthalene	Y	6.54E-02	4	NA	NA	5.18E-04	4	2.50E+01	4	NA	NA	2.41E+02	4	NA	NA	3.02E+03	4	2.46E+01	4	142.2	0.1	6	0.1423	7
Acenaphthene	Y	4.21E-02	1	7.69E-06	1	1.55E-04	1	2.50E+01	1	1.22E+04	1	5.51E+02	1	8.03E+02	1	7.08E+03	1	4.24E+00	1	154.2	0.15	6	0.1326	7
Anthracene	N	NA	NA	NA	NA	6.51E-05	1	2.50E+01	1	1.31E+04	1	6.15E+02	1	8.73E+02	1	2.95E+04	1	4.34E-02	1	178	0.15	6	0.2258	7
Benz(a)anthracene	N	NA	NA	NA	NA	3.34E-06	1	2.50E+01	1	1.60E+04	1	7.08E+02	1	1.00E+03	1	3.98E+05	1	9.40E-03	1	228.3	0.15	6	0.81	6
Chrysene	N	NA	NA	NA	NA	9.46E-05	1	2.50E+01	1	1.65E+04	1	7.14E+02	1	9.79E+02	1	3.98E+05	1	1.60E-03	1	228.3	0.15	6	0.81	6
Dibenzofuran	N	NA	NA	NA	NA	1.30E-05	2	NA	NA	NA	NA	NA	NA	NA	NA	7.76E+03	2	3.10E+00	2	170	0.1	6	0.1473	7
Fluoranthene	N	NA	NA	NA	NA	1.61E-05	1	2.50E+01	1	1.38E+04	1	6.56E+02	1	9.05E+02	1	1.07E+05	1	2.06E-01	1	202	0.15	6	0.36	6
Fluorene	N	NA	NA	NA	NA	6.37E-05	1	2.50E+01	1	1.27E+04	1	5.70E+02	1	8.70E+02	1	1.38E+04	1	1.98E+00	1	166.2	0.15	6	0.1714	7
Naphthalene	Y	5.90E-02	1	7.50E-06	1	4.83E-04	1	2.50E+01	1	1.04E+04	1	4.91E+02	1	7.48E+02	1	2.00E+03	1	3.10E+01	1	128.2	0.15	6	0.0694	7
Phenanthrene	N	NA	NA	NA	NA	4.23E-05	4	2.50E+01	4	NA	NA	6.13E+02	4	NA	NA	1.22E+04	4	1.15E+00	4	178.2	0.15	6	0.27	6
Pyrene	N	NA	NA	NA	NA	1.10E-05	1	2.50E+01	1	1.44E+04	1	6.68E+02	1	9.36E+02	1	1.05E+05	1	1.35E-01	1	200	0.15	6	0.3348	7
Petroleum Hydrocarbons																								
TPH-Diesel	Y	7.00E-02	3	6.40E-06	3	7.20E-04	5	NA	NA	NA	NA	NA	NA	NA	NA	2.75E+05	3	3.48E+00	3	182	0.1	6	0.0694	7
TPH-Gasoline	Y	7.60E-02	3	1.00E-05	3	7.20E-04	5	NA	NA	NA	NA	NA	NA	NA	NA	3.17E+04	3	1.68E+01	3	98	0.1	6	0.0694	7
Metals																								
Arsenic	N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	74.9	0.03	6	0.001	6
Barium	N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	137.3	0.01	6	0.001	6

TABLE 5-1: PHYSICOCHEMICAL PROPERTIES OF THE CHEMICALS OF POTENTIAL CONCERN
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Chemical	VOC?	Diffusivity in air, Da (cm^2/s)	Source	Diffusivity in water, Dw (cm^2/s)	Source	Henry's law constant at reference temperature, H (atm-m^3/mol)	Source	Henry's law constant reference temperature, TR (oC)	Source	Enthalpy of vaporization at the normal boiling point, DHv,b (cal/mol)	Source	Normal boiling point, TB (oK)	Source	Critical temperature, TC (oK)	Source	Organic carbon partition coefficient, Koc (cm^3/g)	Source	Pure component water solubility, S (mg/L)	Source	MW	ABS	Source	Kp (cm/hr)	Source
Cadmium	N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	112.4	0.001	6	0.001	6
Cobalt	N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	58.9	0.01	6	0.0004	6
Copper	N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	63.54	0.01	6	0.001	6
Lead	N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	207.2	0.01	6	0.0001	6
Molybdenum	N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	95.9	0.01	6	0.001	6
Vanadium	N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	50.9	0.01	6	0.001	6
Zinc	N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	65.38	0.01	6	0.0006	6

Notes:

NA = Not applicable or available.

[a] Kp listed for xylenes corresponds to Kp listed for m-xylene in USEPA 2001.

[b] Kp listed for cis-1,2-dichloroethylene corresponds to value listed for 1,2-dichloroethylene (no isomer specified).

References:

1. USEPA. 1997. *User's Guide for the Johnson and Ettinger (1991) Model For Subsurface Vapor Intrusion Into Buildings*. Office of Emergency and Remedial Response. Washington, D.C., September.
2. United States Environmental Protection Agency (USEPA). 1999. *Region IX Preliminary Remediation Goals. October.*
3. Massachusetts Department of Environmental Protection. 2002. *Characterizing Risks posed by Petroleum Contamination; Implementation of the MADEP VPH/EPH Approach, Final Policy.* October 31.
4. SRC PhysProp Database. 2002. found at http://esc.syrres.com/interkow/physdemo.htm and methods from Schwarzenback R. P. et al. 1993. *Environmental Organic Chemistry*. John Wiley and Sons, Inc., New York, NY.
5. Regional Water Quality Control Board (RWQCB). 2001. *Risked Based Screening Levels,* Appendix 7, MADEP TPH Surrogates. December.
6. California Environmental Protection Agency (Cal/EPA). 1994. Preliminary Endangerment Assessment Guidance Manual. Department of Toxic Substances Control, January.
7. Calculated value. Water-octanol partition coefficient obtained from SRC PhysProp Database. 2002. found at http://esc.syrres.com/interkow/physdemo.htm Equation for K_p obtained from U.S. Environmental Protection Agency (USEPA). 1992. Interim Report, Dermal Exposure Assessment: Principles and Applications. EPA/600/8-9011. January.
8. Predicted value listed in: United States Environmental Protection Agency (USEPA). 2001. Risk Assessment for Superfund: Volume I - Human Health Evaluation Manual, Part E, Supplement Guidance for Dermal Risk Assessment, Interim. Review Draft. EPA/540/R/99/005. OSWER 9285.7-02EP. September.

TABLE 5-2: SITE-SPECIFIC PROPERTIES
***Future Port* of Oakland Field Support Services Complex**
2225 and 2277 Seventh Street
Oakland, California

Parameter	Symbol	Commercial	Outdoors	Units	Source
Soil Parameters					
Average soil/groundwater temperature	T_S	16	16	°C	1
Depth below grade to top of contamination	L_t	46	15	cm	Conservative Estimate
Thickness of soil stratum A	h_A	15	15	cm	Conservative Estimate
Depth below grade to bottom of contamination	L_b	213	259	cm	Conservative Estimate
Depth to groundwater	L_{gw}	213	259	cm	Conservative Estimate
Soil stratum A SCS soil type		LS	LS		Conservative Estimate
Stratum A soil dry bulk density	r_b^A	1.70	1.70	g/cm^3	2
Stratum A soil total porosity	n^A	0.36	0.36	cm^3/cm^3	2
Stratum A soil water-filled porosity	q_w^A	0.14	0.14	cm^3/cm^3	2
Stratum A soil organic carbon fraction	f_{oc}^A	0.0014	0.0014	g/g	2
Groundwater Parameters					
Depth below grade to water table	L_{WT}	213	259	cm	Conservative Estimate
Thickness of soil stratum A	h_A	213	259	cm	Conservative Estimate
SCS soil type directly above water table		LS	LS		Conservative Estimate
Building Parameters					
Depth below grade to bottom of enclosed space floor	L_F	15	15	cm	Default from 1
Enclosed space floor thickness	L_{crack}	15	15	cm	Default from 1
Soil-bldg. pressure differential	DP	40	40	g/cm-s^2	Default from 1
Baseline methane pressure differential	BM_{dp}	15000	15000	g/cm-s^2	Default from 3
Methane pressure differential with engineering controls	$M_{dp,ec}$	0	0	g/cm-s^2	Engineering judgement
Enclosed space floor length	L_B	22860	22860	cm	Site-specific
Enclosed space floor width	W_B	2134	2134	cm	Site-specific
Enclosed space height	H_B	488	488	cm	Default from 1
Floor-wall seam crack width	w	0.10	0.20	cm	Default from 1
Indoor air exchange rate	ER	0.80	0.80	1/hr	Default from 1
Area of Building Over Plume		100%	100%		Default from 1
Trench Parameters					
Depth of Trench	D	NA	100	cm	Engineering judgement
Width of Trench	W	NA	150	cm	Engineering judgement
Length of Trench	L	NA	400	cm	Engineering judgement
Default Surface Wind Speed		NA	2.25	m/s	Engineering judgement
Trench factor		NA	0.1		Engineering judgement

Notes:
LS = Loamy Sand.
NA = Not applicable.

1. USEPA. 1997. *User's Guide for the Johnson and Ettinger (1991) Model For Subsurface Vapor Intrusion Into Buildings*. Office of Emergency and Remedial Response. Washington, D.C., September.
2. Site-specific value for Berths 23 and 24. Treadwell & Rollo Environmental and Geotechnical Consultants. 2002. *Revised Human Health Risk Assessment and Methane Hazard Evaluation, Former Mobil Bulk Fuel Terminal, Port of Oakland Berths 23 and 24, Oakland, California.* October 7.
3. Little et al. 1992. *Transport of Subsurface Contaminants into Buildings.* Environ. Sci. Technol., Vol. 26, No. 11.

TABLE 5-3: BASELINE AMBIENT AIR CONCENTRATIONS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Resulting from Soil Gas (mg/m^3)			Resulting from Soil (mg/m^3)			Resulting from Groundwater (mg/m^3)		
	Development	Future Land Use		Development	Future Land Use		Development	Future Land Use	
Chemical	On-Site Construction Workers	On-Site Commercial Workers	On-Site Intrusive Workers	On-Site Construction Workers	On-Site Commercial Workers	On-Site Intrusive Workers	On-Site Construction Workers	On-Site Commercial Workers	On-Site Intrusive Workers
Volatile Organic Compounds									
1,1-Dichloroethane	NA	NA	NA	NA	NA	NA	3.01E-04	9.01E-06	3.01E-04
1,1-Dichloroethylene	NA	NA	NA	2.42E-06	7.23E-06	9.69E-08	8.37E-04	2.50E-05	8.37E-04
1,2,4-Trimethylbenzene	9.67E-06	1.33E-05	3.87E-07	3.66E-06	5.04E-06	1.46E-07	2.01E-03	6.00E-05	2.01E-03
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA	5.56E-05	1.98E-06	5.56E-05
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	1.39E-03	4.16E-05	1.39E-03
1,3,5-Trimethylbenzene	NA	NA	NA	3.14E-06	9.36E-06	1.25E-07	7.24E-04	2.16E-05	7.24E-04
Acetone	NA	NA	NA	2.94E-05	1.14E-05	1.17E-06	NA	NA	NA
Benzene	2.83E-05	8.45E-05	1.13E-06	2.67E-06	7.96E-06	1.07E-07	1.50E-03	4.48E-05	1.50E-03
Chlorobenzene	NA	NA	NA	2.41E-06	7.20E-06	9.64E-08	NA	NA	NA
Chloroethane	NA	NA	NA	NA	NA	NA	1.47E-03	4.39E-05	1.47E-03
cis-1,2-Dichloroethylene	6.56E-07	1.96E-06	2.62E-08	NA	NA	NA	7.83E-03	2.34E-04	7.83E-03
Di-isopropyl ether	NA	NA	NA	NA	NA	NA	1.33E-04	3.97E-06	1.33E-04
Ethylbenzene	5.38E-06	1.61E-05	2.15E-07	2.52E-06	7.53E-06	1.01E-07	1.20E-03	3.58E-05	1.20E-03
Freon 113	1.35E-07	4.02E-07	5.39E-09	NA	NA	NA	NA	NA	NA
Isopropylbenzene (Cumene)	8.23E-08	2.46E-07	3.29E-09	7.16E-06	2.14E-05	2.87E-07	3.43E-01	1.02E-02	3.43E-01
Methane	3.23E-02	9.63E-02	1.29E-03	NA	NA	NA	NA	NA	NA
Methyl tert-butyl ether	3.56E-05	1.06E-04	1.42E-06	3.19E-06	9.53E-06	1.28E-07	3.22E-04	1.77E-05	3.22E-04
Naphthalene	NA	NA	NA	1.67E-04	1.77E-05	6.70E-06	1.31E-03	4.61E-05	1.31E-03
n-Butylbenzene	NA	NA	NA	1.04E-05	3.11E-05	4.16E-07	4.01E-03	1.20E-04	4.01E-03
N-propylbenzene	6.21E-06	1.85E-05	2.49E-07	1.03E-05	3.09E-05	4.14E-07	4.66E-03	1.39E-04	4.66E-03
sec-Butylbenzene	3.42E-06	1.02E-05	1.37E-07	8.43E-06	2.52E-05	3.37E-07	5.50E-03	1.64E-04	5.50E-03
Tetrachloroethylene	NA	NA	NA	2.63E-06	7.86E-06	1.05E-07	9.77E-04	2.92E-05	9.77E-04
Toluene	8.92E-07	2.66E-06	3.57E-08	2.94E-06	8.76E-06	1.17E-07	2.26E-04	6.76E-06	2.26E-04
trans-1,2-Dichloroethylene	NA	NA	NA	NA	NA	NA	3.22E-03	9.63E-05	3.22E-03
Trichloroethylene	6.72E-07	2.01E-06	2.69E-08	2.41E-06	7.20E-06	9.64E-08	1.04E-03	3.10E-05	1.04E-03
Trichlorofluoromethane	1.78E-07	5.32E-07	7.13E-09	NA	NA	NA	NA	NA	NA
Vinyl chloride (chloroethene)	3.87E-07	1.16E-06	1.55E-08	NA	NA	NA	1.47E-02	4.40E-04	1.47E-02
Xylenes	3.03E-06	9.04E-06	1.21E-07	3.30E-06	9.86E-06	1.32E-07	1.02E-03	3.05E-05	1.02E-03
Semi-Volatile Compounds									
2-methylnaphthalene	NA	NA	NA	1.55E-03	2.40E-04	6.21E-05	8.15E-03	2.44E-04	8.15E-03
Acenaphthene	NA	NA	NA	1.22E-03	9.99E-06	4.87E-05	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benz(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	7.06E-04	7.47E-05	2.83E-05	1.86E-03	6.58E-05	1.86E-03
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons									
TPH-Diesel	NA	NA	NA	2.08E-01	4.99E-04	8.30E-03	1.18E-01	3.52E-03	1.18E-01
TPH-Gasoline	2.29E+01	4.76E-01	9.14E-01	8.81E-03	1.83E-04	3.52E-04	2.09E-02	6.24E-04	2.09E-02
Metals									
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
NA = Not applicable

TABLE 5-4: SITE DEVELOPMENT AMBIENT AIR CONCENTRATIONS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Chemical	Resulting from Soil Gas (mg/m^3)	Resulting from Soil (mg/m^3)	Resulting from Groundwater (mg/m^3)
	On-Site Commercial Workers	On-Site Commercial Workers	On-Site Commercial Workers
Volatile Organic Compounds			
1,1-Dichloroethane	NA	NA	5.64E-06
1,1-Dichloroethylene	NA	7.23E-06	1.63E-05
1,2,4-Trimethylbenzene	1.17E-05	4.42E-06	3.47E-05
1,2-Dichloroethane	NA	NA	1.98E-06
1,2-Dichloropropane	NA	NA	3.01E-05
1,3,5-Trimethylbenzene	NA	9.36E-06	1.23E-05
Acetone	NA	1.03E-05	NA
Benzene	8.45E-05	7.96E-06	3.20E-05
Chlorobenzene	NA	7.20E-06	NA
Chloroethane	NA	NA	3.33E-05
cis-1,2-Dichloroethylene	1.96E-06	NA	1.57E-04
Di-isopropyl ether	NA	NA	2.08E-06
Ethylbenzene	1.61E-05	7.53E-06	2.13E-05
Freon 113	4.02E-07	NA	NA
Isopropylbenzene (Cumene)	2.46E-07	2.14E-05	5.47E-03
Methane	9.63E-02	NA	NA
Methyl tert-butyl ether	1.06E-04	9.53E-06	1.77E-05
Naphthalene	NA	1.58E-05	4.61E-05
n-Butylbenzene	NA	3.11E-05	6.66E-05
N-propylbenzene	1.85E-05	3.09E-05	6.80E-05
sec-Butylbenzene	1.02E-05	2.52E-05	9.03E-05
Tetrachloroethylene	NA	7.86E-06	1.58E-05
Toluene	2.66E-06	8.76E-06	4.65E-06
trans-1,2-Dichloroethylene	NA	NA	5.50E-05
Trichloroethylene	2.01E-06	7.20E-06	1.89E-05
Trichlorofluoromethane	5.32E-07	NA	NA
Vinyl chloride (chloroethene)	1.16E-06	NA	3.33E-04
Xylenes	9.04E-06	9.86E-06	1.64E-05
Semi-Volatile Compounds			
2-methylnaphthalene	NA	2.15E-04	1.14E-04
Acenaphthene	NA	8.84E-06	NA
Anthracene	NA	NA	NA
Benz(a)anthracene	NA	NA	NA
Chrysene	NA	NA	NA
Dibenzofuran	NA	NA	NA
Fluoranthene	NA	NA	NA
Fluorene	NA	NA	NA
Naphthalene	NA	6.68E-05	6.58E-05
Phenanthrene	NA	NA	NA
Pyrene	NA	NA	NA
Petroleum Hydrocarbons			
TPH-Diesel	NA	4.49E-04	2.77E-03
TPH-Gasoline	4.29E-01	1.65E-04	5.98E-04
Metals			
Arsenic	NA	NA	NA
Barium	NA	NA	NA
Cadmium	NA	NA	NA
Cobalt	NA	NA	NA
Lead	NA	NA	NA
Molybdenum	NA	NA	NA
Vanadium	NA	NA	NA

Notes:
NA = Not applicable

TABLE 6-1: TOXICITY VALUES OF THE CHEMICALS OF POTENTIAL CONCERN
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Chemical	Cancer Slope Factor (CSF) (mg/kg-day)$^{-1}$				Chronic Noncancer Reference Dose (RfD) (mg/kg-day)			
	Inhalation	Source	Oral	Source	Inhalation	Source	Oral	Source
Volatile Organic Compounds								
1,1-Dichloroethane	5.70E-03	1	5.70E-03	1	1.43E-01	2	1.00E-01	2
1,1-Dichloroethylene	1.75E-01	3	6.00E-01	3	2.00E-02	1	9.00E-03	3
1,2,4-Trimethylbenzene	NC	1	NC	1	1.70E-03	4	5.00E-02	4
1,2-Dichloroethane	7.20E-02	1	4.70E-02	1	1.40E-03	4	3.00E-02	4
1,2-Dichloropropane	3.60E-02	1	3.60E-02	1	1.14E-03	3	1.14E-03	3a
1,3,5-Trimethylbenzene	NC	1	NC	1	1.70E-03	4	5.00E-02	4
Acetone	NC	1	NC	1	1.00E-01	3a	1.00E-01	3
Benzene	1.00E-01	1	1.00E-01	1	1.71E-02	1b	3.00E-03	4
Chlorobenzene	NC	1	NC	1	2.86E-01	1b	2.00E-02	3
Chloroethane	NC	1	NC	1	8.57E+00	1b	4.00E-01	4
cis-1,2-Dichloroethylene	NC	1	NC	1	1.0E-02	2a	1.0E-02	2
Di-isopropyl ether	NC	3	NC	3	2.00E-01	3c	2.00E-01	3c
Ethylbenzene	NC	1	NC	1	5.71E-01	1b	1.00E-01	3
Freon 113	NC	1	NC	1	3.00E+01	3a	3.00E+01	3
Isopropylbenzene (Cumene)	NC	1	NC	1	1.14E-01	3b	1.00E-01	3
Methane	NC	1	NC	1	NA	1	NA	1
Methyl tert-butyl ether	1.80E-03	1	1.80E-03	1	2.29E+00	1b	8.60E-01	3a
Naphthalene	NC	1	NC	1	2.57E-03	1b	2.00E-02	3
n-Butylbenzene	NC	1	NC	1	1.00E-02	4a	1.00E-02	4
N-propylbenzene	NC	1	NC	1	1.00E-02	4a	1.00E-02	4
sec-Butylbenzene	NC	1	NC	1	1.00E-02	4a	1.00E-02	4
Tetrachloroethylene	5.40E-01	1	1.50E-01	1	1.00E-02	1b	1.00E-02	3
Toluene	NC	1	NC	1	8.57E-02	1b	2.00E-01	3
trans-1,2-Dichloroethylene	NC	1	NC	1	2.00E-02	3	2.00E-02	3
Trichloroethylene	1.00E-02	1	1.53E-02	1	1.71E-01	1b	6.00E-03	5d
Trichlorofluoromethane	NC	1	NC	1	3.00E-01	3a	3.00E-01	3
Vinyl chloride (chloroethene)	2.70E-01	1	2.70E-01	1	2.86E-02	3b	3.00E-03	3
Xylenes	NC	1	NC	1	2.00E-01	1b	2.00E+00	3
Semi-Volatile Compounds								
2-methylnaphthalene	NC	1	NC	1	2.57E-03	1e	2.00E-02	3e
Acenaphthene	NC	1	NC	1	6.00E-02	3a	6.00E-02	3
Anthracene	NC	1	NC	1	3.00E-01	3a	3.00E-01	3
Benz(a)anthracene	3.90E-01	1	1.20E+00	1	3.00E-02	3f	3.00E-02	3f
Chrysene	3.90E-02	1	1.20E-01	1	3.00E-02	3f	3.00E-02	3f
Dibenzofuran	NC	1	NC	1	4.00E-03	4a	4.00E-03	4
Fluoranthene	NC	1	NC	1	4.00E-02	3a	4.00E-02	3
Fluorene	NC	1	NC	1	4.00E-02	3a	4.00E-02	3
Naphthalene	NC	1	NC	1	2.57E-03	1b	2.00E-02	3
Phenanthrene	NC	1	NC	1	3.00E-01	3g	3.00E-01	3g
Pyrene	NC	1	NC	1	3.00E-02	3a	3.00E-02	3
Metals								
Arsenic	1.20E+01	1	1.50E+00	1	8.57E-06	1b	3.00E-04	3
Barium	NC	1	NC	1	1.43E-04	2	7.00E-02	3
Cadmium	1.50E+01	1	3.80E-01	1	5.71E-06	1b	1.00E-03	3h
Cobalt	NC	1	NC	1	6.00E-02	4a	6.00E-02	4
Copper	NC	1	NC	1	3.71E-02	3a	3.70E-02	4i
Lead	NA	j	NA	j	NA	j	NA	j
Molybdenum	NC	1	NC	1	5.00E-03	3a	5.00E-03	3
Vanadium	NC	1	NC	1	7.00E-03	2a	7.00E-03	2
Zinc	NC	1	NC	1	3.00E-01	3a	3.00E-01	3

TABLE 6-1: TOXICITY VALUES OF THE CHEMICALS OF POTENTIAL CONCERN
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Notes:

NA - Not available. Route-specific toxicity value for this compound was not available.

NC - Not considered to be a carcinogen.

[a] Route-to-route extrapolation.

[b] This value has been converted from an RfC value (units: mg chemical/m^3 air), assuming a 20 m^3/day inhalation rate and a 70 kg body weight.

[c] Surrogate value - assumes toxicity for ethyl ether

[d] This value was withdrawn from the Integrated Risk Information System Database. Value obtained from USEPA 2000.

[e] Surrogate value - assumes toxicity for naphthalene

[f] Because the USEPA has not developed an RfD for this chemical, the noncancer RfD for pyrene is used as a surrogate value.

[g] Surrogate value - assumes toxicity for anthracene

[h] The RfD for cadmium is estimated for cadmium exposure in food.

[i] The RfD for copper is based on a drinking water standard of 1.3 mg/L.

[j] Lead exposure is evaluated using Cal/EPA's LEADSPREAD Model. See Section 6.3

Sources:

1. California Environmental Protection Agency (Cal/EPA). 2001. *Toxicity Criteria Database.* Maintained online at www.oehha.org. Office of Environmental Health Hazard Assessment (OEHHA).
2. United States Environmental Protection Agency (USEPA). 1997. *Health Effects Assessment Summary Tables.* FY 1997 Update. July. Office of Environmental Health Hazard Assessment (OEHHA).
3. United States Environmental Protection Agency (USEPA). 2001. *Integrated Risk Information System Database.* Maintained online by the USEPA.
4. NCEA. National Center for Environmental Assessment from Region IX PRG table. Found at www.epa.gov/region09/waste/sfund/prg/s4_06.htm.
5. United States Environmental Protection Agency (USEPA) 1999. *Region IX Preliminary Remediation Goals. October.*

TABLE 7-1: EQUATIONS USED TO CALCULATE CHRONIC DAILY INTAKES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Chronic Daily Intake: Vapor Inhalation

Noncancer

$$CDI_{inh,v} = \frac{C_a \times BR \times EF \times ED}{BW \times At_{nc}}$$

Cancer

$$CDI_{inh,v} = \frac{C_a \times BR \times EF \times Ed}{BW \times AT_c}$$

Chronic Daily Intake: Soil Particulate Inhalation

Noncancer

$$CDI_{inh,p} = \frac{C_s \times TF_p \times BR \times EF \times ED}{BW \times At_{nc}}$$

Cancer

$$CDI_{inh,p} = \frac{C_s \times TF_p \times BR \times EF \times Ed}{BW \times AT_c}$$

Chronic Daily Intake: Soil Dermal Contact

Noncancer

$$CDI_{derm} = \frac{C_s \times SA \times AF \times ABS \times EF \times ED \times CF}{BW \times At_{nc}}$$

Cancer

$$CDI_{derm} = \frac{C_s \times SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT_c}$$

Chronic Daily Intake: Soil Ingestion

Noncancer

$$CDI_{ing} = \frac{C_s \times IR \times CF \times EF \times ED}{BW \times At_{nc}}$$

Cancer

$$CDI_{ing} = \frac{C_s \times IR \times CF \times EF \times ED}{BW \times AT_c}$$

TABLE 7-1: EQUATIONS USED TO CALCULATE CHRONIC DAILY INTAKES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Chronic Daily Intake: Dermal Contact with Groundwater

Noncancer

$$CDI_{derm} = \frac{C_w \times SA \times K_p \times EF \times ED \times CF}{BW \times At_{nc}}$$

Cancer

$$CDI_{derm} = \frac{C_w \times SA \times K_p \times EF \times ED \times CF}{BW \times AT_c}$$

Where:

ABS =	Absorption Factor [Unitless]
AF =	Soil to Skin Adherence Factor [mg/cm^2]
AT_c =	Averaging Time for Carcinogenic Compounds [days]
AT_{nc} =	Averaging Time for Noncarcinogenic Compounds [days]
BR =	Breathing Rate [m^3/day]
BW =	Body Weight [kg]
CF =	Conversion Factor [kg/mg]
ED =	Exposure Duration [years]
EF =	Exposure Frequency [days/year]
CDI_{derm} =	Chronic Daily Intake: Dermal Contact [$mg_{chemical}/kg_{body\ weight}$-day]
CDI_{ing} =	Chronic Daily Intake: Ingestion [$mg_{chemical}/kg_{body\ weight}$-day]
$CDI_{inh,\ p}$ =	Chronic Daily Intake: Soil Particulate Inhalation [$mg_{chemical}/kg_{body\ weight}$-day]
$CDI_{inh,\ v}$ =	Chronic Daily Intake: Vapor Inhalation [$mg_{chemical}/kg_{body\ weight}$-day]
C_s =	Concentration of Chemical in Soil [mg/kg]
C_w =	Concentration of Chemical in Water [mg/L]
C_a =	Concentration of Chemical in Air [mg/m^3]
IRs =	Soil Ingestion Rate [mg/day]
IRw =	Water Ingestion Rate [liters/day]
SA =	Surface Area of Exposed Skin [cm^2/day]
K_p =	Dermal permeability coefficient (unitless)
TF_p =	Soil Particulate-to-Air Transfer Factor [(mg/m^3)/(mg/kg)]

TABLE 7-2: BASELINE CHRONIC DAILY INTAKES-CARCINOGENS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Development Phase						
	On-Site Construction Worker						
	Soil Gas Pathway (mg/kg-day)	Soil Pathway (mg/kg-day)				Groundwater Pathway (mg/kg-day)	
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Dermal Contact	Vapor Inhalation
Volatile Organic Compounds							
1,1-Dichloroethane	ND	ND	ND	ND	ND	2.70E-08	4.04E-07
1,1-Dichloroethylene	ND	1.46E-12	9.61E-12	6.99E-11	3.25E-09	2.73E-08	1.12E-06
1,2,4-Trimethylbenzene	NC	NC	NC	NC	NC	NC	NC
1,2-Dichloroethane	ND	ND	ND	ND	ND	1.81E-08	7.46E-08
1,2-Dichloropropane	ND	ND	ND	ND	ND	3.01E-07	1.87E-06
1,3,5-Trimethylbenzene	ND	NC	NC	NC	NC	NC	NC
Acetone	ND	NC	NC	NC	NC	ND	ND
Benzene	3.80E-08	1.60E-12	1.06E-11	7.70E-11	3.58E-09	3.33E-07	2.01E-06
Chlorobenzene	ND	NC	NC	NC	NC	ND	ND
Chloroethane	ND	ND	ND	ND	ND	NC	NC
cis-1,2-Dichloroethylene	NC	ND	ND	ND	ND	NC	NC
Di-isopropyl ether	ND	ND	ND	ND	ND	NC	NC
Ethylbenzene	NC	NC	NC	NC	NC	NC	NC
Freon 113	NC	ND	ND	ND	ND	ND	ND
Isopropylbenzene (Cumene)	NC	NC	NC	NC	NC	NC	NC
Methane	NC	ND	ND	ND	ND	ND	ND
Methyl tert-butyl ether	4.78E-08	1.92E-12	1.27E-11	9.21E-11	4.28E-09	7.92E-08	4.32E-07
Naphthalene	ND	NC	NC	NC	NC	NC	NC
n-Butylbenzene	ND	NC	NC	NC	NC	NC	NC
N-propylbenzene	NC	NC	NC	NC	NC	NC	NC
sec-Butylbenzene	NC	NC	NC	NC	NC	NC	NC
Tetrachloroethylene	ND	1.58E-12	1.05E-11	7.60E-11	3.53E-09	1.62E-07	1.31E-06
Toluene	NC	NC	NC	NC	NC	NC	NC
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	NC	NC
Trichloroethylene	9.02E-10	1.45E-12	9.57E-12	6.96E-11	3.23E-09	9.72E-08	1.39E-06
Trichlorofluoromethane	NC	ND	ND	ND	ND	ND	ND
Vinyl chloride (chloroethene)	5.20E-10	ND	ND	ND	ND	1.97E-07	1.98E-05
Xylenes	NC	NC	NC	NC	NC	NC	NC
Semi-Volatile Compounds							
2-methylnaphthalene	ND	NC	NC	NC	NC	NC	NC
Acenaphthene	ND	NC	NC	NC	NC	ND	ND
Anthracene	ND	NC	NC	NC	Not VOC	ND	ND
Benz(a)anthracene	ND	3.45E-10	3.41E-09	1.66E-08	Not VOC	ND	ND
Chrysene	ND	3.06E-10	3.03E-09	1.47E-08	Not VOC	ND	ND
Dibenzofuran	ND	NC	NC	NC	Not VOC	NC	Not VOC
Fluoranthene	ND	NC	NC	NC	Not VOC	ND	ND
Fluorene	ND	NC	NC	NC	Not VOC	NC	Not VOC
Naphthalene	ND	NC	NC	NC	NC	NC	NC
Phenanthrene	ND	NC	NC	NC	Not VOC	NC	Not VOC
Pyrene	ND	NC	NC	NC	Not VOC	ND	ND
Petroleum Hydrocarbons							
TPH-Diesel	ND	NC	NC	NC	NC	NC	NC
TPH-Gasoline	NC	NC	NC	NC	NC	NC	NC
Metals							
Arsenic	ND	2.81E-08	5.57E-08	1.35E-06	Not VOC	ND	ND
Barium	ND	NC	NC	NC	Not VOC	ND	ND
Cadmium	ND	1.64E-09	1.08E-10	7.89E-08	Not VOC	ND	ND
Cobalt	ND	NC	NC	NC	Not VOC	ND	ND
Copper	ND	NC	NC	NC	Not VOC	ND	ND
Lead	ND	NA	NA	NA	Not VOC	ND	ND
Molybdenum	ND	NC	NC	NC	Not VOC	ND	ND
Vanadium	ND	NC	NC	NC	Not VOC	ND	ND
Zinc	ND	Not VOC	Not VOC	Not VOC	Not VOC	ND	ND

Notes:
ND = Chemical not detected in medium.
NC = Not considered a carcinogen.
Not VOC = Chemical not volatile.

TABLE 7-2: BASELINE CHRONIC DAILY INTAKES-CARCINOGENS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use					
	On-Site Commercial Worker					
	Soil Gas Pathway (mg/kg-day)	Soil Pathway (mg/kg-day)				Groundwater Pathway (mg/kg-day)
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Vapor Inhalation
Volatile Organic Compounds						
1,1-Dichloroethane	ND	ND	ND	ND	ND	6.30E-07
1,1-Dichloroethylene	ND	7.58E-12	3.03E-10	3.79E-10	5.05E-07	1.75E-06
1,2,4-Trimethylbenzene	NC	NC	NC	NC	NC	NC
1,2-Dichloroethane	ND	ND	ND	ND	ND	1.38E-07
1,2-Dichloropropane	ND	ND	ND	ND	ND	2.91E-06
1,3,5-Trimethylbenzene	ND	NC	NC	NC	NC	NC
Acetone	ND	NC	NC	NC	NC	ND
Benzene	5.90767E-06	8.35E-12	3.33E-10	4.18E-10	5.57E-07	3.13E-06
Chlorobenzene	ND	NC	NC	NC	NC	ND
Chloroethane	ND	ND	ND	ND	ND	NC
cis-1,2-Dichloroethylene	NC	ND	ND	ND	ND	NC
Di-isopropyl ether	ND	ND	ND	ND	ND	NC
Ethylbenzene	NC	NC	NC	NC	NC	NC
Freon 113	NC	ND	ND	ND	ND	ND
Isopropylbenzene (Cumene)	NC	NC	NC	NC	NC	NC
Methane	NC	ND	ND	ND	ND	ND
Methyl tert-butyl ether	7.43168E-06	9.99E-12	3.99E-10	5.00E-10	6.66E-07	1.24E-06
Naphthalene	ND	NC	NC	NC	NC	NC
n-Butylbenzene	ND	NC	NC	NC	NC	NC
N-propylbenzene	NC	NC	NC	NC	NC	NC
sec-Butylbenzene	NC	NC	NC	NC	NC	NC
Tetrachloroethylene	ND	8.25E-12	3.29E-10	4.12E-10	5.50E-07	2.04E-06
Toluene	NC	NC	NC	NC	NC	NC
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	NC
Trichloroethylene	1.40241E-07	7.55E-12	3.01E-10	3.77E-10	5.03E-07	2.17E-06
Trichlorofluoromethane	NC	ND	ND	ND	ND	ND
Vinyl chloride (chloroethene)	8.07844E-08	ND	ND	ND	ND	3.08E-05
Xylenes	NC	NC	NC	NC	NC	NC
Semi-Volatile Compounds						
2-methylnaphthalene	ND	NC	NC	NC	NC	NC
Acenaphthene	ND	NC	NC	NC	NC	ND
Anthracene	ND	NC	NC	NC	Not VOC	ND
Benz(a)anthracene	ND	1.80E-09	1.08E-07	8.98E-08	Not VOC	ND
Chrysene	ND	1.59E-09	9.54E-08	7.97E-08	Not VOC	ND
Dibenzofuran	ND	NC	NC	NC	Not VOC	Not VOC
Fluoranthene	ND	NC	NC	NC	Not VOC	ND
Fluorene	ND	NC	NC	NC	Not VOC	Not VOC
Naphthalene	ND	NC	NC	NC	NC	NC
Phenanthrene	ND	NC	NC	NC	Not VOC	Not VOC
Pyrene	ND	NC	NC	NC	Not VOC	ND
Petroleum Hydrocarbons						
TPH-Diesel	ND	NC	NC	NC	NC	NC
TPH-Gasoline	NC	NC	NC	NC	NC	NC
Metals						
Arsenic	ND	1.46E-07	1.75E-06	7.32E-06	Not VOC	ND
Barium	ND	NC	NC	NC	Not VOC	ND
Cadmium	ND	8.56E-09	3.42E-09	4.28E-07	Not VOC	ND
Cobalt	ND	NC	NC	NC	Not VOC	ND
Copper	ND	NC	NC	NC	Not VOC	ND
Lead	ND	NA	NA	NA	Not VOC	ND
Molybdenum	ND	NC	NC	NC	Not VOC	ND
Vanadium	ND	NC	NC	NC	Not VOC	ND
Zinc	ND	Not VOC	Not VOC	Not VOC	Not VOC	ND

Notes:
ND = Chemical not detected in medium.
NC = Not considered a carcinogen.
Not VOC = Chemical not volatile.

TABLE 7-2: BASELINE CHRONIC DAILY INTAKES-CARCINOGENS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use						
	On-Site Intrusive Worker						
	Soil Gas Pathway (mg/kg-day)	Soil Pathway (mg/kg-day)				Groundwater Pathway (mg/kg-day)	
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Dermal Contact	Vapor Inhalation
Volatile Organic Compounds							
1,1-Dichloroethane	ND	ND	ND	ND	ND	1.12E-08	1.68E-07
1,1-Dichloroethylene	ND	6.07E-13	4.00E-12	2.91E-11	5.42E-11	1.14E-08	4.68E-07
1,2,4-Trimethylbenzene	NC	NC	NC	NC	NC	NC	NC
1,2-Dichloroethane	ND	ND	ND	ND	ND	7.55E-09	3.11E-08
1,2-Dichloropropane	ND	ND	ND	ND	ND	1.25E-07	7.79E-07
1,3,5-Trimethylbenzene	ND	NC	NC	NC	NC	NC	NC
Acetone	ND	NC	NC	NC	NC	ND	ND
Benzene	6.33244E-10	6.68E-13	4.41E-12	3.21E-11	5.97E-11	1.39E-07	8.38E-07
Chlorobenzene	ND	NC	NC	NC	NC	ND	ND
Chloroethane	ND	ND	ND	ND	ND	NC	NC
cis-1,2-Dichloroethylene	NC	ND	ND	ND	ND	NC	NC
Di-isopropyl ether	ND	ND	ND	ND	ND	NC	NC
Ethylbenzene	NC	NC	NC	NC	NC	NC	NC
Freon 113	NC	ND	ND	ND	ND	ND	ND
Isopropylbenzene (Cumene)	NC	NC	NC	NC	NC	NC	NC
Methane	NC	ND	ND	ND	ND	ND	ND
Methyl tert-butyl ether	7.96604E-10	8.00E-13	5.28E-12	3.84E-11	7.14E-11	3.30E-08	1.80E-07
Naphthalene	ND	NC	NC	NC	NC	NC	NC
n-Butylbenzene	ND	NC	NC	NC	NC	NC	NC
N-propylbenzene	NC	NC	NC	NC	NC	NC	NC
sec-Butylbenzene	NC	NC	NC	NC	NC	NC	NC
Tetrachloroethylene	ND	6.60E-13	4.35E-12	3.17E-11	5.89E-11	6.77E-08	5.46E-07
Toluene	NC	NC	NC	NC	NC	NC	NC
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	NC	NC
Trichloroethylene	1.50325E-11	6.04E-13	3.99E-12	2.90E-11	5.39E-11	4.05E-08	5.81E-07
Trichlorofluoromethane	NC	ND	ND	ND	ND	ND	ND
Vinyl chloride (chloroethene)	8.6593E-12	ND	ND	ND	ND	8.19E-08	8.24E-06
Xylenes	NC	NC	NC	NC	NC	NC	NC
Semi-Volatile Compounds							
2-methylnaphthalene	ND	NC	NC	NC	NC	NC	NC
Acenaphthene	ND	NC	NC	NC	NC	ND	ND
Anthracene	ND	NC	NC	NC	Not VOC	ND	ND
Benz(a)anthracene	ND	1.44E-10	1.42E-09	6.90E-09	Not VOC	ND	ND
Chrysene	ND	1.27E-10	1.26E-09	6.12E-09	Not VOC	ND	ND
Dibenzofuran	ND	NC	NC	NC	Not VOC	NC	Not VOC
Fluoranthene	ND	NC	NC	NC	Not VOC	ND	ND
Fluorene	ND	NC	NC	NC	Not VOC	NC	Not VOC
Naphthalene	ND	NC	NC	NC	NC	NC	NC
Phenanthrene	ND	NC	NC	NC	Not VOC	NC	Not VOC
Pyrene	ND	NC	NC	NC	Not VOC	ND	ND
Petroleum Hydrocarbons							
TPH-Diesel	ND	NC	NC	NC	NC	NC	NC
TPH-Gasoline	NC	NC	NC	NC	NC	NC	NC
Metals							
Arsenic	ND	1.17E-08	2.32E-08	5.62E-07	Not VOC	ND	ND
Barium	ND	NC	NC	NC	Not VOC	ND	ND
Cadmium	ND	6.85E-10	4.52E-11	3.29E-08	Not VOC	ND	ND
Cobalt	ND	NC	NC	NC	Not VOC	ND	ND
Copper	ND	NC	NC	NC	Not VOC	ND	ND
Lead	ND	NA	NA	NA	Not VOC	ND	ND
Molybdenum	ND	NC	NC	NC	Not VOC	ND	ND
Vanadium	ND	NC	NC	NC	Not VOC	ND	ND
Zinc	ND	Not VOC	Not VOC	Not VOC	Not VOC	ND	ND

Notes:
ND = Chemical not detected in medium.
NC = Not considered a carcinogen.
Not VOC = Chemical not volatile.

TABLE 7-3: SITE DEVELOPMENT CHRONIC DAILY INTAKES-CARCINOGENS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Chemical	Future Land Use		
	On-Site Commercial Worker		
	Soil Gas Pathway (mg/kg-day)	Soil Pathway (mg/kg-day)	Groundwater Pathway (mg/kg-day)
	Vapor Inhalation	Vapor Inhalation	Vapor Inhalation
Volatile Organic Compounds			
1,1-Dichloroethane	ND	ND	3.94E-07
1,1-Dichloroethylene	ND	5.05E-07	1.14E-06
1,2,4-Trimethylbenzene	NC	NC	NC
1,2-Dichloroethane	ND	ND	1.38E-07
1,2-Dichloropropane	ND	ND	2.11E-06
1,3,5-Trimethylbenzene	ND	NC	NC
Acetone	ND	NC	ND
Benzene	5.90767E-06	5.57E-07	2.24E-06
Chlorobenzene	ND	NC	ND
Chloroethane	ND	ND	NC
cis-1,2-Dichloroethylene	NC	ND	NC
Di-isopropyl ether	ND	ND	NC
Ethylbenzene	NC	NC	NC
Freon 113	NC	ND	ND
Isopropylbenzene (Cumene)	NC	NC	NC
Methane	NC	ND	ND
Methyl tert-butyl ether	7.43168E-06	6.66E-07	1.24E-06
Naphthalene	ND	NC	NC
n-Butylbenzene	ND	NC	NC
N-propylbenzene	NC	NC	NC
sec-Butylbenzene	NC	NC	NC
Tetrachloroethylene	ND	5.50E-07	1.10E-06
Toluene	NC	NC	NC
trans-1,2-Dichloroethylene	ND	ND	NC
Trichloroethylene	1.40241E-07	5.03E-07	1.32E-06
Trichlorofluoromethane	NC	ND	ND
Vinyl chloride (chloroethene)	8.07844E-08	ND	2.33E-05
Xylenes	NC	NC	NC
Semi-Volatile Compounds			
2-methylnaphthalene	ND	NC	NC
Acenaphthene	ND	NC	ND
Anthracene	ND	Not VOC	ND
Benz(a)anthracene	ND	Not VOC	ND
Chrysene	ND	Not VOC	ND
Dibenzofuran	ND	Not VOC	Not VOC
Fluoranthene	ND	Not VOC	ND
Fluorene	ND	Not VOC	Not VOC
Naphthalene	ND	NC	NC
Phenanthrene	ND	Not VOC	Not VOC
Pyrene	ND	Not VOC	ND
Metals			
Arsenic	ND	Not VOC	ND
Barium	ND	Not VOC	ND
Cadmium	ND	Not VOC	ND
Cobalt	ND	Not VOC	ND
Copper	ND	Not VOC	ND
Lead	ND	Not VOC	ND
Molybdenum	ND	Not VOC	ND
Vanadium	ND	Not VOC	ND
Zinc	ND	Not VOC	ND

Notes:
ND = Chemical not detected in medium.
NC = Not considered a carcinogen.
Not VOC = Chemical not volatile.

TABLE 7-4: BASELINE CHRONIC DAILY INTAKES-NONCARCINOGENS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Development Phase						
	On-Site Construction Worker						
	Soil Gas Pathway (mg/kg-day)	Soil Pathway (mg/kg-day)				Groundwater Pathway (mg/kg-day)	
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Dermal Contact	Vapor Inhalation
Volatile Organic Compounds							
1,1-Dichloroethane	ND	ND	ND	ND	ND	1.89E-06	2.83E-05
1,1-Dichloroethylene	ND	1.02E-10	6.73E-10	4.89E-09	2.27E-07	1.91E-06	7.86E-05
1,2,4-Trimethylbenzene	9.08E-07	1.54E-10	1.02E-09	7.39E-09	3.44E-07	1.24E-04	1.89E-04
1,2-Dichloroethane	ND	ND	ND	ND	ND	1.27E-06	5.22E-06
1,2-Dichloropropane	ND	ND	ND	ND	ND	2.11E-05	1.31E-04
1,3,5-Trimethylbenzene	ND	1.32E-10	8.71E-10	6.33E-09	2.95E-07	2.34E-05	6.80E-05
Acetone	ND	1.24E-09	8.15E-09	5.93E-08	2.76E-06	ND	ND
Benzene	2.66E-06	1.12E-10	7.41E-10	5.39E-09	2.51E-07	2.33E-05	1.41E-04
Chlorobenzene	ND	1.01E-10	6.70E-10	4.87E-09	2.26E-07	ND	ND
Chloroethane	ND	ND	ND	ND	ND	2.82E-06	1.38E-04
cis-1,2-Dichloroethylene	6.16E-08	ND	ND	ND	ND	7.76E-05	7.36E-04
Di-isopropyl ether	ND	ND	ND	ND	ND	8.37E-07	1.25E-05
Ethylbenzene	5.05E-07	1.06E-10	7.01E-10	5.09E-09	2.37E-07	5.18E-05	1.13E-04
Freon 113	1.27E-08	ND	ND	ND	ND	ND	ND
Isopropylbenzene (Cumene)	7.73E-09	3.02E-10	1.99E-09	1.45E-08	6.73E-07	1.06E-04	3.22E-02
Methane	NA	ND	ND	ND	ND	ND	ND
Methyl tert-butyl ether	3.35E-06	1.34E-10	8.87E-10	6.45E-09	3.00E-07	5.54E-06	3.02E-05
Naphthalene	ND	7.05E-09	6.97E-08	3.38E-07	1.57E-05	1.01E-03	1.23E-04
n-Butylbenzene	ND	4.38E-10	2.89E-09	2.10E-08	9.77E-07	3.01E-04	3.77E-04
N-propylbenzene	5.84E-07	4.35E-10	2.87E-09	2.09E-08	9.72E-07	1.72E-04	4.38E-04
sec-Butylbenzene	3.21E-07	3.55E-10	2.34E-09	1.70E-08	7.91E-07	3.94E-04	5.16E-04
Tetrachloroethylene	ND	1.11E-10	7.32E-10	5.32E-09	2.47E-07	1.14E-05	9.18E-05
Toluene	8.38E-08	1.24E-10	8.15E-10	5.93E-09	2.76E-07	6.70E-06	2.12E-05
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	1.03E-05	3.03E-04
Trichloroethylene	6.31E-08	1.01E-10	6.70E-10	4.87E-09	2.26E-07	6.80E-06	9.75E-05
Trichlorofluoromethane	1.68E-08	ND	ND	ND	ND	ND	ND
Vinyl chloride (chloroethene)	3.64E-08	ND	ND	ND	ND	1.38E-05	1.38E-03
Xylenes	2.84E-07	1.39E-10	9.18E-10	6.67E-09	3.10E-07	2.94E-05	9.58E-05
Semi-Volatile Compounds							
2-methylnaphthalene	ND	6.53E-08	4.31E-07	3.13E-06	1.46E-04	5.91E-03	7.66E-04
Acenaphthene	ND	5.12E-08	5.07E-07	2.46E-06	1.14E-04	ND	ND
Anthracene	ND	4.58E-08	4.53E-07	2.20E-06	Not VOC	ND	ND
Benz(a)anthracene	ND	2.41E-08	2.39E-07	1.16E-06	Not VOC	ND	ND
Chrysene	ND	2.14E-08	2.12E-07	1.03E-06	Not VOC	ND	ND
Dibenzofuran	ND	3.62E-08	2.39E-07	1.74E-06	Not VOC	8.40E-05	Not VOC
Fluoranthene	ND	5.40E-08	5.35E-07	2.59E-06	Not VOC	ND	ND
Fluorene	ND	4.65E-08	4.61E-07	2.23E-06	Not VOC	8.37E-04	Not VOC
Naphthalene	ND	2.97E-08	2.94E-07	1.43E-06	6.64E-05	1.44E-03	1.75E-04
Phenanthrene	ND	1.15E-07	1.13E-06	5.50E-06	Not VOC	2.87E-03	Not VOC
Pyrene	ND	5.40E-08	5.35E-07	2.59E-06	Not VOC	ND	ND
Petroleum Hydrocarbons							
TPH-Diesel	ND	8.74E-06	5.77E-05	4.19E-04	1.95E-02	3.00E-02	1.11E-02
TPH-Gasoline	2.15E+00	3.71E-07	2.45E-06	1.78E-05	8.27E-04	5.31E-03	1.96E-03
Metals							
Arsenic	ND	1.97E-06	3.90E-06	9.45E-05	Not VOC	ND	ND
Barium	ND	2.85E-06	1.88E-06	1.37E-04	Not VOC	ND	ND
Cadmium	ND	1.15E-07	7.59E-09	5.52E-06	Not VOC	ND	ND
Cobalt	ND	3.09E-07	2.04E-07	1.48E-05	Not VOC	ND	ND
Copper	ND	2.24E-06	1.48E-06	1.08E-04	Not VOC	ND	ND
Lead	ND	NA	NA	NA	Not VOC	ND	ND
Molybdenum	ND	2.67E-08	1.76E-08	1.28E-06	Not VOC	ND	ND
Vanadium	ND	1.29E-06	8.49E-07	6.18E-05	Not VOC	ND	ND
Zinc	ND	2.99E-06	1.97E-06	1.43E-04	Not VOC	ND	ND

Notes:
ND = Chemical not detected or not sampled.
NA = Not applicable. See Appendix D.
Not VOC = Chemical not volatile.

TABLE 7-4: BASELINE CHRONIC DAILY INTAKES-NONCARCINOGENS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use					
	On-Site Commercial Worker					
	Soil Gas Pathway (mg/kg-day)	Soil Pathway (mg/kg-day)				Groundwater Pathway (mg/kg-day)
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Vapor Inhalation
Volatile Organic Compounds						
1,1-Dichloroethane	ND	ND	ND	ND	ND	1.76E-06
1,1-Dichloroethylene	ND	2.12E-11	8.47E-10	1.06E-09	1.41E-06	4.90E-06
1,2,4-Trimethylbenzene	2.60E-06	3.21E-11	1.28E-09	1.60E-09	9.86E-07	1.17E-05
1,2-Dichloroethane	ND	ND	ND	ND	ND	3.87E-07
1,2-Dichloropropane	ND	ND	ND	ND	ND	8.15E-06
1,3,5-Trimethylbenzene	ND	2.75E-11	1.10E-09	1.37E-09	1.83E-06	4.24E-06
Acetone	ND	2.57E-10	1.03E-08	1.29E-08	2.23E-06	ND
Benzene	1.65E-05	2.34E-11	9.33E-10	1.17E-09	1.56E-06	8.77E-06
Chlorobenzene	ND	2.11E-11	8.43E-10	1.06E-09	1.41E-06	ND
Chloroethane	ND	ND	ND	ND	ND	8.58E-06
cis-1,2-Dichloroethylene	3.83E-07	ND	ND	ND	ND	4.58E-05
Di-isopropyl ether	ND	ND	ND	ND	ND	7.77E-07
Ethylbenzene	3.14E-06	2.21E-11	8.82E-10	1.11E-09	1.47E-06	7.01E-06
Freon 113	7.88E-08	ND	ND	ND	ND	ND
Isopropylbenzene (Cumene)	4.81E-08	6.28E-11	2.51E-09	3.14E-09	4.19E-06	2.00E-03
Methane	NA	ND	ND	ND	ND	ND
Methyl tert-butyl ether	2.08E-05	2.80E-11	1.12E-09	1.40E-09	1.86E-06	3.47E-06
Naphthalene	ND	1.47E-09	8.78E-08	7.34E-08	3.47E-06	9.02E-06
n-Butylbenzene	ND	9.12E-11	3.64E-09	4.56E-09	6.08E-06	2.35E-05
N-propylbenzene	3.63E-06	9.07E-11	3.62E-09	4.54E-09	6.04E-06	2.73E-05
sec-Butylbenzene	2.00E-06	7.39E-11	2.95E-09	3.69E-09	4.92E-06	3.22E-05
Tetrachloroethylene	ND	2.31E-11	9.21E-10	1.15E-09	1.54E-06	5.71E-06
Toluene	5.21E-07	2.57E-11	1.03E-09	1.29E-09	1.71E-06	1.32E-06
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	1.88E-05
Trichloroethylene	3.93E-07	2.11E-11	8.43E-10	1.06E-09	1.41E-06	6.07E-06
Trichlorofluoromethane	1.04E-07	ND	ND	ND	ND	ND
Vinyl chloride (chloroethene)	2.26E-07	ND	ND	ND	ND	8.62E-05
Xylenes	1.77E-06	2.90E-11	1.16E-09	1.45E-09	1.93E-06	5.97E-06
Semi-Volatile Compounds						
2-methylnaphthalene	ND	1.36E-08	5.43E-07	6.80E-07	4.69E-05	4.77E-05
Acenaphthene	ND	1.07E-08	6.38E-07	5.33E-07	1.96E-06	ND
Anthracene	ND	9.54E-09	5.71E-07	4.77E-07	Not VOC	ND
Benz(a)anthracene	ND	5.03E-09	3.01E-07	2.51E-07	Not VOC	ND
Chrysene	ND	4.46E-09	2.67E-07	2.23E-07	Not VOC	ND
Dibenzofuran	ND	7.53E-09	3.01E-07	3.77E-07	Not VOC	Not VOC
Fluoranthene	ND	1.13E-08	6.73E-07	5.63E-07	Not VOC	ND
Fluorene	ND	9.70E-09	5.80E-07	4.85E-07	Not VOC	Not VOC
Naphthalene	ND	6.19E-09	3.71E-07	3.10E-07	1.46E-05	1.29E-05
Phenanthrene	ND	2.39E-08	1.43E-06	1.19E-06	Not VOC	Not VOC
Pyrene	ND	1.13E-08	6.73E-07	5.63E-07	Not VOC	ND
Petroleum Hydrocarbons						
TPH-Diesel	ND	1.82E-06	7.26E-05	9.10E-05	9.76E-05	6.89E-04
TPH-Gasoline	0.09306659	7.72E-08	3.08E-06	3.86E-06	3.58E-05	1.22E-04
Metals						
Arsenic	ND	4.10E-07	4.91E-06	2.05E-05	Not VOC	ND
Barium	ND	5.94E-07	2.37E-06	2.97E-05	Not VOC	ND
Cadmium	ND	2.40E-08	9.57E-09	1.20E-06	Not VOC	ND
Cobalt	ND	6.44E-08	2.57E-07	3.22E-06	Not VOC	ND
Copper	ND	4.67E-07	1.86E-06	2.33E-05	Not VOC	ND
Lead	ND	NA	NA	NA	Not VOC	ND
Molybdenum	ND	5.56E-09	2.22E-08	2.78E-07	Not VOC	ND
Vanadium	ND	2.68E-07	1.07E-06	1.34E-05	Not VOC	ND
Zinc	ND	6.22E-07	2.48E-06	3.11E-05	Not VOC	ND

Notes:
ND = Chemical not detected or not sampled.
NA = Not applicable. See Appendix D.
Not VOC = Chemical not volatile.

TABLE 7-4: BASELINE CHRONIC DAILY INTAKES-NONCARCINOGENS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use						
	On-Site Intrusive Worker						
	Soil Gas Pathway (mg/kg-day)	Soil Pathway (mg/kg-day)				Groundwater Pathway (mg/kg-day)	
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Dermal Contact	Vapor Inhalation
Volatile Organic Compounds							
1,1-Dichloroethane	ND	ND	ND	ND	ND	3.15E-08	4.72E-07
1,1-Dichloroethylene	ND	1.70E-12	1.12E-11	8.15E-11	1.52E-10	3.18E-08	1.31E-06
1,2,4-Trimethylbenzene	6.05353E-10	2.57E-12	1.69E-11	1.23E-10	2.29E-10	2.06E-06	3.14E-06
1,2-Dichloroethane	ND	ND	ND	ND	ND	2.11E-08	8.70E-08
1,2-Dichloropropane	ND	ND	ND	ND	ND	3.51E-07	2.18E-06
1,3,5-Trimethylbenzene	ND	2.20E-12	1.45E-11	1.06E-10	1.96E-10	3.90E-07	1.13E-06
Acetone	ND	2.06E-11	1.36E-10	9.88E-10	1.84E-09	ND	ND
Benzene	1.77308E-09	1.87E-12	1.23E-11	8.98E-11	1.67E-10	3.89E-07	2.35E-06
Chlorobenzene	ND	1.69E-12	1.12E-11	8.12E-11	1.51E-10	ND	ND
Chloroethane	ND	ND	ND	ND	ND	4.70E-08	2.30E-06
cis-1,2-Dichloroethylene	4.11E-11	ND	ND	ND	ND	1.29E-06	1.23E-05
Di-isopropyl ether	ND	ND	ND	ND	ND	1.39E-08	2.08E-07
Ethylbenzene	3.37E-10	1.77E-12	1.17E-11	8.49E-11	1.58E-10	8.64E-07	1.88E-06
Freon 113	8.44E-12	ND	ND	ND	ND	ND	ND
Isopropylbenzene (Cumene)	5.15E-12	5.03E-12	3.32E-11	2.41E-10	4.49E-10	1.76E-06	5.36E-04
Methane	NA	ND	ND	ND	ND	ND	ND
Methyl tert-butyl ether	2.23E-09	2.24E-12	1.48E-11	1.07E-10	2.00E-10	9.24E-08	5.04E-07
Naphthalene	ND	1.17E-10	1.16E-09	5.64E-09	1.05E-08	1.68E-05	2.04E-06
n-Butylbenzene	ND	7.30E-12	4.82E-11	3.50E-10	6.51E-10	5.02E-06	6.28E-06
N-propylbenzene	3.89E-10	7.26E-12	4.79E-11	3.48E-10	6.48E-10	2.87E-06	7.30E-06
sec-Butylbenzene	2.14E-10	5.91E-12	3.90E-11	2.84E-10	5.28E-10	6.57E-06	8.61E-06
Tetrachloroethylene	ND	1.85E-12	1.22E-11	8.87E-11	1.65E-10	1.89E-07	1.53E-06
Toluene	5.59E-11	2.06E-12	1.36E-11	9.88E-11	1.84E-10	1.12E-07	3.54E-07
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	1.72E-07	5.04E-06
Trichloroethylene	4.21E-11	1.69E-12	1.12E-11	8.12E-11	1.51E-10	1.13E-07	1.63E-06
Trichlorofluoromethane	1.12E-11	ND	ND	ND	ND	ND	ND
Vinyl chloride (chloroethene)	2.42E-11	ND	ND	ND	ND	2.29E-07	2.31E-05
Xylenes	1.90E-10	2.32E-12	1.53E-11	1.11E-10	2.07E-10	4.89E-07	1.60E-06
Semi-Volatile Compounds							
2-methylnaphthalene	ND	1.09E-09	7.18E-09	5.22E-08	9.71E-08	9.85E-05	1.28E-05
Acenaphthene	ND	8.53E-10	8.45E-09	4.10E-08	7.62E-08	ND	ND
Anthracene	ND	7.63E-10	7.56E-09	3.66E-08	Not VOC	ND	ND
Benz(a)anthracene	ND	4.02E-10	3.98E-09	1.93E-08	Not VOC	ND	ND
Chrysene	ND	3.57E-10	3.53E-09	1.71E-08	Not VOC	ND	ND
Dibenzofuran	ND	6.03E-10	3.98E-09	2.89E-08	Not VOC	1.40E-06	Not VOC
Fluoranthene	ND	9.00E-10	8.91E-09	4.32E-08	Not VOC	ND	ND
Fluorene	ND	7.76E-10	7.68E-09	3.72E-08	Not VOC	1.40E-05	Not VOC
Naphthalene	ND	4.95E-10	4.91E-09	2.38E-08	4.42E-08	2.39E-05	2.92E-06
Phenanthrene	ND	1.91E-09	1.89E-08	9.17E-08	Not VOC	4.78E-05	Not VOC
Pyrene	ND	9.00E-10	8.91E-09	4.32E-08	Not VOC	ND	ND
Petroleum Hydrocarbons							
TPH-Diesel	ND	1.46E-07	9.61E-07	6.99E-06	1.30E-05	5.00E-04	1.84E-04
TPH-Gasoline	0.001431661	6.18E-09	4.08E-08	2.96E-07	5.51E-07	8.85E-05	3.27E-05
Metals							
Arsenic	ND	3.28E-08	6.49E-08	1.57E-06	Not VOC	ND	ND
Barium	ND	4.75E-08	3.14E-08	2.28E-06	Not VOC	ND	ND
Cadmium	ND	1.92E-09	1.27E-10	9.21E-08	Not VOC	ND	ND
Cobalt	ND	5.15E-09	3.40E-09	2.47E-07	Not VOC	ND	ND
Copper	ND	3.73E-08	2.46E-08	1.79E-06	Not VOC	ND	ND
Lead	ND	NA	NA	NA	Not VOC	ND	ND
Molybdenum	ND	4.45E-10	2.93E-10	2.13E-08	Not VOC	ND	ND
Vanadium	ND	2.14E-08	1.42E-08	1.03E-06	Not VOC	ND	ND
Zinc	ND	4.98E-08	3.29E-08	2.39E-06	Not VOC	ND	ND

Notes:
ND = Chemical not detected or not sampled.
NA = Not applicable. See Appendix D.
Not VOC = Chemical not volatile.

TABLE 7-5: SITE DEVELOPMENT CHRONIC DAILY INTAKES-NONCARCINOGENS
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use		
	On-Site Commercial Worker		
	Soil Gas Pathway (mg/kg-day)	Soil Pathway (mg/kg-day)	Groundwater Pathway (mg/kg-day)
Chemical	Vapor Inhalation	Vapor Inhalation	Vapor Inhalation
Volatile Organic Compounds			
1,1-Dichloroethane	ND	ND	1.10E-06
1,1-Dichloroethylene	ND	1.41E-06	3.20E-06
1,2,4-Trimethylbenzene	2.28E-06	8.64E-07	6.79E-06
1,2-Dichloroethane	ND	ND	3.87E-07
1,2-Dichloropropane	ND	ND	5.89E-06
1,3,5-Trimethylbenzene	ND	1.83E-06	2.40E-06
Acetone	ND	2.02E-06	ND
Benzene	1.65E-05	1.56E-06	6.26E-06
Chlorobenzene	ND	1.41E-06	ND
Chloroethane	ND	ND	6.52E-06
cis-1,2-Dichloroethylene	3.83E-07	ND	3.07E-05
Di-isopropyl ether	ND	ND	4.08E-07
Ethylbenzene	3.14E-06	1.47E-06	4.17E-06
Freon 113	7.88E-08	ND	ND
Isopropylbenzene (Cumene)	4.81E-08	4.19E-06	1.07E-03
Methane	NA	ND	ND
Methyl tert-butyl ether	2.08E-05	1.86E-06	3.47E-06
Naphthalene	ND	3.10E-06	9.02E-06
n-Butylbenzene	ND	6.08E-06	1.30E-05
N-propylbenzene	3.63E-06	6.04E-06	1.33E-05
sec-Butylbenzene	2.00E-06	4.92E-06	1.77E-05
Tetrachloroethylene	ND	1.54E-06	3.09E-06
Toluene	5.21E-07	1.71E-06	9.09E-07
trans-1,2-Dichloroethylene	ND	ND	1.08E-05
Trichloroethylene	3.93E-07	1.41E-06	3.71E-06
Trichlorofluoromethane	1.04E-07	ND	ND
Vinyl chloride (chloroethene)	2.26E-07	ND	6.52E-05
Xylenes	1.77E-06	1.93E-06	3.22E-06
Semi-Volatile Compounds			
2-methylnaphthalene	ND	4.20E-05	2.24E-05
Acenaphthene	ND	1.73E-06	ND
Anthracene	ND	Not VOC	ND
Benz(a)anthracene	ND	Not VOC	ND
Chrysene	ND	Not VOC	ND
Dibenzofuran	ND	Not VOC	Not VOC
Fluoranthene	ND	Not VOC	ND
Fluorene	ND	Not VOC	Not VOC
Naphthalene	ND	1.31E-05	1.29E-05
Phenanthrene	ND	Not VOC	Not VOC
Pyrene	ND	Not VOC	ND
Metals			
Arsenic	ND	Not VOC	ND
Barium	ND	Not VOC	ND
Cadmium	ND	Not VOC	ND
Cobalt	ND	Not VOC	ND
Copper	ND	Not VOC	ND
Lead	ND	Not VOC	ND
Molybdenum	ND	Not VOC	ND
Vanadium	ND	Not VOC	ND
Zinc	ND	Not VOC	ND

Notes:
ND = Chemical not detected or not sampled.
Not VOC = Chemical not volatile.

TABLE 7-6: BASELINE CANCER RISK ESTIMATES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Development Phase							
	On-Site Construction Worker							
	Soil Gas Pathway	Soil Pathway				Groundwater Pathway		Total Risk
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Dermal Contact	Vapor Inhalation	
Volatile Organic Compounds								
1,1-Dichloroethane	ND	ND	ND	ND	ND	1.54E-10	2.30E-09	2.46E-09
1,1-Dichloroethylene	ND	2.55E-13	5.77E-12	4.19E-11	5.69E-10	1.64E-08	1.97E-07	2.14E-07
1,2,4-Trimethylbenzene	NC	NC	NC	NC	NC	NC	NC	NC
1,2-Dichloroethane	ND	ND	ND	ND	ND	8.52E-10	5.37E-09	6.22E-09
1,2-Dichloropropane	ND	ND	ND	ND	ND	1.08E-08	6.73E-08	7.81E-08
1,3,5-Trimethylbenzene	ND	NC	NC	NC	NC	NC	NC	NC
Acetone	ND	NC	NC	NC	NC	ND	ND	NC
Benzene	3.80E-09	1.60E-13	1.06E-12	7.70E-12	3.58E-10	3.33E-08	2.01E-07	2.39E-07
Chlorobenzene	ND	NC	NC	NC	NC	ND	ND	NC
Chloroethane	ND	ND	ND	ND	ND	NC	NC	NA
cis-1,2-Dichloroethylene	NC	ND	ND	ND	ND	NC	NC	NA
Di-isopropyl ether	ND	ND	ND	ND	ND	NC	NC	NA
Ethylbenzene	NC	NC	NC	NC	NC	NC	NC	NC
Freon 113	NC	ND	ND	ND	ND	ND	ND	NA
Isopropylbenzene (Cumene)	NC	NC	NC	NC	NC	NC	NC	NC
Methane	NC	ND	ND	ND	ND	ND	ND	NA
Methyl tert-butyl ether	8.60E-11	3.45E-15	2.28E-14	1.66E-13	7.71E-12	1.42E-10	7.78E-10	1.01E-09
Naphthalene	ND	NC	NC	NC	NC	NC	NC	NC
n-Butylbenzene	ND	NC	NC	NC	NC	NC	NC	NC
N-propylbenzene	NC	NC	NC	NC	NC	NC	NC	NC
sec-Butylbenzene	NC	NC	NC	NC	NC	NC	NC	NC
Tetrachloroethylene	ND	8.55E-13	1.57E-12	1.14E-11	1.91E-09	2.44E-08	7.08E-07	7.34E-07
Toluene	NC	NC	NC	NC	NC	NC	NC	NC
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	NC	NC	NA
Trichloroethylene	9.02E-12	1.45E-14	1.46E-13	1.06E-12	3.23E-11	1.49E-09	1.39E-08	1.55E-08
Trichlorofluoromethane	NC	ND	ND	ND	ND	ND	ND	NA
Vinyl chloride (chloroethene)	1.40E-10	ND	ND	ND	ND	5.31E-08	5.34E-06	5.39E-06
Xylenes	NC	NC	NC	NC	NC	NC	NC	NC
Semi-Volatile Compounds								
2-methylnaphthalene	ND	NC	NC	NC	NC	NC	NC	NC
Acenaphthene	ND	NC	NC	NC	NC	ND	ND	NC
Anthracene	ND	NC	NC	NC	Not VOC	ND	ND	NC
Benz(a)anthracene	ND	1.34E-10	4.10E-09	1.99E-08	Not VOC	ND	ND	2.41E-08
Chrysene	ND	1.19E-11	3.63E-10	1.76E-09	Not VOC	ND	ND	2.14E-09
Dibenzofuran	ND	NC	NC	NC	Not VOC	NC	Not VOC	NC
Fluoranthene	ND	NC	NC	NC	Not VOC	ND	ND	NC
Fluorene	ND	NC	NC	NC	Not VOC	NC	Not VOC	NC
Naphthalene	ND	NC	NC	NC	NC	NC	NC	NC
Phenanthrene	ND	NC	NC	NC	Not VOC	NC	Not VOC	NC
Pyrene	ND	NC	NC	NC	Not VOC	ND	ND	NC
Petroleum Hydrocarbons								
TPH-Diesel	ND	NC	NC	NC	NC	NC	NC	NC
TPH-Gasoline	NC	NC	NC	NC	NC	NC	NC	NC
Metals								
Arsenic	ND	3.37E-07	8.35E-08	2.02E-06	Not VOC	ND	ND	2.44E-06
Barium	ND	NC	NC	NC	Not VOC	ND	ND	NC
Cadmium	ND	2.47E-08	4.12E-11	3.00E-08	Not VOC	ND	ND	5.47E-08
Cobalt	ND	NC	NC	NC	Not VOC	ND	ND	NC
Copper	ND	NC	NC	NC	Not VOC	ND	ND	NC
Lead	ND	NA	NA	NA	Not VOC	ND	ND	NA
Molybdenum	ND	NC	NC	NC	Not VOC	ND	ND	NC
Vanadium	ND	NC	NC	NC	Not VOC	ND	ND	NC
Zinc	ND	NC	NC	NC	Not VOC	ND	ND	NC
Cumulative Cancer Risk	4.03E-09	3.62E-07	8.80E-08	2.08E-06	2.88E-09	1.41E-07	6.53E-06	9.21E-06

Notes:
ND = Not detected/sampled in medium.
NC = Not considered a carcinogen.
NA = Not applicable. See Appendix D.
Not VOC = Not volatile.

TABLE 7-6: BASELINE CANCER RISK ESTIMATES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use						
	On-Site Commercial Worker						
	Soil Gas Pathway	Soil Pathway				Groundwater Pathway	Total Risk
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Vapor Inhalation	
Volatile Organic Compounds							
1,1-Dichloroethane	ND	ND	ND	ND	ND	3.59E-09	3.59E-09
1,1-Dichloroethylene	ND	1.33E-12	1.82E-10	2.27E-10	8.84E-08	3.06E-07	3.95E-07
1,2,4-Trimethylbenzene	NC	NC	NC	NC	NC	NC	NC
1,2-Dichloroethane	ND	ND	ND	ND	ND	9.95E-09	9.95E-09
1,2-Dichloropropane	ND	ND	ND	ND	ND	1.05E-07	1.05E-07
1,3,5-Trimethylbenzene	ND	NC	NC	NC	NC	NC	NA
Acetone	ND	NC	NC	NC	NC	ND	NA
Benzene	5.91E-07	8.35E-13	3.33E-11	4.18E-11	5.57E-08	3.13E-07	9.60E-07
Chlorobenzene	ND	NC	NC	NC	NC	ND	NA
Chloroethane	ND	ND	ND	ND	ND	NC	NA
cis-1,2-Dichloroethylene	NC	ND	ND	ND	ND	NC	NC
Di-isopropyl ether	ND	ND	ND	ND	ND	NC	NA
Ethylbenzene	NC	NC	NC	NC	NC	NC	NC
Freon 113	NC	ND	ND	ND	ND	ND	NC
Isopropylbenzene (Cumene)	NC	NC	NC	NC	NC	NC	NC
Methane	NC	ND	ND	ND	ND	ND	NC
Methyl tert-butyl ether	1.34E-08	1.80E-14	7.18E-13	8.99E-13	1.20E-09	2.23E-09	1.68E-08
Naphthalene	ND	NC	NC	NC	NC	NC	NA
n-Butylbenzene	ND	NC	NC	NC	NC	NC	NA
N-propylbenzene	NC	NC	NC	NC	NC	NC	NC
sec-Butylbenzene	NC	NC	NC	NC	NC	NC	NC
Tetrachloroethylene	ND	4.45E-12	4.94E-11	6.19E-11	2.97E-07	1.10E-06	1.40E-06
Toluene	NC	NC	NC	NC	NC	NC	NC
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	NC	NA
Trichloroethylene	1.40E-09	7.55E-14	4.61E-12	5.77E-12	5.03E-09	2.17E-08	2.81E-08
Trichlorofluoromethane	NC	ND	ND	ND	ND	ND	NC
Vinyl chloride (chloroethene)	2.18E-08	ND	ND	ND	ND	8.31E-06	8.33E-06
Xylenes	NC	NC	NC	NC	NC	NC	NC
Semi-Volatile Compounds							
2-methylnaphthalene	ND	NC	NC	NC	NC	NC	NA
Acenaphthene	ND	NC	NC	NC	NC	ND	NA
Anthracene	ND	NC	NC	NC	Not VOC	ND	NA
Benz(a)anthracene	ND	7.01E-10	1.29E-07	1.08E-07	Not VOC	ND	2.37E-07
Chrysene	ND	6.21E-11	1.14E-08	9.56E-09	Not VOC	ND	2.11E-08
Dibenzofuran	ND	NC	NC	NC	Not VOC	Not VOC	NA
Fluoranthene	ND	NC	NC	NC	Not VOC	ND	NA
Fluorene	ND	NC	NC	NC	Not VOC	Not VOC	NA
Naphthalene	ND	NC	NC	NC	NC	NC	NA
Phenanthrene	ND	NC	NC	NC	Not VOC	Not VOC	NA
Pyrene	ND	NC	NC	NC	Not VOC	ND	NA
Petroleum Hydrocarbons							
TPH-Diesel	ND	NC	NC	NC	NC	NC	NA
TPH-Gasoline	NC	NC	NC	NC	NC	NC	NC
Metals							
Arsenic	ND	1.76E-06	2.63E-06	1.10E-05	Not VOC	ND	1.54E-05
Barium	ND	NC	NC	NC	Not VOC	ND	NA
Cadmium	ND	1.28E-07	1.30E-09	1.63E-07	Not VOC	ND	2.92E-07
Cobalt	ND	NC	NC	NC	Not VOC	ND	NA
Copper	ND	NC	NC	NC	Not VOC	ND	NA
Lead	ND	NA	NA	NA	Not VOC	ND	NA
Molybdenum	ND	NC	NC	NC	Not VOC	ND	NA
Vanadium	ND	NC	NC	NC	Not VOC	ND	NA
Zinc	ND	NC	NC	NC	Not VOC	ND	NA
Cumulative Cancer Risk	6.27E-07	1.89E-06	2.77E-06	1.13E-05	4.47E-07	1.02E-05	2.72E-05

Notes:
ND = Not detected/sampled in medium.
NC = Not considered a carcinogen.
NA = Not applicable. See Appendix D.
Not VOC = Not volatile.

TABLE 7-6: BASELINE CANCER RISK ESTIMATES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use							
	On-Site Intrusive Worker							
	Soil Gas Pathway	Soil Pathway				Groundwater Pathway		Total Risk
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Dermal Contact	Vapor Inhalation	
Volatile Organic Compounds								
1,1-Dichloroethane	ND	ND	ND	ND	ND	6.40E-11	9.60E-10	1.02E-09
1,1-Dichloroethylene	ND	1.06E-13	2.40E-12	1.75E-11	9.48E-12	6.82E-09	8.19E-08	8.88E-08
1,2,4-Trimethylbenzene	NC	NC	NC	NC	NC	NC	NC	NC
1,2-Dichloroethane	ND	ND	ND	ND	ND	3.55E-10	2.24E-09	2.59E-09
1,2-Dichloropropane	ND	ND	ND	ND	ND	4.52E-09	2.80E-08	3.25E-08
1,3,5-Trimethylbenzene	ND	NC	NC	NC	NC	NC	NC	NC
Acetone	ND	NC	NC	NC	NC	ND	ND	NC
Benzene	6.33E-11	6.68E-14	4.41E-13	3.21E-12	5.97E-12	1.39E-08	8.38E-08	9.78E-08
Chlorobenzene	ND	NC	NC	NC	NC	ND	ND	NC
Chloroethane	ND	ND	ND	ND	ND	NC	NC	NA
cis-1,2-Dichloroethylene	NC	ND	ND	ND	ND	NC	NC	NA
Di-isopropyl ether	ND	ND	ND	ND	ND	NC	NC	NA
Ethylbenzene	NC	NC	NC	NC	NC	NC	NC	NC
Freon 113	NC	ND	ND	ND	ND	ND	ND	NA
Isopropylbenzene (Cumene)	NC	NC	NC	NC	NC	NC	NC	NC
Methane	NC	ND	ND	ND	ND	ND	ND	NA
Methyl tert-butyl ether	1.43E-12	1.44E-15	9.50E-15	6.91E-14	1.28E-13	5.94E-11	3.24E-10	3.85E-10
Naphthalene	ND	NC	NC	NC	NC	NC	NC	NC
n-Butylbenzene	ND	NC	NC	NC	NC	NC	NC	NC
N-propylbenzene	NC	NC	NC	NC	NC	NC	NC	NC
sec-Butylbenzene	NC	NC	NC	NC	NC	NC	NC	NC
Tetrachloroethylene	ND	3.56E-13	6.53E-13	4.75E-12	3.18E-11	1.01E-08	2.95E-07	3.05E-07
Toluene	NC	NC	NC	NC	NC	NC	NC	NC
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	NC	NC	NA
Trichloroethylene	1.50E-13	6.04E-15	6.10E-14	4.43E-13	5.39E-13	6.20E-10	5.81E-09	6.43E-09
Trichlorofluoromethane	NC	ND	ND	ND	ND	ND	ND	NA
Vinyl chloride (chloroethene)	2.34E-12	ND	ND	ND	ND	2.21E-08	2.22E-06	2.25E-06
Xylenes	NC	NC	NC	NC	NC	NC	NC	NC
Semi-Volatile Compounds								
2-methylnaphthalene	ND	NC	NC	NC	NC	NC	NC	NC
Acenaphthene	ND	NC	NC	NC	NC	ND	ND	NC
Anthracene	ND	NC	NC	NC	Not VOC	ND	ND	NC
Benz(a)anthracene	ND	5.60E-11	1.71E-09	8.28E-09	Not VOC	ND	ND	1.00E-08
Chrysene	ND	4.97E-12	1.51E-10	7.34E-10	Not VOC	ND	ND	8.91E-10
Dibenzofuran	ND	NC	NC	NC	Not VOC	NC	Not VOC	NC
Fluoranthene	ND	NC	NC	NC	Not VOC	ND	ND	NC
Fluorene	ND	NC	NC	NC	Not VOC	NC	Not VOC	NC
Naphthalene	ND	NC	NC	NC	NC	NC	NC	NC
Phenanthrene	ND	NC	NC	NC	Not VOC	NC	Not VOC	NC
Pyrene	ND	NC	NC	NC	Not VOC	ND	ND	NC
Petroleum Hydrocarbons								
TPH-Diesel	ND	NC	NC	NC	NC	NC	NC	NC
TPH-Gasoline	NC	NC	NC	NC	NC	NC	NC	NC
Metals								
Arsenic	ND	1.41E-07	3.48E-08	8.43E-07	Not VOC	ND	ND	1.02E-06
Barium	ND	NC	NC	NC	Not VOC	ND	ND	NC
Cadmium	ND	1.03E-08	1.72E-11	1.25E-08	Not VOC	ND	ND	2.28E-08
Cobalt	ND	NC	NC	NC	Not VOC	ND	ND	NC
Copper	ND	NC	NC	NC	Not VOC	ND	ND	NC
Lead	ND	NA	NA	NA	Not VOC	ND	ND	NA
Molybdenum	ND	NC	NC	NC	Not VOC	ND	ND	NC
Vanadium	ND	NC	NC	NC	Not VOC	ND	ND	NC
Zinc	ND	NC	NC	NC	Not VOC	ND	ND	NC
Cumulative Cancer Risk	6.72E-11	1.51E-07	3.67E-08	8.65E-07	4.79E-11	5.86E-08	2.72E-06	3.83E-06

Notes:
ND = Not detected/sampled in medium.
NC = Not considered a carcinogen.
NA = Not applicable. See Appendix D.
Not VOC = Not volatile.

TABLE 7-7: BASELINE NONCANCER HAZARD INDICES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Development Phase							
	On-Site Construction Worker							
	Soil Gas Pathway	Soil Pathway				Groundwater Pathway		Total Noncancer HI
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Dermal Contact	Vapor Inhalation	
Volatile Organic Compounds								
1,1-Dichloroethane	ND	ND	ND	ND	ND	1.89E-07	1.98E-04	1.98E-04
1,1-Dichloroethylene	ND	5.10E-09	7.47E-08	5.44E-07	1.14E-05	1.72E-08	3.93E-03	3.94E-03
1,2,4-Trimethylbenzene	9.08E-07	9.06E-08	2.03E-08	1.48E-07	2.02E-04	6.19E-06	1.11E-01	1.11E-01
1,2-Dichloroethane	ND	ND	ND	ND	ND	3.80E-08	3.73E-03	3.73E-03
1,2-Dichloropropane	ND	ND	ND	ND	ND	2.40E-08	1.15E-01	1.15E-01
1,3,5-Trimethylbenzene	ND	7.76E-08	1.74E-08	1.27E-07	1.73E-04	1.17E-06	4.00E-02	4.02E-02
Acetone	ND	1.24E-08	8.15E-08	5.93E-07	2.76E-05	ND	ND	2.83E-05
Benzene	2.66E-06	6.55E-09	2.47E-07	1.80E-06	1.46E-05	7.00E-08	8.21E-03	8.23E-03
Chlorobenzene	ND	3.55E-10	3.35E-08	2.43E-07	7.93E-07	ND	ND	1.07E-06
Chloroethane	ND	ND	ND	ND	ND	1.13E-06	1.61E-05	1.72E-05
cis-1,2-Dichloroethylene	6.16E-08	ND	ND	ND	ND	7.76E-07	7.36E-02	7.36E-02
Di-isopropyl ether	ND	ND	ND	ND	ND	1.67E-07	6.24E-05	6.25E-05
Ethylbenzene	5.05E-07	1.86E-10	7.01E-09	5.09E-08	4.15E-07	5.18E-06	1.97E-04	2.03E-04
Freon 113	1.27E-08	ND	ND	ND	ND	ND	ND	1.27E-08
Isopropylbenzene (Cumene)	7.73E-09	2.64E-09	1.99E-08	1.45E-07	5.89E-06	1.06E-05	2.82E-01	2.82E-01
Methane	NA	ND	ND	ND	ND	ND	ND	NA
Methyl tert-butyl ether	3.35E-06	5.88E-11	1.03E-09	7.50E-09	1.31E-07	4.77E-06	1.32E-05	2.15E-05
Naphthalene	ND	2.74E-06	3.49E-06	1.69E-05	6.12E-03	2.01E-05	4.77E-02	5.38E-02
n-Butylbenzene	ND	4.38E-08	2.89E-07	2.10E-06	9.77E-05	3.01E-06	3.77E-02	3.78E-02
N-propylbenzene	5.84E-07	4.35E-08	2.87E-07	2.09E-06	9.72E-05	1.72E-06	4.38E-02	4.39E-02
sec-Butylbenzene	3.21E-07	3.55E-08	2.34E-07	1.70E-06	7.91E-05	3.94E-06	5.16E-02	5.17E-02
Tetrachloroethylene	ND	1.11E-08	7.32E-08	5.32E-07	2.47E-05	1.14E-07	9.18E-03	9.20E-03
Toluene	8.38E-08	1.44E-09	4.08E-09	2.96E-08	3.22E-06	1.34E-06	2.48E-04	2.53E-04
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	2.06E-07	1.51E-02	1.51E-02
Trichloroethylene	6.31E-08	5.92E-10	1.12E-07	8.12E-07	1.32E-06	4.08E-08	5.69E-04	5.71E-04
Trichlorofluoromethane	1.68E-08	ND	ND	ND	ND	ND	ND	1.68E-08
Vinyl chloride (chloroethene)	3.64E-08	ND	ND	ND	ND	4.13E-08	4.84E-02	4.84E-02
Xylenes	2.84E-07	6.95E-10	4.59E-10	3.34E-09	1.55E-06	5.87E-05	4.79E-04	5.40E-04
Semi-Volatile Compounds								
2-methylnaphthalene	ND	2.54E-05	2.15E-05	1.57E-04	5.67E-02	1.18E-04	2.98E-01	3.55E-01
Acenaphthene	ND	8.53E-07	8.45E-06	4.10E-05	1.90E-03	ND	ND	1.95E-03
Anthracene	ND	1.53E-07	1.51E-06	7.33E-06	Not VOC	ND	ND	8.99E-06
Benz(a)anthracene	ND	8.05E-07	7.97E-06	3.86E-05	Not VOC	ND	ND	4.74E-05
Chrysene	ND	7.14E-07	7.07E-06	3.43E-05	Not VOC	ND	ND	4.20E-05
Dibenzofuran	ND	9.04E-06	5.97E-05	4.34E-04	Not VOC	3.36E-07	Not VOC	5.03E-04
Fluoranthene	ND	1.35E-06	1.34E-05	6.48E-05	Not VOC	ND	ND	7.95E-05
Fluorene	ND	1.16E-06	1.15E-05	5.59E-05	Not VOC	3.35E-05	Not VOC	1.02E-04
Naphthalene	ND	1.16E-05	1.47E-05	7.14E-05	2.58E-02	2.87E-05	6.80E-02	9.40E-02
Phenanthrene	ND	3.82E-07	3.78E-06	1.83E-05	Not VOC	8.60E-04	Not VOC	8.82E-04
Pyrene	ND	1.80E-06	1.78E-05	8.64E-05	Not VOC	ND	ND	1.06E-04
Petroleum Hydrocarbons								
TPH-Diesel	ND	1.68E-05	1.34E-04	9.75E-04	3.75E-02	1.29E-02	2.13E-02	7.28E-02
TPH-Gasoline	2.15E+00	1.21E-07	8.43E-07	6.13E-06	2.70E-04	1.54E-02	6.40E-04	2.16E+00
Metals								
Arsenic	ND	2.30E-01	1.30E-02	3.15E-01	Not VOC	ND	ND	5.57E-01
Barium	ND	1.99E-02	2.69E-05	1.95E-03	Not VOC	ND	ND	2.19E-02
Cadmium	ND	2.01E-02	7.59E-06	5.52E-03	Not VOC	ND	ND	2.57E-02
Cobalt	ND	5.15E-06	3.40E-06	2.47E-04	Not VOC	ND	ND	2.56E-04
Copper	ND	6.04E-05	4.00E-05	2.91E-03	Not VOC	ND	ND	3.01E-03
Lead	ND	NA	NA	NA	Not VOC	ND	ND	NA
Molybdenum	ND	5.34E-06	3.52E-06	2.56E-04	Not VOC	ND	ND	2.65E-04
Vanadium	ND	1.84E-04	1.21E-04	8.82E-03	Not VOC	ND	ND	9.13E-03
Zinc	ND	9.96E-06	6.57E-06	4.78E-04	Not VOC	ND	ND	4.94E-04
Cumulative Non-cancer Hazard Index	2.15E+00	2.70E-01	1.35E-02	3.37E-01	1.29E-01	2.94E-02	1.28E+00	4.21

ND = Chemical not detected or not sampled in medium.
NA = Not applicable.
Not VOC = Chemical is not volatile.

TABLE 7-7: BASELINE NONCANCER HAZARD INDICES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use						
	On-Site Commercial Worker						
	Soil Gas Pathway	Soil Pathway				Groundwater Pathway	Total Noncancer HI
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Vapor Inhalation	
Volatile Organic Compounds							
1,1-Dichloroethane	ND	ND	ND	ND	ND	1.23E-05	1.23E-05
1,1-Dichloroethylene	ND	1.06E-09	9.41E-08	1.18E-07	7.07E-05	2.45E-04	3.16E-04
1,2,4-Trimethylbenzene	2.60E-06	1.89E-08	2.56E-08	3.21E-08	5.80E-04	6.91E-03	7.49E-03
1,2-Dichloroethane	ND	ND	ND	ND	ND	2.76E-04	2.76E-04
1,2-Dichloropropane	ND	ND	ND	ND	ND	7.15E-03	7.15E-03
1,3,5-Trimethylbenzene	ND	1.62E-08	2.19E-08	2.75E-08	1.08E-03	2.49E-03	3.57E-03
Acetone	ND	2.57E-09	1.03E-07	1.29E-07	2.23E-05	ND	2.25E-05
Benzene	1.65E-05	1.36E-09	3.11E-07	3.90E-07	9.09E-05	5.11E-04	6.20E-04
Chlorobenzene	ND	7.40E-11	4.22E-08	5.28E-08	4.93E-06	ND	5.02E-06
Chloroethane	ND	ND	ND	ND	ND	1.00E-06	1.00E-06
cis-1,2-Dichloroethylene	3.83E-07	ND	ND	ND	ND	4.58E-03	4.58E-03
Di-isopropyl ether	ND	ND	ND	ND	ND	3.88E-06	3.88E-06
Ethylbenzene	3.14E-06	3.87E-11	8.82E-09	1.11E-08	2.58E-06	1.23E-05	1.80E-05
Freon 113	7.88E-08	ND	ND	ND	ND	ND	7.88E-08
Isopropylbenzene (Cumene)	4.81E-08	5.50E-10	2.51E-08	3.14E-08	3.66E-05	1.75E-02	1.76E-02
Methane	NA	ND	ND	ND	ND	ND	NA
Methyl tert-butyl ether	2.08E-05	1.22E-11	1.30E-09	1.63E-09	8.16E-07	1.52E-06	2.31E-05
Naphthalene	ND	5.71E-07	4.39E-06	3.67E-06	1.35E-03	3.51E-03	4.86E-03
n-Butylbenzene	ND	9.12E-09	3.64E-07	4.56E-07	6.08E-04	2.35E-03	2.95E-03
N-propylbenzene	3.63E-06	9.07E-09	3.62E-07	4.54E-07	6.04E-04	2.73E-03	3.34E-03
sec-Butylbenzene	2.00E-06	7.39E-09	2.95E-07	3.69E-07	4.92E-04	3.22E-03	3.71E-03
Tetrachloroethylene	ND	2.31E-09	9.21E-08	1.15E-07	1.54E-04	5.71E-04	7.26E-04
Toluene	5.21E-07	3.00E-10	5.13E-09	6.43E-09	2.00E-05	1.54E-05	3.60E-05
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	9.42E-04	9.42E-04
Trichloroethylene	3.93E-07	1.23E-10	1.41E-07	1.76E-07	8.22E-06	3.54E-05	4.44E-05
Trichlorofluoromethane	1.04E-07	ND	ND	ND	ND	ND	1.04E-07
Vinyl chloride (chloroethene)	2.26E-07	ND	ND	ND	ND	3.01E-03	3.01E-03
Xylenes	1.77E-06	1.45E-10	5.78E-10	7.24E-10	9.65E-06	2.98E-05	4.13E-05
Semi-Volatile Compounds							
2-methylnaphthalene	ND	5.29E-06	2.71E-05	3.40E-05	1.82E-02	1.85E-02	3.68E-02
Acenaphthene	ND	1.78E-07	1.06E-05	8.89E-06	3.26E-05	ND	5.23E-05
Anthracene	ND	3.18E-08	1.90E-06	1.59E-06	Not VOC	ND	3.53E-06
Benz(a)anthracene	ND	1.68E-07	1.00E-05	8.38E-06	Not VOC	ND	1.86E-05
Chrysene	ND	1.49E-07	8.90E-06	7.44E-06	Not VOC	ND	1.65E-05
Dibenzofuran	ND	1.88E-06	7.52E-05	9.42E-05	Not VOC	Not VOC	1.71E-04
Fluoranthene	ND	2.81E-07	1.68E-05	1.41E-05	Not VOC	ND	3.12E-05
Fluorene	ND	2.42E-07	1.45E-05	1.21E-05	Not VOC	Not VOC	2.69E-05
Naphthalene	ND	2.41E-06	1.85E-05	1.55E-05	5.69E-03	5.00E-03	1.07E-02
Phenanthrene	ND	7.96E-08	4.76E-06	3.98E-06	Not VOC	Not VOC	8.82E-06
Pyrene	ND	3.75E-07	2.24E-05	1.88E-05	Not VOC	ND	4.16E-05
Petroleum Hydrocarbons							
TPH-Diesel	ND	3.50E-06	1.69E-04	2.12E-04	1.88E-04	1.33E-03	1.90E-03
TPH-Gasoline	9.31E-02	2.52E-08	1.06E-06	1.33E-06	1.17E-05	3.99E-05	9.31E-02
Metals							
Arsenic	ND	4.78E-02	1.64E-02	6.83E-02	Not VOC	ND	1.33E-01
Barium	ND	4.15E-03	3.39E-05	4.24E-04	Not VOC	ND	4.61E-03
Cadmium	ND	4.20E-03	9.57E-06	1.20E-03	Not VOC	ND	5.40E-03
Cobalt	ND	1.07E-06	4.28E-06	5.37E-05	Not VOC	ND	5.90E-05
Copper	ND	1.26E-05	5.03E-05	6.31E-04	Not VOC	ND	6.94E-04
Lead	ND	NA	NA	NA	Not VOC	ND	NA
Molybdenum	ND	1.11E-06	4.44E-06	5.56E-05	Not VOC	ND	6.11E-05
Vanadium	ND	3.83E-05	1.53E-04	1.92E-03	Not VOC	ND	2.11E-03
Zinc	ND	2.07E-06	8.28E-06	1.04E-04	Not VOC	ND	1.14E-04
Cumulative Non-cancer Hazard Index	9.31E-02	5.63E-02	1.70E-02	7.31E-02	2.93E-02	8.10E-02	0.35

ND = Chemical not detected or not sampled in medium.
NA = Not applicable.
Not VOC = Chemical is not volatile.

TABLE 7-7: BASELINE NONCANCER HAZARD INDICES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use							
	On-Site Intrusive Worker							
	Soil Gas Pathway	Soil Pathway				Groundwater Pathway		Total Noncancer HI
Chemical	Vapor Inhalation	Particulate Inhalation	Dermal Contact	Ingestion	Vapor Inhalation	Dermal Contact	Vapor Inhalation	
Volatile Organic Compounds								
1,1-Dichloroethane	ND	ND	ND	ND	ND	3.15E-09	3.30E-06	3.30E-06
1,1-Dichloroethylene	ND	8.49E-11	1.25E-09	9.06E-09	7.58E-09	2.86E-10	6.55E-05	6.55E-05
1,2,4-Trimethylbenzene	6.05E-10	1.51E-09	3.39E-10	2.46E-09	1.35E-07	1.03E-07	1.85E-03	1.85E-03
1,2-Dichloroethane	ND	ND	ND	ND	ND	6.34E-10	6.21E-05	6.21E-05
1,2-Dichloropropane	ND	ND	ND	ND	ND	4.00E-10	1.91E-03	1.91E-03
1,3,5-Trimethylbenzene	ND	1.29E-09	2.90E-10	2.11E-09	1.16E-07	1.95E-08	6.67E-04	6.67E-04
Acetone	ND	2.06E-10	1.36E-09	9.88E-09	1.84E-08	ND	ND	2.98E-08
Benzene	1.77E-09	1.09E-10	4.12E-09	2.99E-08	9.74E-09	1.17E-09	1.37E-04	1.37E-04
Chlorobenzene	ND	5.92E-12	5.58E-10	4.06E-09	5.28E-10	ND	ND	5.15E-09
Chloroethane	ND	ND	ND	ND	ND	1.88E-08	2.68E-07	2.87E-07
cis-1,2-Dichloroethylene	4.11E-11	ND	ND	ND	ND	1.29E-08	1.23E-03	1.23E-03
Di-isopropyl ether	ND	ND	ND	ND	ND	2.79E-09	1.04E-06	1.04E-06
Ethylbenzene	3.37E-10	3.10E-12	1.17E-10	8.49E-10	2.76E-10	8.64E-08	3.28E-06	3.37E-06
Freon 113	8.44E-12	ND	ND	ND	ND	ND	ND	8.44E-12
Isopropylbenzene (Cumene)	5.15E-12	4.40E-11	3.32E-10	2.41E-09	3.93E-09	1.76E-07	4.69E-03	4.69E-03
Methane	NA	ND	ND	ND	ND	ND	ND	NA
Methyl tert-butyl ether	2.23E-09	9.79E-13	1.72E-11	1.25E-10	8.74E-11	7.94E-08	2.21E-07	3.02E-07
Naphthalene	ND	4.57E-08	5.81E-08	2.82E-07	4.08E-06	3.35E-07	7.95E-04	7.99E-04
n-Butylbenzene	ND	7.30E-10	4.82E-09	3.50E-08	6.51E-08	5.02E-08	6.28E-04	6.28E-04
N-propylbenzene	3.89E-10	7.26E-10	4.79E-09	3.48E-08	6.48E-08	2.87E-08	7.30E-04	7.30E-04
sec-Butylbenzene	2.14E-10	5.91E-10	3.90E-09	2.84E-08	5.28E-08	6.57E-08	8.61E-04	8.61E-04
Tetrachloroethylene	ND	1.85E-10	1.22E-09	8.87E-09	1.65E-08	1.89E-09	1.53E-04	1.53E-04
Toluene	5.59E-11	2.40E-11	6.79E-11	4.94E-10	2.14E-09	2.23E-08	4.13E-06	4.16E-06
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	3.44E-09	2.52E-04	2.52E-04
Trichloroethylene	4.21E-11	9.86E-12	1.86E-09	1.35E-08	8.81E-10	6.80E-10	9.48E-06	9.50E-06
Trichlorofluoromethane	1.12E-11	ND	ND	ND	ND	ND	ND	1.12E-11
Vinyl chloride (chloroethene)	2.42E-11	ND	ND	ND	ND	6.88E-10	8.06E-04	8.06E-04
Xylenes	1.90E-10	1.16E-11	7.65E-12	5.56E-11	1.03E-09	9.79E-07	7.99E-06	8.97E-06
Semi-Volatile Compounds								
2-methylnaphthalene	ND	4.23E-07	3.59E-07	2.61E-06	3.78E-05	1.97E-06	4.96E-03	5.00E-03
Acenaphthene	ND	1.42E-08	1.41E-07	6.83E-07	1.27E-06	ND	ND	2.11E-06
Anthracene	ND	2.54E-09	2.52E-08	1.22E-07	Not VOC	ND	ND	1.50E-07
Benz(a)anthracene	ND	1.34E-08	1.33E-07	6.44E-07	Not VOC	ND	ND	7.90E-07
Chrysene	ND	1.19E-08	1.18E-07	5.71E-07	Not VOC	ND	ND	7.01E-07
Dibenzofuran	ND	1.51E-07	9.95E-07	7.23E-06	Not VOC	5.60E-09	Not VOC	8.38E-06
Fluoranthene	ND	2.25E-08	2.23E-07	1.08E-06	Not VOC	ND	ND	1.33E-06
Fluorene	ND	1.94E-08	1.92E-07	9.31E-07	Not VOC	5.58E-07	Not VOC	1.70E-06
Naphthalene	ND	1.93E-07	2.45E-07	1.19E-06	1.72E-05	4.79E-07	1.13E-03	1.15E-03
Phenanthrene	ND	6.37E-09	6.30E-08	3.06E-07	Not VOC	1.43E-05	Not VOC	1.47E-05
Pyrene	ND	3.00E-08	2.97E-07	1.44E-06	Not VOC	ND	ND	1.77E-06
Petroleum Hydrocarbons								
TPH-Diesel	ND	2.80E-07	2.23E-06	1.63E-05	2.50E-05	2.15E-04	3.55E-04	6.13E-04
TPH-Gasoline	1.43E-03	2.02E-09	1.41E-08	1.02E-07	1.80E-07	2.57E-04	1.07E-05	1.70E-03
Metals								
Arsenic	ND	3.83E-03	2.16E-04	5.25E-03	Not VOC	ND	ND	9.29E-03
Barium	ND	3.32E-04	4.48E-07	3.26E-05	Not VOC	ND	ND	3.65E-04
Cadmium	ND	3.36E-04	1.27E-07	9.21E-05	Not VOC	ND	ND	4.28E-04
Cobalt	ND	8.58E-08	5.67E-08	4.12E-06	Not VOC	ND	ND	4.26E-06
Copper	ND	1.01E-06	6.66E-07	4.84E-05	Not VOC	ND	ND	5.01E-05
Lead	ND	NA	NA	NA	Not VOC	ND	ND	NA
Molybdenum	ND	8.89E-08	5.87E-08	4.27E-06	Not VOC	ND	ND	4.42E-06
Vanadium	ND	3.06E-06	2.02E-06	1.47E-04	Not VOC	ND	ND	1.52E-04
Zinc	ND	1.66E-07	1.10E-07	7.97E-06	Not VOC	ND	ND	8.24E-06
Cumulative Non-cancer Hazard Index	1.43E-03	4.50E-03	2.25E-04	5.62E-03	8.60E-05	4.91E-04	2.13E-02	0.03

ND = Chemical not detected or not sampled in medium.
NA = Not applicable.
Not VOC = Chemical is not volatile.

TABLE 7-8: SITE DEVELOPMENT CANCER RISK ESTIMATES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use			
	On-Site Commercial Worker			
	Soil Gas Pathway	Soil Pathway	Groundwater Pathway	Total Risk
Chemical	Vapor Inhalation	Vapor Inhalation	Vapor Inhalation	
Volatile Organic Compounds				
1,1-Dichloroethane	ND	ND	2.25E-09	2.25E-09
1,1-Dichloroethylene	ND	8.84E-08	2.00E-07	2.88E-07
1,2,4-Trimethylbenzene	NC	NC	NC	NC
1,2-Dichloroethane	ND	ND	9.95E-09	9.95E-09
1,2-Dichloropropane	ND	ND	7.58E-08	7.58E-08
1,3,5-Trimethylbenzene	ND	NC	NC	NA
Acetone	ND	NC	ND	NA
Benzene	5.91E-07	5.57E-08	2.24E-07	8.70E-07
Chlorobenzene	ND	NC	ND	NA
Chloroethane	ND	ND	NC	NA
cis-1,2-Dichloroethylene	NC	ND	NC	NC
Di-isopropyl ether	ND	ND	NC	NA
Ethylbenzene	NC	NC	NC	NC
Freon 113	NC	ND	ND	NC
Isopropylbenzene (Cumene)	NC	NC	NC	NC
Methane	NC	ND	ND	NC
Methyl tert-butyl ether	1.34E-08	1.20E-09	2.23E-09	1.68E-08
Naphthalene	ND	NC	NC	NA
n-Butylbenzene	ND	NC	NC	NA
N-propylbenzene	NC	NC	NC	NC
sec-Butylbenzene	NC	NC	NC	NC
Tetrachloroethylene	ND	2.97E-07	5.96E-07	8.93E-07
Toluene	NC	NC	NC	NC
trans-1,2-Dichloroethylene	ND	ND	NC	NA
Trichloroethylene	1.40E-09	5.03E-09	1.32E-08	1.97E-08
Trichlorofluoromethane	NC	ND	ND	NC
Vinyl chloride (chloroethene)	2.18E-08	ND	6.29E-06	6.31E-06
Xylenes	NC	NC	NC	NC
Semi-Volatile Compounds				
2-methylnaphthalene	ND	NC	NC	NA
Acenaphthene	ND	NC	ND	NA
Anthracene	ND	Not VOC	ND	NA
Benz(a)anthracene	ND	Not VOC	ND	NA
Chrysene	ND	Not VOC	ND	NA
Dibenzofuran	ND	Not VOC	Not VOC	NA
Fluoranthene	ND	Not VOC	ND	NA
Fluorene	ND	Not VOC	Not VOC	NA
Naphthalene	ND	NC	NC	NA
Phenanthrene	ND	Not VOC	Not VOC	NA
Pyrene	ND	Not VOC	ND	NA
Petroleum Hydrocarbons				
TPH-Diesel	ND	NC	NC	NA
TPH-Gasoline	NC	NC	NC	NC
Metals				
Arsenic	ND	Not VOC	ND	NA
Barium	ND	Not VOC	ND	NA
Cadmium	ND	Not VOC	ND	NA
Cobalt	ND	Not VOC	ND	NA
Copper	ND	Not VOC	ND	NA
Lead	ND	Not VOC	ND	NA
Molybdenum	ND	Not VOC	ND	NA
Vanadium	ND	Not VOC	ND	NA
Zinc	ND	Not VOC	ND	NA
Cumulative Cancer Risk	6.27E-07	4.47E-07	7.41E-06	8.49E-06

Notes:
ND = Chemical not detected or sampled in medium.
NC = Chemical not considered a carcinogen.
NA = Not applicable.
Not VOC = Not volatile.

TABLE 7-9: SITE DEVELOPMENT NONCANCER HAZARD INDICES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

	Future Land Use			
	On-Site Commercial Worker			
	Soil Gas Pathway	Soil Pathway	Groundwater Pathway	Total Noncancer HI
Chemical	Vapor Inhalation	Vapor Inhalation	Vapor Inhalation	
Volatile Organic Compounds				
1,1-Dichloroethane	ND	ND	7.72E-06	7.72E-06
1,1-*Dichloroethylene*	ND	7.07E-05	1.60E-04	2.31E-04
1,2,4-Trimethylbenzene	2.28E-06	5.08E-04	4.00E-03	4.51E-03
1,2-Dichloroethane	ND	ND	2.76E-04	2.76E-04
1,2-Dichloropropane	ND	ND	5.17E-03	5.17E-03
1,3,5-Trimethylbenzene	ND	1.08E-03	1.41E-03	2.49E-03
Acetone	ND	2.02E-05	ND	2.02E-05
Benzene	1.65E-05	9.09E-05	3.65E-04	4.73E-04
Chlorobenzene	ND	4.93E-06	ND	4.93E-06
Chloroethane	ND	ND	7.61E-07	7.61E-07
cis-1,2-Dichloroethylene	3.83E-07	ND	3.07E-03	3.07E-03
Di-isopropyl ether	ND	ND	2.04E-06	2.04E-06
Ethylbenzene	3.14E-06	2.58E-06	7.30E-06	1.30E-05
Freon 113	7.88E-08	ND	ND	7.88E-08
Isopropylbenzene (Cumene)	4.81E-08	3.66E-05	9.37E-03	9.41E-03
Methane	NA	ND	ND	NA
Methyl tert-butyl ether	2.08E-05	8.16E-07	1.52E-06	2.31E-05
Naphthalene	ND	1.20E-03	3.51E-03	4.71E-03
n-Butylbenzene	ND	6.08E-04	1.30E-03	1.91E-03
N-propylbenzene	3.63E-06	6.04E-04	1.33E-03	1.94E-03
sec-Butylbenzene	2.00E-06	4.92E-04	1.77E-03	2.26E-03
Tetrachloroethylene	ND	1.54E-04	3.09E-04	4.63E-04
Toluene	5.21E-07	2.00E-05	1.06E-05	3.11E-05
trans-1,2-Dichloroethylene	ND	ND	5.39E-04	5.39E-04
Trichloroethylene	3.93E-07	8.22E-06	2.16E-05	3.02E-05
Trichlorofluoromethane	1.04E-07	ND	ND	1.04E-07
Vinyl chloride (chloroethene)	2.26E-07	ND	2.28E-03	2.28E-03
Xylenes	1.77E-06	9.65E-06	1.61E-05	2.75E-05
Semi-Volatile Compounds				
2-methylnaphthalene	ND	1.63E-02	8.70E-03	2.50E-02
Acenaphthene	ND	2.88E-05	ND	2.88E-05
Anthracene	ND	Not VOC	ND	NA
Benz(a)anthracene	ND	Not VOC	ND	NA
Chrysene	ND	Not VOC	ND	NA
Dibenzofuran	ND	Not VOC	Not VOC	NA
Fluoranthene	ND	Not VOC	ND	NA
Fluorene	ND	Not VOC	Not VOC	NA
Naphthalene	ND	5.08E-03	5.00E-03	1.01E-02
Phenanthrene	ND	Not VOC	Not VOC	NA
Pyrene	ND	Not VOC	ND	NA
Petroleum Hydrocarbons				
TPH-Diesel	ND	1.69E-04	1.04E-03	1.21E-03
TPH-Gasoline	8.40E-02	1.06E-05	3.83E-05	8.40E-02
Metals				
Arsenic	ND	Not VOC	ND	NA
Barium	ND	Not VOC	ND	NA
Cadmium	ND	Not VOC	ND	NA
Cobalt	ND	Not VOC	ND	NA
Copper	ND	Not VOC	ND	NA
Lead	ND	Not VOC	ND	NA
Molybdenum	ND	Not VOC	ND	NA
Vanadium	ND	Not VOC	ND	NA
Zinc	ND	Not VOC	ND	NA
Cumulative Non-cancer Hazard Index	8.40E-02	2.65E-02	4.97E-02	0.16

ND = Chemical not detected or not sampled in medium.
NA= Not applicable.
Not VOC = Chemical is not volatile.

TABLE 7-10: BASELINE ACUTE HAZARD ESTIMATES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Chemical	Explosive Threshold		Odor Threshold		On-Site ConstructionWorker			On-Site Commercial Worker			On-Site Intrusive Worker		
					Ambient Air			Indoor Air			Ambient Air		
	(mg/m^3)	Source	(mg/m^3)	Source	Vapor Concentration (mg/m^3)	Ratio to Explosive Threshold	Ratio to Odor Threshold	Vapor Concentration (mg/m^3)	Ratio to Explosive Threshold	Ratio to Odor Threshold	Vapor Concentration (mg/m^3)	Ratio to Explosive Threshold	Ratio to Odor Threshold
Volatile Organic Compounds													
Methane	3.28E+03	1	NA	--	3.23E-02	9.84E-06	--	9.63E-02	2.94E-05	--	1.29E-03	3.93E-07	--
Petroleum Hydrocarbons													
TPH-Diesel	2.61E+04	2	0.44	4	3.25E-01	1.25E-05	7.40E-01	4.02E-03	1.54E-07	9.14E-03	1.26E-01	4.84E-06	2.87E-01
TPH-Gasoline	5.61E+03	3	4.9	4	2.29E+01	4.08E-03	4.67E+00	4.76E-01	8.49E-05	9.72E-02	9.36E-01	1.67E-04	1.91E-01
Cumulative Hazard Ratio	--	--	--	--	--	0.00	5.41	--	0.00011	0.11	--	0.0002	0.48

Notes:
NA - Methane odor threshold is negligible.
The explosive thresholds incorporate a safety factor of 10 (i.e. 10% of the Lower Explosive Limit).

Sources:
1. National Institute of Health (NIOSH). 2002. International Chemical Safety Card (ICSC: 0206). http://www.cdc.gov/niosh/ipcsneng/neng0291.html.
2. Walters Forensic Engineering. 2002. http://www.cdc.gov/niosh/ipcsneng/neng0291.html.
3. National Institute of Health (NIOSH) Online Pocket Guide to Chemical Hazards. 2002. http://www.cdc.gov/niosh/npg/npgd0299.html
4. Corresponds to the 50% odor threshold levels of napthalene (0.4 mg/m^3) and benzene (4.9 mg/m^3), which are among the consituents of TPH-Diesel and TPH-Gasoline; as found in Table H-2 of the RWQCB RBSLs (December 2001). (Odor threshold values for TPH are not listed in Table H-2.)

TABLE 7-11: BASELINE ACUTE HAZARD ESTIMATES
Future Port of Oakland Field Support Services Complex
2225 and 2277 Seventh Street
Oakland, California

Chemical	Explosive Threshold		Odor Threshold		On-Site Commercial Worker		
					Indoor Air	Ratio to Explosive Threshold	Ratio to Odor Threshold
	(mg/m^3)	Source	(mg/m^3)	Source	Vapor Concentration (mg/m^3)		
Volatile Organic Compounds							
Methane	3.28E+03	1	NA	--	9.63E-02	2.94E-05	NA
Petroleum Hydrocarbons							
TPH-Diesel	2.61E+04	2	0.44	4	3.22E-03	1.24E-07	7.32E-03
TPH-Gasoline	5.61E+03	3	4.9	4	4.30E-01	7.66E-05	8.77E-02
Cumulative Hazard Ratio	--	--	--	--	--	0.00011	0.10

Notes:
NA - Methane odor threshold is negligible.
The explosive thresholds incorporate a safety factor of 10 (i.e. 10% of the Lower Explosive Limit).

Sources:

1. National Institute of Health (NIOSH). 2002. International Chemical Safety Card (ICSC: 0206). http://www.cdc.gov/niosh/ipcsneng/neng0291.html.
2. Walters Forensic Engineering. 2002. http://www.cdc.gov/niosh/ipcsneng/neng0291.html.
3. National Institute of Health (NIOSH) Online Pocket Guide to Chemical Hazards. 2002. http://www.cdc.gov/niosh/npg/npgd0299.html
4. Corresponds to the 50% odor threshold levels of napthalene (0.4 mg/m^3) and benzene (4.9 mg/m^3), which are among the consituents of TPH-Diesel and TPH-Gasoline; as found in Table H-2 of the RWQCB RBSLs (December 2001). (Odor threshold values for TPH are not listed in Table H-2.)

APPENDIX B

Appendix B. Modeling Methodologies

This appendix explains the methods used to model exposure to contaminants of potential concern (COPCs) for human receptors considered at the Site. These models were used to estimate on-Site, indoor and outdoor ambient air concentrations associated with the emission of COPCs from soil, soil gas, and groundwater. Estimation of airborne COPC concentrations at on-Site receptors comprised the calculation of (i) emission rates of COPCs at the appropriate surface boundaries and (ii) dispersion factors for these COPCs into trenches and indoor environments. The calculated COPC concentrations were combined with exposure assumptions and chemical toxicity data to characterize potential adverse health effects to on-Site receptors. Note that all of the models presented in this appendix will overestimate ambient air concentrations when non-aqueous phase liquids are present.

B.1 Exposure Modeling Summary

Iris Environmental initially performed baseline modeling under an assumed default condition where specific design elements that will be incorporated into the development were not included. These specific design elements include 1) the planned passive soil-venting systems that will be placed beneath all constructed buildings and 2) the asphalt cap that will completely cover the Site. We then conducted modeling under conditions consistent with the planned site redevelopment, incorporating the aforementioned design elements. Note that these design elements will only affect the fate and transport of the COPCs in the commercial-worker scenario. The calculated, site-specific exposures were combined with the appropriate COPC-specific toxicological data to characterize the potential for adverse health effects, as described in Section 6 of the assessment. The following table summarizes the models used to estimate exposure for each human receptor subject to a complete exposure pathway, as described in Section 5 of the assessment. Uncertainties associated with these modeling approaches are discussed in Appendix C.

Baseline Evaluation				
Scenario		**Model Name**	**Model Breakdown**	
			Emissions	**Dispersion**
Development				
On-Site Construction Worker	Soil Particulate	Dust	Default	Default
	Soil	Trench	Methane Advection	Trench Model
	Subsurface Soil Gas	Trench	Methane Advection	Trench Model
	Groundwater	Trench	Methane Advection	Trench Model
Future Use				
Intrusive Worker	Soil Particulate	Dust	Default	Default
	Soil	Trench	Methane Advection	Trench Model
	Subsurface Soil Gas	Trench	Methane Advection	Trench Model
	Groundwater	Trench	Methane Advection	Trench Model
On-Site Commercial Worker	Soil Particulate	Dust	Default	Default
	Soil	Johnson & Ettinger	Methane Advection	Johnson & Ettinger
	Subsurface Soil Gas	Johnson & Ettinger	Methane Advection	Johnson & Ettinger
	Groundwater	Johnson & Ettinger	Methane Advection	Johnson & Ettinger
Planned Site Redevelopment Evaluation				
On-Site Commercial Worker	Soil Particulate	Dust	Default	Default
	Soil	Johnson & Ettinger	Diffusive Flux	Johnson & Ettinger
	Subsurface Soil Gas	Johnson & Ettinger	Diffusive Flux	Johnson & Ettinger
	Groundwater	Johnson & Ettinger	Diffusive Flux	Johnson & Ettinger

B.2 Physicochemical Properties and Site Parameters

The mobility of a COPC in the subsurface is governed by the physicochemical properties of the COPC and by the soil properties. The COPC-specific properties that govern transport include the diffusion coefficient in air, diffusion coefficient in water, Henry's law constant, solubility in water, and the organic carbon partition coefficient. The values assumed for these properties and their corresponding sources are listed in Table 5-1.

Soil properties required to estimate the transport of COPCs include total porosity, dry bulk density, soil saturation, and organic carbon content. As there is considerable uncertainty with respect to the soil properties, conservative values were assumed where site-specific data were not available. Site-specific properties were used where available, and were based on data from the Phase II ESA. Site soil, groundwater, building, and trench parameters are presented in Table 5-2. Soil properties were assumed to be homogeneous.

B.3 Trench Model

The Trench Model was used to estimate airborne COPC concentrations resulting from the volatilization of COPCs from soil, soil gas, and groundwater into trenches dug by construction workers during Site development. This model assumes that COPCs present in subsurface soil, soil gas, and groundwater are volatilized from the surface of the trench walls and dispersed throughout the trench by winds.

Estimation of ambient COPC concentrations for the intrusive worker consisted of two steps: (i) the estimation of the volatilization flux of COPCs into the air; and, (ii) the modeling of the dispersion of the COPCs in the trench. An analytical solution to the Fickian diffusion equation was used to calculate the volatilization flux of COPCs from soil, soil gas, and groundwater into the trench. An empirical analogy approach was used to estimate the dispersion in the trench. Section A.4.1 describes the methodology used to estimate the volatilization flux from soil, soil gas, and groundwater to the trench. Section A.4.2 describes the methodology used in estimating the concentration of COPCs in the trench. Ambient air concentrations from trench modeling are incorporated into Tables 5-3 and 5-4.

B.3.1 Estimation of Baseline Flux of COPCs from Soil, Soil Gas, and Groundwater to the Trench Assuming Methane Advection

COPCs can flux through the pores of soil and be emitted into the trench. In situations where there is evidence of methane production resulting from the action of subsurface microorganisms, the potential for the pressurized flux of methane to resulting in the advective transport of other COPCs must be addressed. Methane concentrations at the Site are likely the result of the use of hydrocarbons as a food substrate by subsurface microorganisms. As the microorganisms consume the hydrocarbons as food, methane is released as a byproduct. The methane so released begins to build up pressure, resulting in a pressure gradient between the source and the surface. This pressure gradient causes methane, and other collocated gases, to be "pushed" to surface at a rate greater that expected from the diffusion gradient.

The COPC flux associated with the methane pressure gradient can be estimated by assuming a steady-state flow associated with this pressure gradient (Little et al., 1992). Under this assumption, the normalized average flux is:

$$J/C = Q / A * 10^{-5}$$

where:

- J/C = normalized contaminant flux at ground surface (m/s);
- Q = steady state flux rate of the methane gas (cm^3/s);
- C = soil gas concentration resulting from media of concern (mg/m^3); and
- A = area of trench surface (cm^2).

The steady-state flux rate of methane is calculated from:

$$Q = (k/u)\ (P/L)\ A$$

where:

- k = soil intrinsic permeability (cm^2);
- u = vapor viscosity ($g/m \cdot s$);
- P = pressure of methane at groundwater table ($g/cm \cdot s^2$);
- L = distance from groundwater table to surface (cm); and
- A = area of trench surface (cm^2).

Note that the total flux into the trench may not exceed the mass available for transport. While groundwater sources are considered infinite, soil and soil gas sources are finite; therefore, both soil and soil gas flux estimates are checked to ensure they do not result in violation of conservation of mass. To estimate the flux under these conditions, we assumed that all of the mass potentially available to flux into the trench did so, taking into account the potential flux of COPCs to the surface. Under these assumptions, the normalized flux into the trench would be:

$$J/C = \frac{(2W + 2L)\pi Z^2 / 4 + (D - Z) * WL}{AT} \times 10^{-2}$$

where:

J/C	=	normalized contaminant flux at ground surface over time T (m/s);
C	=	soil gas concentration resulting from media of concern (mg/m^3);
T	=	total flux time (exposure period, s);
D	=	depth of COPC contamination (cm);
W	=	width of trench (cm);
L	=	length of trench (cm);
Z	=	depth of trench (cm); and
A	=	surface area of trench (cm^2).

The trench parameters referenced above are presented in Table 5-2. Note that the formulation of this Trench model requires that there are no NAPLs present. If this model is used to estimate the flux of NAPLs, the flux will be overestimated. Therefore, as a conservative screen of the impact of NAPLs on exposure concentrations, this approach may be used.

B.3.2 Concentration of COPCs in the Trench

Atmospheric dispersion in trenches is similar to that found in street canyons. Street canyons are streets lined on both sides by buildings. This configuration results in a cross-street profile bound on three sides, with an open surface above the street. Winds normal to the street flow over building roof tops and drop down through the open surface above the street to create zones of turbulence within the canyon. Like street canyons, trenches are bound on three sides and surface winds traveling over the trench drop down to create zones of turbulence within the trench. Similar to emissions from cars traveling along the street at the bottom of the street

canyon, emissions from the bottom of the trench may get trapped within the trench walls. Therefore, ambient air concentrations resulting from emissions in the bottom of the trench may be estimated from street canyon modeling of automotive emissions. Using this analogy, the concentrations resulting from the formation of turbulent eddies in the trench may be estimated from the following equation (Cermak, 1974):

$$C_a = \frac{J A_t}{0.1 H_t L_t u_s}$$

where:

C_a	=	air concentration in the trench (mg/m^3)
J	=	flux of COPCs into the trench ($g/s\text{-}m^2$)
L_t	=	length of the trench (m)
H_t	=	depth of the trench (m)
A_t	=	area of trench walls and floor (m^2)
u_s	=	average surface wind speed (m/s)

To maintain the analogy with the experimental results presented in Cermak et al. (1974) the width of the trench was assumed to be one and half times the depth of the trench. All the input parameters used in the trench modeling are presented in Table 5-2. The hypothetical trench is assumed to be 100 cm deep, 150 cm wide, and 400 cm long.

The trench equation presented above assumes that the wind is constant and is always blowing normal to the trench; therefore, the equation gives a maximum one-hour average concentration. A multiplication factor of 0.08 is generally used to convert maximum one-hour concentrations to annual average concentrations. Nonetheless, Iris Environmental conservatively assumed that the one-year average concentrations in the trench would equal the maximum hourly concentrations; therefore, this multiplication factor was not used. Furthermore, wind speed and direction normal to the trench will vary significantly with change in meteorology. Therefore, it is likely that this Trench Model will provide a conservative estimate of the actual annual average concentration in the trench.

B.4 Dust Model

The estimation of concentration goals attendant to inhalation of particulates requires the determination of the quantitative relationship between chemical concentrations in the soil (mg/kg) and the concentration of respirable particulates (PM_{10}) in the air due to fugitive dust emissions. Particulate emissions are due to wind erosion and, therefore, depend on the erodibility of the surface material. For the fugitive dust inhalation pathway, we assumed that the ambient air particulates at the Site are equal to the National Ambient Air Quality Standard for the annual average respirable portion of suspended particulate matter (0.050 mg/m^3 [50 $\mu g/m^3$] PM_{10}) and that the particulates have the same concentration of contaminants as the soil (DTSC, 1994). For the intrusive worker, we have assumed that the airborne dust level present during the intrusive activities would be one tenth of the standard for respirable dust particulates (i.e., one tenth of 5 mg/m^3, or 0.5 mg/m^3 [500 $\mu g/m^3$]), as established by the California Occupational Safety and Health Administration (Cal/OSHA). For both the resident and worker populations, we have assumed that 100% of the inhaled particulates come from surface soil.

B.5 Johnson and Ettinger Model

The transport of COPCs into indoor air was simulated using the USEPA-approved Johnson and Ettinger Model ("the J & E Model"; USEPA, 2000), as modified by Cal/EPA. The Advanced version of the Model was used (SL-ADV Version 2.3; 3/01). The J & E Model is used to estimate indoor air concentrations associated with the volatilization and dispersion of COPCs in soil, soil gas, and groundwater into indoor environments. COPCs in subsurface soil, soil gas, and groundwater, may be emitted into indoor environments through advection and diffusion. Once released into indoor air, turbulent mixing will disperse the COPCs in the building.

The J & E Model estimates the COPC indoor air concentrations in a two steps process: (i) the estimation of the flux of COPCs into the building; and, (ii) the estimation of the dispersion of the COPCs in the building. For our baseline analysis, we have assumed that COPCs in subsurface soil, soil gas, and groundwater, may migrate vertically into on-Site buildings by advection and diffusion. The advective component of the flux is the result of a methane pressure gradient, as discussed above. Currently, the J & E Model does not include this advective transport

mechanism. As this transport pathway can significantly increase the total flux into a building, we have modified the J & E Model to incorporate this pathway.

Using the approach developed in Section A.4.1, the advective component of the flux was incorporated into the J & E Model. This adjusted J & E Model simulates the transport of a compound into the building by both advection and diffusion and relates the flux of the substance to the pressure gradient of methane.

The planned site redevelopment will include passive vapor venting systems below building built on-Site. The passive vapor venting system will decouple the advective transport of COPCs into the building, allowing the COPCs to escape around the building, and thereby reducing the advective transport of soil gas to zero. In this case, we have conservatively assumed that diffusive transport of COPCs into the building will continue even with the addition of a passive vapor venting system. We used the standard J & E Model to estimate the diffusive transport to COPCs into the building.

The development of the Model is described in detail in the user's guide (USEPA, 2000). The modeling inputs that affect the estimate of the indoor air concentrations include building, soil, methane flow rate, and physicochemical parameters. Default building parameters used include building height, the building air exchange rate, and the seam between the floor and the building walls. Modeling parameters are presented in Tables 5-2. Table 5-3 shows the predicted air concentrations associated with baseline evaluation and Table 5-4 shows the predicted indoor ambient air concentrations associated with the inclusion of planned design elements.

B.6 Modeling References

California Environmental Protection Agency, Department of Toxic Substances Control (DTSC). 1994. *Preliminary Endangerment Assessment Manual.*

Cermak, J. E., Lombardi, D. J., and R. S. Thompson. 1974. *Applications of Physical Modeling to the Investigations of Air Pollution Problems in Urban Areas.* Presented at the 67th Annual Meeting of the Air Pollution Control Association, Denver, June 9-13, Paper No. 74-160.

Little, J.C., Daisy, J.M., and W.M. Nazaroff. 1992. *Transport of Subsurface Contaminants into Buildings – An Exposure Pathway for Volatile Organics.* Environmental Science and Technology, Volume 26, Number 11.

U.S. Environmental Protection Agency (USEPA). 2000. User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings. December.