

September 21, 1994

side # ~~2043~~ 2043
STED 4573

Ms. Madhulla Logan
 Hazardous Materials Specialist
 Alameda County Health Care Services Agency
 1131 Harbor Bay Parkway, Suite 250
 Alameda, CA 94501

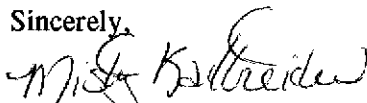
RE: Human Health and Environmental Risk Assessment
 Former Island Gun Club, 500 Maitland Drive, Alameda, CA

Dear Ms. Logan:

Enclosed, please find the Human Health and Environmental Risk Assessment for the former Island Gun Club property located at 500 Maitland Avenue, Alameda, California.

If you have any questions regarding this report, please contact me.

Sincerely,



Misty C. Kaltreider
 Geologist

cc: Mr. Ravi Arulanantham - Alameda County Health Care Services Agency
 Mr. Rich Hiett - Regional Water Quality Control Board
 Mr. Aidan Barry - Harbor Bay Isle Associates
 Mr. Bob Warnick / Mr. Dick Rudloff - City of Alameda
 Ms. Donna Dehn - Health/Sciences Consulting
 Mr. Gary Pischke - CEG

ALCO
 HAZMAT
 9/21 SEP 22 PM 22

1200

ALCOO
HAZMAT
94 SEP 22 PM 3: 22

**HUMAN HEALTH AND ENVIRONMENTAL RISK ASSESSMENT
FORMER ISLAND GUN CLUB
500 MAITLAND DRIVE
ALAMEDA, CALIFORNIA**

Job Number 94-6140-1

Prepared for:

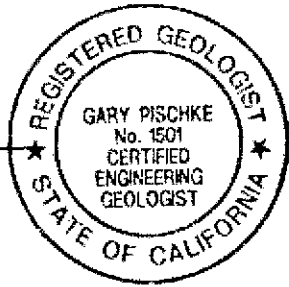
Ms. Madhulla Logan
Alameda County Health Care Services Agency
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502

September 1994

Prepared by: *Donna Dehn*
Donna Dehn
Health/Sciences Consulting

Reviewed by: *Misty Kaltreider*
Misty Kaltreider
Project Geologist

Reviewed by: *Gary Pischke*
Gary Pischke, CEG #1501



**HUMAN HEALTH AND ENVIRONMENTAL RISK ASSESSMENT
ISLAND GUN CLUB PROPERTY**

	<u>Page</u>
EXECUTIVE SUMMARY	
Site Description	i
Investigations Performed and Results Obtained	i
The Health Risk Assessment Process	ii
Results of the Health Risk Assessment	v
Risk of Failure	vi
Cleanup Strategies	vii
1.0 INTRODUCTION	
1.1 Background	1-1
1.2 Description of the Project	1-1
1.3 Purpose and Scope of the Risk Assessment	1-1
1.4 Organization	1-2
2.0 DATA SUMMARY AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN	
2.1 Available Data	2-1
2.1.1 Investigations and Sampling	2-1
2.1.2 Results and Data Summary	2-2
2.2 Data Useability	2-4
2.3 Selection of Chemicals of Potential Concern	2-4
2.3.1 Background Comparison	2-4
2.3.2 Frequency of Detection	2-5
3.0 EXPOSURE ASSESSMENT	
3.1 Site Characterization	3-1
3.1.1 Physical Setting	3-1
3.1.2 Land Use and Demographics	3-3
3.2 Potential Fate and Transport of COPCs	3-5
3.3 Description of the Development Plan	3-6
3.3.1 Description of the Storage Facility Operations	3-7
3.3.2 Uncontained Media	3-7
3.4 Potential Exposures	3-7
3.4.1 Short-term Exposure During Construction	3-7
3.4.2 Potential Long-term Exposure After Completion of the Storage Facility	3-8
3.4.3 Potential Current Exposures	3-9
3.5 Quantification of Exposure	3-9
3.5.1 Determination of Exposure Point Concentrations	3-10
3.5.2 Estimation of Chemical Intake	3-12
3.5.3 Estimation of Dermal Dose	3-13
3.5.4 Estimation of Lead Exposure	3-14

3.5.5	Intake and Dose Parameters	3-14
4.0	TOXICITY ASSESSMENT	
4.1	Quantity Toxicity for Human Health	4-1
4.1.1	Carcinogenic Effects	4-1
4.1.2	Noncarcinogenic Effects	4-3
4.1.3	Developmental Effects	4-4
4.2	Issues Related to Carcinogenic PNAs	4-4
4.3	Issues Related to Lead	4-5
5.0	RISK CHARACTERIZATION	
5.1	Methodology for Quantitative Risk Estimation	5-1
5.1.1	Cancer Risk	5-1
5.1.2	Noncarcinogenic Hazard Quotient	5-2
5.2	Risk Estimation for Short-term Construction Worker	5-3
5.3	Risk Estimation for Long-term Storage Facility Worker	5-4
5.4	Risk of Failure	5-5
6.0	UNCERTAINTIES	
6.1	Uncertainties Associated with Data Evaluation and COPC Selection	6-1
6.2	Uncertainty Associated with the Exposure Assessment	6-1
6.3	Uncertainties Associated with the Toxicity Assessment	6-2
6.4	Uncertainty in Risk Characterization	6-4
7.0	SUMMARY AND CLEANUP STRATEGIES	
7.1	Data Evaluation and Selection of COPCs	7-1
7.2	Exposure Assessment	7-1
7.2.1	Exposure Scenarios	7-1
7.2.2	Confidence in Exposure Estimates	7-2
7.3	Toxicity Assessment	7-2
7.4	Risk Characterization	7-2
7.4.1	Risk Estimates	7-3
7.5	Cleanup Strategies	7-3
8.0	REFERENCES	
	Appendix A Available Data	
	Appendix B Well Survey	
	Appendix C Chemical Intake	
	Appendix D Toxicity Profiles	

LIST OF TABLES

Table 2-1	Available Data
Table 2-2	Summary Statistics for Near Surface Soil Site-Wide (without Inorganic Hot Spots)
Table 2-3	Summary Statistics for Subsurface Soil (below 1' Foot)
Table 2-4	Summary Statistics for PNAs in Near Surface Soil of the Clay Pigeon Debris Area
Table 2-5	Summary Statistics for Groundwater
Table 2-6	Chemicals of Potential Concern
Table 3-1	Groundwater Depth Information
Table 3-2	Physical/Chemical Parameters of COPCs
Table 3-3	Exposure Point Concentrations
Table 3-4	Exposure Parameters and Media Intake Factors
Table 3-5	Dermal Exposure Parameters and Absorbed Dose
Table 4-1	Toxicity Values for Chemicals with Carcinogenic Effects
Table 4-2	Toxicity Values for Chemicals with Non-Carcinogenic Effects
Table 4-3	Estimated Relative Potency of PNAs
Table 5-1	Short-term Construction Worker Scenario, Excess Lifetime Cancer Risk from Investigation of Near Surface Soil (w/out hot spots)
Table 5-2	Short-term Construction Worker Scenario, Non-Cancer Risk from Incidental Ingestion of Near Surface Soil (w/out hot spots)
Table 5-3	Short-term Construction Worker Scenario, Non-Cancer Risk from Ingestion of Hot Spot Near Surface Soil
Table 5-4	Short-term Construction Worker Scenario, Excess Lifetime Cancer Risk from Inhalation of Dust (w/out hot spots)
Table 5-5	Short-term Construction Worker Scenario, Non-Cancer Risk from Inhalation of Dust (w/out hot spots)
Table 5-6	Short-term Construction Worker Scenario, Non-Cancer Risk form Inhalation of Hot Spot Dust
Table 5-7	Summary of Risk by Exposure Route for the Short-term Construction Worker
Table 5-8	Short-term Construction Worker Scenario, Lead Risk Assessment Spreadsheet
Table 5-9	Long-term Storage Facility Worker, Excess Lifetime Cancer Risk from Inhalation of Dust from Asphalt Cracking
Table 5-10	Long-term Storage Facility Worker, Non-Cancer Risk from Inhalation of Dust from Asphalt Cracking
Table 5-11	Long-term Storage Facility Worker, Lead Risk Assessment Spreadsheet

LIST OF FIGURES

- Figure 2-1 Sample Locations
Figure 2-2 Location of Off-Site Well
Figure 2-3 Hot Spot Locations and Concentrations (mg/kg)
- Figure 3-1 General Site Location
Figure 3-2 Groundwater Gradient
Figure 3-3 Current Land Use and Zoning
Figure 3-4 TTLC versus STLC for Lead in Near Surface Soil Samples
Figure 3-5 TTLC versus STLC for Lead in Subsurface Soil Samples
Figure 3-6 TTLC versus STLC for Copper in Near Surface Soil Samples
Figure 3-7 TTLC versus STLC for Copper in Subsurface Soil Samples

EXECUTIVE SUMMARY

This report presents the results of an assessment of the human health risk (HRA) associated with the construction and operation of a mini-storage unit with recreational vehicle (RV) storage and parking at the Former Gun Club site, 500 Maitland Drive, Alameda, California. The results of the HRA are used to recommend cleanup levels and strategies for the site.

Site Description

The site is the former Island Gun Club which operated as a gun shooting range from 1926 to approximately 1982. It consists of a 5 acre parcel of land located at 500 Maitland Drive at the northwest corner of Maitland Drive and Harbor Bay Parkway on the Bay Farm Island portion of Alameda. The site is currently unpaved and overgrown. Unused wood frame buildings remain on the site. The property is completely fenced.

The City's zoning designation for the project site is ~~Community Shopping/Commercial~~ Zone (CM/PD). The site lies under the straight-out take-off tracks for Metropolitan Oakland International Airport (MOIA) within the Inner Portion of the Alameda County Land Use Commission (ALUC) safety zone. As such, current zoning regulations allow nonresidential use such as warehousing, nonintensive industry and equipment storage.

East Bay Municipal Utilities District (EBMUD) supplies water to the City of Alameda. No municipal or domestic wells were identified within a one mile radius of the site, although no permitted irrigation wells are within 1/2 mile of the site. Precipitation either infiltrates into the subsurface on-site or leaves the site as runoff. A small, man-made ditch (two feet across by 3 to 4' deep) lies just west of the trap shelters. This ditch empties into the City of Alameda stormwater system on the west side of Maitland Drive. A catch basin, less than one block from where the drainage ditch leaves the site, directs flow underground where it empties into the Golf Course drainage system and then to the San Leandro Channel. The channel empties into the bay.

Investigations Performed and Results Obtained

Investigations have occurred on the property over a four year period. Surface soil, subsurface soil and groundwater samples have been taken. Samples have also been taken of the clay pigeon debris. The most recent investigation included a tide study.

Lead and copper were found to be lognormally distributed throughout the site. Four "hot spots" for lead and one for copper were identified. Hot spots are those samples in which the constituent was detected at a concentration two orders of magnitude greater than the next highest concentration. "Hot Spots" are not necessary considered hazardous.

100 100

Sixteen PNAs were detected in near surface soil samples site-wide and seven in one subsurface soil sample. The greatest variety of compounds and highest concentrations of PNAs were detected in soil on the south side of the ditch that trends across the property from west to east. This area is referred to as the clay pigeon debris area. All PNA compounds detected in near surface soil from this area were also detected in the clay pigeon sample. Concentrations of PNAs in soil are one-quarter to three orders of magnitude lower than the concentrations detected in the clay pigeon sample. The concentrations of the seven PNAs detected in the subsurface soil sample taken 5 feet in depth from MW-3 (also within the clay pigeon debris area) were one-quarter to two orders of magnitude lower than those detected in near surface samples.

Total lead and copper were detected in each monitoring well, except MW-4, during the last one round of sampling (May 1994). Of the PNA compounds, pyrene was detected in one groundwater sample (from MW-5) at 20 ug/L. Total dissolved solids in groundwater ranged from 2,200 to 4,800 mg/L. Lead and copper were detected in the sample taken from the off-site well while PNAs were not.

The Health Risk Assessment Process

This assessment primarily utilized guidance set forth in the *EPA Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual, Part C, Risk Evaluation of Remedial Alternatives and Actions* (EPA, 1991). This guidance was developed to satisfy the National Contingency Plans (NCP) requirement to evaluate the long- and short-term effectiveness of a remedial alternative. Evaluating effectiveness involves evaluating the long-term and short-term risk associated with the remedial alternative. Long-term risk are those that will remain after the remedial action is complete, those associated with uncontained media, and those associated with permanence of the remedy. Short-term risks are those that occur during implementation of the remedial action. Evaluation of risk during and after completion of the remedial action uses the guidance set forth in *EPAs Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual, Part A, Baseline Risk Assessment* (EPA, 1989) and the *California DTSCs Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities* (DTSC, 1992). This guidance established the risk assessment process.

Four basic steps are involved in preparing a risk assessment; data evaluation, exposure assessment, toxicity assessment and risk characterization. The following is a generic discussion of the risk assessment process.

The data evaluation step assesses the quality of the data available for risk assessment purposes and selects chemicals of potential concern (COPC) from those detected at the site. The purpose of identifying COPCs is to focus the risk assessment on the most prevalent and toxic site-related chemicals. Screening steps may include:

- determining if the chemical concentration in the sample is greater than the chemical concentration under natural background conditions
- determining the frequency of a chemical

- using a toxicity-concentration screen to identify those chemicals in each media that contribute 99 percent of the risk

The exposure assessment identifies who could be exposed to COPCs (receptors), how exposure occurs (exposure pathways) and estimates how much exposure does or could occur. Determining who could be exposed involves looking at both current and future land use practices and population estimates. Then a complete exposure pathway must exist. For a pathway to be complete, the following four elements must exist:

- a chemical source
- mechanism(s) for chemical release
- feasible route(s) of exposure (ingestion, inhalation and dermal exposure)
- a point of exposure with a receptor

For example, a chemical is identified in soil. Humans may contact soil directly and ingest soil that sticks to their hands. This is a complete pathway. The chemical may also be transferred to a different environmental medium through chemical/physical properties and exposure may occur through this medium as well. For example, if the chemical in soil is volatile, humans can inhale the chemical in vapor form while in contact with the dirt.

The following parameters are used to estimate how much exposure does or could occur. This is termed chemical intake:

- exposure frequency (number of day exposed per year)
- exposure duration (number of years of exposure)
- contact rate (amount of soil ingested each day measured in milligrams of soil or the amount of air inhaled in an hour or a day measured in cubic meters of air)
- body weight (average body weight over the exposure duration of the receptor)
- averaging time (time period over which exposure is averaged)
- chemical concentration in the environmental medium (for example, milligrams of chemical per kilogram of soil)

Values for the first five parameters are obtained through the scientific literature, from the census bureau, or national surveys. A range of possible values is available for each of these parameters. For example, not every person in a population has the same body weight. A single value may be selected for each parameter to represent the average condition (50th percentile) or one may be selected to represent the reasonable maximum conditions, also defined as upper-bound or 95th percentile.

The chemical concentration parameter can either be derived directly from the available data or modeled using conservative mathematical models to estimate the chemical concentration at the point of contact.

The presence of a chemical in an environmental medium and contact with the medium does not necessarily result in a health risk. The toxicity assessment presents information on the toxic effects from exposure to a COPC and the relationship between the level of exposure and the occurrence of adverse health effects (dose-response). Toxic effects from chemical exposure are divided into two broad categories; those that have carcinogenic effects and those that result in noncarcinogenic effects. EPA has developed a classification system that rates chemicals as to their potential to cause cancer.

Noncarcinogenic effects are impacts to an organ or organ system, such as impaired kidney function or respiratory effects. Even though chemicals are classified as carcinogens, they may also result in noncarcinogenic effects prior to the onset of cancer. The dose-response relationship is expressed as critical toxicity values. These values are established by EPA or DTSC and are specific for carcinogens and noncarcinogens. Toxicity values for carcinogens are termed cancer slope factors. The slope factor is defined as the plausible upper-bound estimate of the probability of a carcinogenic response per unit intake of chemical over a lifetime. Toxicity values for noncarcinogens are termed reference doses (RfDs). An RfD is an estimate of a daily exposure level that is likely to occur without an appreciable risk of adverse effects during a lifetime.

The risk characterization section combines the estimates of exposure with the toxicity values to calculate a numerical estimate of the probability of cancer and an index used to evaluate noncancer health effects. The numerical estimate of the probability of cancer is determined by multiplying the chemical intake by the cancer slope factor. The resulting product is termed the excess lifetime cancer risk. If exposure occurs to more than one carcinogenic chemical, the EPA assumes risks can be added together to account for exposure to multiple chemicals.

The excess lifetime cancer risk is a probability of an increase in the incidence in cancer over the background probability of developing cancer (no exposure to site related chemicals). For example, a cancer risk of 1×10^{-5} means that if 100,000 persons are exposed to a carcinogenic chemical or chemicals, the incidence of cancer is increase by one case because of that exposure.

why an increase?

The potential for occurrence of an adverse health effect from intake of a noncarcinogenic chemical is estimated by dividing the chemical intake by its RfD. If the resulting quotient, termed the hazard quotient (HQ), is less than one, the potential for adverse effects is low. If the HQ is greater than one, it is an indicator that adverse effects could occur.

Toxic effects of lead exposure are correlated with blood lead levels rather than exposure estimates. The potential for adverse effects from lead exposure were evaluated using the DTSC lead spreadsheet. The spreadsheet calculates percentile blood lead levels for adults. Calculated blood lead levels below the target level of 30 ug/dl for adults are without significant adverse effects (FDA, 1990).

Regulatory agencies have made policy decisions on the level of risk that is insignificant. The State of California has established an excess lifetime cancer risk of 1×10^{-5} (1 in 100,000) as a level of "no significant risk" under Proposition 65 (California Code of Regulations, Title 22, Section 12711(a)(1)). EPA, through the NCP, has established a risk range of 1×10^{-4} to 1×10^{-6} as acceptable.

Results of the Health Risk Assessment

Construction workers on-site are the primary receptors for short-term exposures. Workers could be exposed through inadvertent ingestion of soil, inhalation of particulates and direct dermal contact with soil while dirt moving activities are taking place and prior to completion of the asphalt cover. The maximum excess lifetime cancer risk from all exposure routes was estimated as 4×10^{-6} , primarily due to ingestion of PNAs in soil through inadvertent means and inhalation of soil as particulates. Noncancer adverse effects are not anticipated as the HI was substantially less than one. Calculated blood lead levels were 6.0 ug/dl for 99th percent of the construction workers. An individual would have an estimated risk of no more than a 1 percent of exceeding the 6.0 ug/dl blood lead level, therefore, lead does not present a significant risk to construction workers. The estimate cancer risk is within the EPA acceptable risk range of 10^{-4} to 10^{-6} (EPA, 1990c) and less than the 10^{-5} level considered by DTSC to represent no significant risk (California Code of Regulations, Title 22, Section 12711(a)(1)).

No exposures are anticipated after completion of the storage facility, as the site will be completely covered in buildings and asphalt paving. No potential exposure routes to soil or groundwater were identified. However, the Alameda County Health Department requested an analyses of the long-term on-site worker exposure to dust arising from soil at the site. Excess lifetime cancer risk from inhalation of particulates that may be emitted through cracks in the asphalt cover was estimated to be a maximum of 1×10^{-5} for the on-site storage facility worker. Noncancer adverse effects are not anticipated. This is within the EPA acceptable risk range of 10^{-4} to 10^{-6} (EPA, 1990c) and at the 10^{-5} level considered by DTSC to represent no significant risk under Proposition 65 (California Code of Regulations, Title 22, Section 12711(a)(1)).

Inhalation of lead on dust generated from near surface soils does not present a significant health risk for the future facility worker. The 99th percentile blood lead level is 3.2 ug/dl for adults. This value includes background exposure in food, air and water and is less than the recommended upper limit of 30 ug/dl for adults (FDA, 1990). Dust inhalation accounts for only 15% of the total intake.

This evaluation of lead did not consider lead at hot spot concentrations. If the maximum hot spot concentration is used in the DTSC Leadsread model and the ingestion rate is set to zero since inhalation is the only route considered, the 99th percentile blood lead level is 61.7 ug/dl with inhalation responsible for 28 percent. Direct soil contact is responsible for 65 percent of the blood lead value. It is unlikely that a worker could be exposed to dust arising from a lead hot spot on a long-term basis. However, using the hot spot concentration dramatically demonstrates the potential affect that lead at hot spot concentrations could have on site workers.

Risk of Failure

The only foreseeable type of containment failure is cracking of the asphalt over time. Although asphalt cracking is likely to occur, regular inspection and maintenance will reduce the potential for exposure to COPCs in near surface soil under the asphalt cover. Regular maintenance will also reduce the potential for infiltration through the cover, retarding movement of COPCs in near-surface soil. Risk of containment failure has been evaluated assuming dust exposure by the long-term storage facility worker.

Cleanup Strategies

Based on the results of the risk assessment, removal of soil containing lead in excess of 1200 mg/kg is recommended. This recommendation is made to provide for protection of public health should cracks in the asphalt of the proposed development release soil as dust from the lead hot spots.

The groundwater quality beneath the site has not been significantly degraded by the site. TDS concentrations vary from 1200 mg/l to 4800 mg/l, exceeding the California State Water Resources Control Board (CSWRCS, Resolution 88-63) definition of a drinking water source (TDS concentration of less than 3000 mg/L) and consistently exceeding the federal secondary MCL of 500 mg/l. Drinking water is not considered a potentially beneficial use of groundwater. Remediation of soil to reduce PNA or lead concentrations would not result in a measurable improvement in the beneficial use of groundwater.

**HUMAN HEALTH AND ENVIRONMENTAL RISK ASSESSMENT
ISLAND GUN CLUB PROPERTY**

1.0 INTRODUCTION

This report presents the results of an assessment of the human health and environmental risk associated with the construction and operation of a mini-storage unit with recreational vehicle (RV) storage and parking at 500 Maitland Drive, Alameda, California. This is the site of the former Island Gun Club which operated as a gun shooting range from 1926 to approximately 1982. It consists of a 5 acre parcel of land located at 500 Maitland Drive at the northwest corner of Maitland Drive and Harbor Bay Parkway on the Bay Farm Island portion of Alameda.

1.1 Background

Investigations performed to date have defined concentrations of lead, copper, and PNAs in soil above background. In addition, samples taken from groundwater monitoring wells at the site indicate lead and copper concentrations above those detected in an adjacent off-site, upgradient well.

1.2 Description of the Project

The proposed development plans for the site conform to existing land use plans and zoning ordinances. The entire site will be graded and paved with asphalt. It is anticipated that limited excavation of soil will be required prior to asphalt paving. Trenching will occur to install underground utility conduits (sewer and electrical). Construction of storage buildings will be built on an asphalted RV parking lot on the property. Light standards will be installed around the perimeter and within the property at 30 foot intervals. Perimeter fencing will complete the site development.

no landscaping

1.3 Purpose and Scope of the Risk Assessment

The purpose of this assessment is to provide decision makers with risk-based information to determine the need for remedial action and future environmental impact at the site. This includes estimating the current risk from the site and the short-term and long-term human health risks associated with construction of the mini-storage units and RV storage and parking lot at the site, both quantitatively and/or qualitatively. It is based on information and data collected by ACC Environmental in 1994, RESNA Industries, Inc. in 1992 and 1993 and Kleinfelder in 1990.

This analysis utilizes guidance set forth in *Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual, Part A, Baseline Risk Assessment* (EPA, 1989a), *Part C, Risk Evaluation of Remedial Alternatives and Actions* (EPA, 1991a), *Supplemental Guidance for Human Health Multimedia Risk Assessments of*

Hazardous Waste Sites and Permitted Facilities (CalEPA, 1992a) and *Preliminary Endangerment Assessment Guidance Manual* (CalEPA, 1994). The format of this report is based on these guidance documents.

1.4 Organization

Section 2 summarizes the available data for use in the risk assessment and identifies the chemicals of potential concern (COPCs). The exposure assessment, presented in Section 3.0, provides a description of the site and surrounding area, a discussion of the proposed construction, identifies the potential for short-term and long-term releases and receptors of those releases, then quantifies the potential for exposure (at the reasonable maximum) to releases. Section 4.0 presents toxicity information on the COPCs and identifies the toxicity values that will be used to quantitatively estimate risk. Risk is characterized in Section 5.0. Both carcinogenic risk and the potential for noncarcinogenic adverse effects are presented and discussed in this section. Uncertainties associated with each step of the assessment are addressed in Section 6.0. A summary of the assessment is presented as Section 7.0. Available data, toxicity profiles and other documentation for the assessment are presented as appendices to the report.

2.0 DATA SUMMARY AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

This assessment is based on data collected at the site over a four year period. This section describes the available data and presents a statistical summary of the data for each medium. All data are assumed to be useable for the risk assessment. The identification of chemicals of potential concern (COPCs) is then discussed.

2.1 Available Data

2.1.1 Investigations and Sampling

A Phase I Environmental Assessment conducted by Kleinfelder, Inc. in 1990 included a review of historical aerial photographs of the site, discussions with persons knowledgeable about the site, a review of regulatory agency files for information relevant to the site, a site reconnaissance, and limited soil sampling (Kleinfelder, 1990). Five surficial soil samples, 0 to 6 inches, were taken from locations believed to contain high concentrations of lead from bullets and shot. One sample was taken across the roadway southeast from the site to serve as a control. These sampling locations, designated as S-43XXX are shown on Figure 2-1. Samples were analyzed for organochlorine pesticides and polychlorinated biphenyls (PCBs) using EPA Method 8080 and for metals using CAM-17 Metal Analysis.

A second Phase I Environmental Assessment was conducted by Exceltech, Inc. in October 1991 to supplement information obtained in the 1990 Kleinfelder report (Exceltech, 1991). This assessment consisted of an additional records search investigating the adjacent property that served as a dump and a characterization of the site for slugs, shot, casings, and clay pigeon debris. No environmental sampling was conducted for this assessment.

A Phase II soil and groundwater investigation was conducted at the site in September 1992 by RESNA Industries, Inc. (RESNA, 1992). Three exploratory borings were drilled in locations with shell fragments and clay pigeon debris. Soil samples were taken every 2 feet during drilling and all three borings were drilled to a depth of 14 feet. Seven subsurface soil samples were analyzed for copper, lead (soluble and total), and polynuclear aromatic hydrocarbons (PNAs).

All borings were completed as monitoring wells, designated as MW-1, MW-2 and MW-3. The location of these wells is shown on Figure 2-1. Wells were sampled once and samples analyzed for copper, lead, PNAs, and total dissolved solids (TDS). An off-site well at 22 Christensen Court, approximately one mile north of the site, was also sampled and analyzed for the same suite of constituents as the on-site wells. This well was selected to represent regional water quality data. The approximate location of the off-site well is shown on Figure 2-2.

During the Phase II investigation, two near surface (0 to 6 inches and 6 to 12 inches) soil samples were taken from each of 15 randomly selected locations on-site. These samples were composited in the laboratory and analyzed for copper and lead using the WET method for STLC and EPA Method 7421/6010 for STLC. Ten of these composited

samples were also analyzed for PNAs using EPA Method 8250. Sample locations are shown on Figure 2-1. One clay pigeon sample was taken and analyzed for PNAs.

RESNA collected eleven addition near surface soil samples from the site in December, 1992 (RESNA, 1993). Most were taken within a 20-foot radius of sample location No. 28. One sample was collected south of Harbor Bay Parkway to serve as a background location. The sample locations are shown on Figure 2-1. Eight samples were analyzed for lead using the WET method for STLC and EPA Method 7421/6010 for TTLC.

As part of a tide study conducted by ACC Environmental in May 1994, two additional borings were drilled and completed as monitoring wells (ACC, 1994). These are designated as MW-4 and MW-5 on Figure 2-1. MW-4 was drilled to a depth of 16.5 feet and MW-5 was drilled to 12.5 feet. Three soil samples were taken from each boring at depth intervals of 2 to 3 feet bgs. All samples were analyzed for copper and lead using the WET method for STLC, EPA Method 6010 for TTLC and EPA Method 8100 for PNAs. One round of groundwater samples was collected from all monitoring wells (MW-1 through MW-5) and analyzed for copper, lead and PNAs.

Table 2-1 denotes sample dates and analyses requested for samples. Appendix A, Tables A-1 through A-3 present the data obtained during the sampling events described above. For the purpose of this assessment, the data set for each medium does not distinguish between sampling dates.

2.1.2 Results and Data Summary

Lead and copper were detected above the detection limit in all near surface soil samples analyzed for these two constituents. Both constituents are lognormally distributed throughout the site, if "hot spots" are not included in the analysis. For this assessment, hot spots are those samples in which the constituent was detected at a concentration two orders of magnitude greater than the next highest concentration. Four sample locations, No. 4, No. 28, S-43182 and S-43185, were identified as "hot spots" for lead. One of those locations, S-43185, was also identified as a "hot spot" for copper. The sample locations and concentrations are shown on Figure 2-3. The concentration of lead at these locations are 91,000, 40,000, 15,000 and 88,000 mg/kg, respectively. The concentration of copper at its hot spot is 10,000 mg/kg. Table 2-2 presents the summary statistics for lead and copper in near surface soil site-wide, not including the hot spots.

Summary statistics includes minimum and maximum detected values, the frequency of detection, the mean (using one-half the method reporting limit for all non-detected values), median, and the upper 95 percent confidence limit (95UCL) of the mean based on the distribution of the data. The 95UCL is calculated to address the statistical uncertainty associated with estimating the mean concentration on a relatively small number of samples. The distribution was determined using the normal probability plot method. As a measure of how well the log-transformed and untransformed data fit a straight line, the regression r^2 values were calculated. A good fit (defined a r^2 less than 0.90) for the long-transformed data was consistent with the assumption of a lognormal distribution. If the

lognormal criterion was not met, the r^2 for the untransformed data was used to test for a normal distribution. A good fit was again defined as r^2 less than 0.90. If a majority of the data points are censored, neither the lognormal or normal distribution could be assumed. In this case, the lognormal distribution was assumed because it typically results in a higher 95UCL.

The 95UCL was calculated using the statistical package MTCASat (WDOE, 1992). This statistical package calculated the 95UCL for lognormally distributed data by the method of Land (1971, 1975) and the H parameter determined from tabled values, with degrees of freedom equal to one less than the number of sample values. If the lognormal criterion was not met and the data were normally distributed, the 95UCL was determined using the t parameter determined from tabled values, with degrees of freedom equal to one less than the number of sample values.

A background near surface soil sample was taken by Kleinfelder in 1990 east of Maitland Drive (S-43186). This off-site sample contained 37 mg/kg lead, 10 mg/kg copper, 0.02 mg/kg DDT, 0.02 mg/kg DDE and 0.01 mg/kg DDD. Lead was detected at 26 mg/kg in another near surface soil background sample (No. 11) taken south of Harbor Bay Parkway (off-site). Copper was not analyzed for in this sample.

Lead was detected above the detection limit (5 mg/kg) in two of seven subsurface soil samples. At MW-3, lead was detected at the 2 1/2 foot sample depth and the 5 foot sample depth at concentrations within the range of near surface soil concentrations, 15 and 290 mg/kg, respectively. Copper was detected in all subsurface soil samples within the range of values detected in near surface soil. Table 2-3 presents the data and summary statistics for lead and copper in subsurface soil.

Sixteen PNAs were detected in near surface soil samples site-wide and seven in one subsurface soil sample. Two of the sixteen PNAs, 2-methylnaphthalene and n-nitroso-di-n-propylamine, were each detected once in separate samples. The greatest variety of compounds and highest concentrations of PNAs were detected in soil on the south side of the ditch that runs across the property from west to east. This area, referred to as the clay pigeon debris area, is shown on Figure 2-2. All PNA compounds detected in near surface soil from this area were also detected in the clay pigeon sample. Concentrations of PNAs in soil are one-quarter to three orders of magnitude lower than the concentrations detected in the clay pigeon sample. The concentrations of the seven PNAs detected in the subsurface soil sample taken 5 feet in depth from MW-3 (also within the clay pigeon debris area) were one-quarter to two orders of magnitude lower than those detected in near surface samples. Table 2-2 presents summary data on PNAs in near surface soil site-wide. Table 2-4 presents summary data for PNAs detected within the clay pigeon debris area only. Table 2-3 presents summary data for PNAs in subsurface soil.

Total lead and copper were detected in each monitoring well, except MW-4, during at least one round of sampling. Of the PNA compounds, pyrene was detected in one groundwater sample (from MW-5) at 20 ug/L. Total dissolved solids in groundwater ranged from 2,200 to 4,800 mg/L. Lead and copper were also detected in the sample

taken from the off-site well while PNAs were not. Table 2-5 presents summary groundwater data. This table includes the frequency of detection, the minimum detected value, the maximum reported value for each constituent and the state MCL.

2.2 Data Useability

An evaluation of data quality is an important step in the risk assessment process (EPA, 1990a). The quality of the data affects its useability in the assessment and impacts the uncertainty of the resulting risk obtained through its use. All data collected in the Phase I and Phase II investigations underwent quality assurance/quality control checks at the time of collection. For the purpose of this assessment, it is assumed that all data are of adequate quality for use in the risk assessment. The Phase II investigation collected the majority of data at the site and standard EPA analytical methods were used. The Phase I investigation used CAM-17 Method 7420 for lead analyses in soil and Method 7210 for copper in soil while the Phase II investigation used EPA Method 6010 for inorganic analyses. The two methods have different detection limits, Method 7420 has a detection limit of 1 mg/kg for lead while EPA Method 6010 has a detection limit of 5 mg/kg. Method 7210 for copper has a detection limit of 1 mg/kg for copper while EPA Method 6010 has a detection limit of 0.5 mg/kg. The detection limits are very similar, and therefore, for the purpose of this assessment it is assumed the identification and quantification of inorganic compounds is similar and that data are therefore comparable and can be combined for use in the risk assessment.

Matrix spike recoveries for the 1994 groundwater samples analyzed by Sequoia Analytical were low (40%) for pyrene. This affects the accuracy of the reported concentration and the value reported may be an underestimate of the actual concentration.

2.3 Selection of Chemicals of Potential Concern

The selection of chemicals of potential concern (COPC) is normally a step-wise process that identifies a set of chemicals that are likely to be the most prevalent, mobile, persistent and toxic. COPC selection is a part of EPA's risk assessment process and usually results in a reduction in the number of chemicals carried through the risk assessment than identified during the investigation (EPA, 1989). This allows the risk assessment to focus on the chemicals that are site related and pose a significant risk.

Because the investigations, both sampling locations and analyses requested, focused on those chemicals associated with activities conducted at the site, the screening process for identification of COPCs for this risk assessment has been reduced to an evaluation of background comparison and frequency of detection.

2.3.1 Background Comparison

The number of background samples collected were not sufficient for statistical comparisons between onsite soil or groundwater. Only general observations can be made with the data. Lead was detected in the background soil samples at 26 mg/kg and 37



Why did not use toxicity screening procedure

mg/kg. The mean onsite lead concentration is 172 mg/kg (without including the hot spots). Fifteen percent of the onsite near surface soil samples had lead concentrations less than 37 mg/kg (4 out of 26 samples, without including the hot spots).

Copper was analyzed in one background sample. It was detected at a concentration of 10 mg/kg. The mean onsite copper concentration is 40 mg/kg (without including the hot spots). Twenty percent of the onsite near surface soil samples had copper concentrations less than 10 mg/kg (4 out of 20 samples, without including the hot spot).

Lead (TTLC) was detected in the off-site well at 0.02 mg/L. Eight samples from onsite wells had lead concentrations below this value (57%). Copper (TTLC) was detected at a concentration of 0.023 mg/L in the off-site well. Two samples from onsite wells had copper concentrations below this value (14%).

No conclusions can be drawn on the on-site background comparison or contribution, because of the limited number of background samples available.

2.3.2 Frequency of Detection

Frequency of detection is reported on Tables 2-2, 2-3 and 2-5 for the media evaluated. Two PNA compounds, 2-methylnaphthalene and n-nitroso-di-n-propylamine, were detected only once in near surface soil, each in a different sample. Neither compound was detected in the clay pigeon sample nor in samples of other media. These two compounds will not be considered COPCs and will not be carried through this assessment.

Pyrene was the only PNA detected in groundwater and it was detected in one sample. Although its frequency of detection is low, it will remain a COPC because of the potential for it to be present at a higher concentration than that reported and its presence in both near surface and subsurface soil.

Table 2-6 presents the COPCs in soil and groundwater for this assessment.

Table 2-1
Available Data
Former Island Gun Club Site

Date of Investigation	Company	Type of Sample					
		Surface Soil 0-6"	Borings	Groundwater	Clay Pigeons	Background Soil	Background Groundwater
2/22/90	Kleinfelder	6 samples metals (CAM-17) -TTL 3-EPA 8080					
9/92	RESNA	15 samples Cu-STLC/TTL Pb-STLC/TTL 10 samples PNAs 8270	7 samples Cu-STLC/TTL Pb-STLC/TTL PNAs 8270	3 samples Cu - STLC/TTL Pb - STLC/TTL PNAs 8270 TDS	1 sample PNAs 8250	1 sample Cu - STLC/TTL Pb - STLC/TTL PNAs 8270 TDS	
9/16/92	RESNA	3 samples Cu - STLC/TTL Pb - STLC/TTL PNAs 8270 TDS					
10/16/92	RESNA	3 samples Cu - STLC/TTL Pb - STLC/TTL PNAs 8270 TDS					
11/30/92	RESNA	3 samples Cu - STLC/TTL Pb - STLC/TTL					
12/22/92	RESNA	3 samples PNAs 8270 TDS					
12/30/92	RESNA	11 samples Pb-STLC/TTL					

Table 2-1, Continued

Date of Investigation	Company	Type of Sample					Background Groundwater
		Surface Soil 0-6"	Borings	Groundwater	Clay Pigeons	Background Soil	
5/94	ACC		6 samples Cu - STLC/TTL Pb - STLC/TTL PNAs 8270	5 samples Cu - STLC/TTL Pb - STLC/TTL PNAs 8270			

Cu = Copper

Pb = Lead

PNAs = Polynuclear aromatic hydrocarbons

STLC refers to dissolved concentrations.

TTL refers to total concentrations.

The number adjacent to PNAs refers to the EPA method for analysis.

Table 2-2

Summary Statistics for Near Surface Soil Site-Wide (without Inorganic Hot Spots)

What we need surface soil site wide
So only the data was analyzed that was the most of the soil

Constituent	Min. (mg/kg)	Max. (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Frequency of Detection	Distribution of Data	95 UCL (mg/kg)
Inorganics							
Copper (TTLIC)	6.0	170	40	22.5	20/20 (100%)	lognormal	65.4
Lead (TTLIC)	9.9	610	172	125.0	26/26 (100%)	lognormal	331.7
PNA's							
Acenaphthene	1.3	33	21.6	26	4/13 (31%)	normal	38
Anthracene	16	26	19.3	16	3/13 (23%)	normal*	42
Benzo(a)anthracene	0.27	260	108.6	115.5	6/13 (46%)	normal	191
Benzo(b)fluoranthene	0.12	380	98.9	6.7	6/13 (46%)	normal*	229
Benzo(k)fluranthene	6.2	220	125.4	150	3/13 (23%)	lognormal	1.0E+19
Benzo(g,h,i)perylene	11	200	127.8	150	4/13 (31%)	normal	220
Benzo(a)pyrene	0.12	410	141.5	78	4/13 (31%)	normal*	360
Chrysene	0.24	140	63.1	59	6/13 (46%)	normal*	118
Dibenzo(a,h)anthracene	9.7	210	130	150	4/13 (31%)	normal	220
Dibenzofuran	0.15	2.2	1.3	1.7	5/13 (38%)	normal*	2.3
Indeno(1,2,3-c,d)pyrene	12	20	140.5	175	4/13 (31%)	normal	240
2-Methylnaphthalene		1.8			1/13 (8%)		
Naphthalene	7.2	14	100.3	8.9	3/13 (23%)	lognormal	30
N-nitroso-di-n-propylamine		0.56			1/13 (8%)		
Phenanthrene	0.32	72	34	47	5/13 (38%)	normal*	64
Pyrene	9.8	120	68.6	76	3/13 (23%)	lognormal	1.5E+09

Distribution of data for PNA's were forced because of the limited number of positive samples.

* Indicates 95UCL calculated with a t-statistic assuming a normal distribution.

Table 2-3
Summary Statistics for Subsurface Soil (below 1')

Constituent	Min. (mg/kg)	Max. (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Frequency of Detection	Distribution of Data	95 UCL (mg/kg)
Inorganics							
Copper (TTLC)	3.1	58	25	19	7/7 (100%)	lognormal	263
Lead (TTLC)	15	290	152.5	152.5	2/7 (29%)	lognormal	-- ^a
PNAs							
Benzo(a)anthracene		2.6					
Benzo(b)fluoranthene		3.0					
Benzo(k)fluranthene		1.3					
Benzo(g,h,i)perylene		2.8					
Benzo(a)pyrene		3.7					
Chrysene		2.1					
Pyrene		2.5					

^a More than 50% of data are censored, therefore no UCL calculated.

Table 2-4

Summary Statistics for PNAs in Near Surface Soil of the Clay Pigeon Debris Area

Constituent	Min. (mg/kg)	Max. (mg/kg)	Mean (mg/kg)	Median (mg/kg)	Frequency of Detection	Distribution of Data ^a	95 UCL (mg/kg)
PNAs							
Acenaphthene	1.3	33	21.6	26	4/13 (31%)	normal	38
Anthracene	16	26	19.3	16	3/13 (23%)	normal	42
Benzo(a)anthracene	91	260	162.8	150	4/13 (31%)	lognormal	380
Benzo(b)fluoranthene	13	380	197.7	200	3/13 (23%)	normal	500
Benzo(k)fluoranthene	6.2	220	125.4	150	3/13 (23%)	lognormal	1.0E+19
Benzo(g,h,i)perylene	11	200	127.8	150	4/13 (31%)	normal	220
Benzo(a)pyrene	16	410	188.7	140	3/13 (23%)	lognormal	3.4E+13
Chrysene	83	140	94.6	115	4/13 (31%)	normal	160
Dibenzo(a,h)anthracene	9.7	210	129.9	150	4/13 (31%)	normal	220
Dibenzofuran	1.7	2.2	2.0	2.2	3/13 (23%)	normal	2.8
Indeno(1,2,3-c,d)pyrene	12	20	140.5	175	4/13 (31%)	normal	240
2-Methylnaphthalene		1.8			1/13 (8%)		
Naphthalene	7.2	14	10.0	8.9	3/13 (23%)	lognormal	30
N-nitroso-di-n-propylamine		0.56			1/13 (8%)		
Phenanthrene	2.0	72	42.5	48	4/13 (31%)	normal	76
Pyrene	9.8	120	68.6	76	3/13 (23%)	lognormal	1.5E+09

^a Distribution of PNAs were forced because of the limited number of positive samples.

**Table 2-5
Summary Statistics for Groundwater**

Constituent	MCL (mg/L)	Min. (mg/L)	Max. (mg/L)	Mean (mg/L)	Median (mg/L)	Frequency of Detection	Distribution of Data	95 UCL (mg/L)
Inorganics								
Copper (TTLC)	1.3	0.0038	0.31	0.07	0.027	9/14 (64%)	lognormal	0.29
Copper (STLC)		0.016	0.056	0.03	0.027	9/14 (64%)	lognormal	0.04
Lead (TTLC)	0.015 ^a	0.0061	0.087	0.04	0.034	8/14 (57%)	normal	0.03
Lead (STLC)		0.018	0.083	0.04	0.019	3/14 (21%)	UN	-- ^b
PNAs								
Pyrene	NA		0.02					

a Action level at customer tap.

b Cannot calculate 95UCL, use maximum detected value.

NA = None available.

UN = Unable to analyze, more than 50% of the data are censored.

Handwritten note:
PNA - Not available
not available
not available
not available

Table 2-6
Chemicals of Potential Concern

Constituent	Near Surface Soil	Subsurface Soil	Groundwater
Inorganics			
Copper	X	X	X
Lead	X	X	X
PNAs			
Acenaphthene	X		
Anthracene	X		
Benzo(a)anthracene	X	X	
Benzo(b)fluoranthene	X	X	
Benzo(k)fluoranthene	X	X	
Benzo(g,h,i)perylene	X	X	
Benzo(a)pyrene	X	X	
Chrysene	X	X	
Dibenzo(a,h)anthracene	X		
Dibenzofuran	X		
Indeno(1,2,3-c,d)pyrene	X		
2-Methylnaphthalene			
Naphthalene	X		
N-nitroso-di-n-propylamine			
Phenanthrene	X		
Pyrene	X	X	X

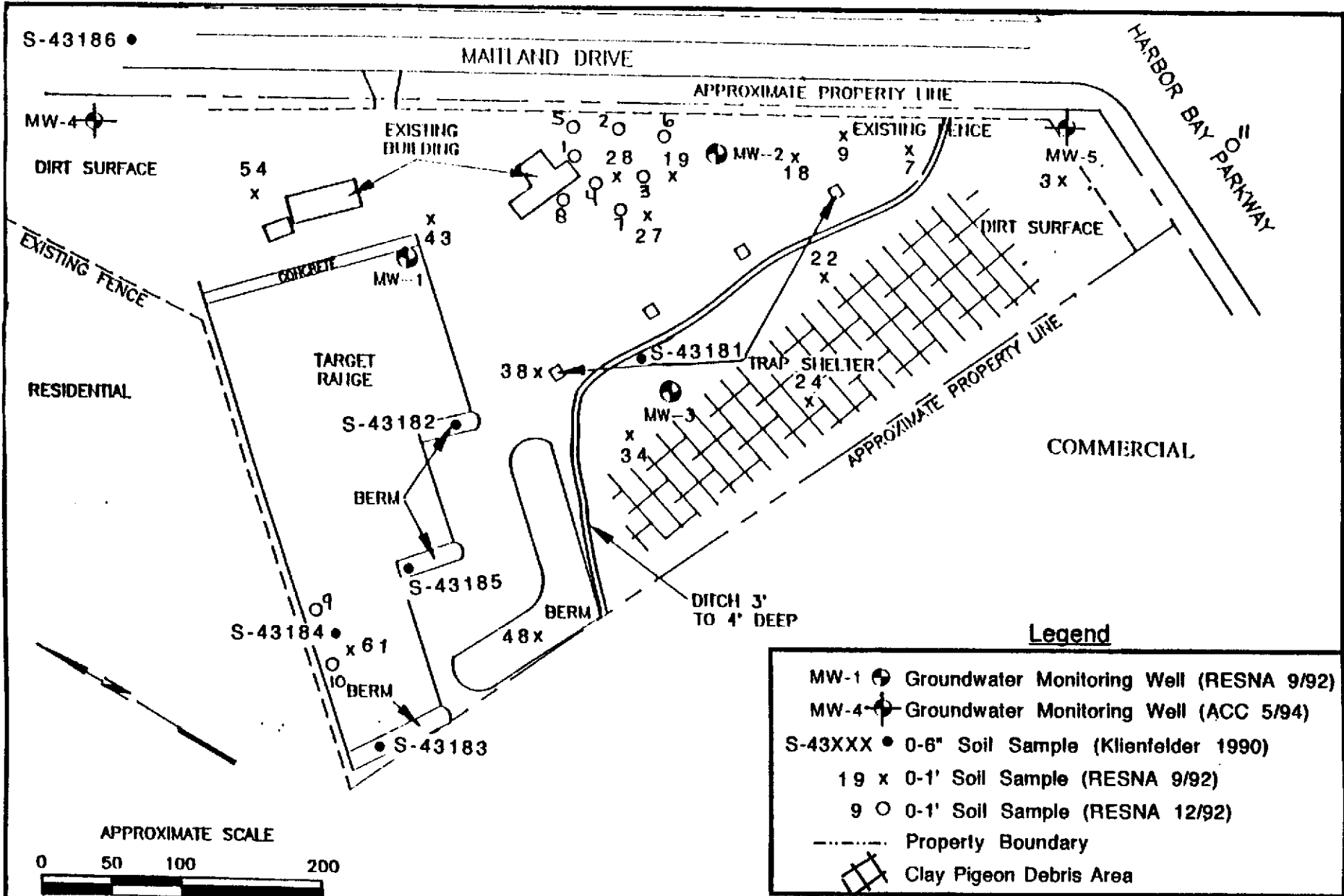
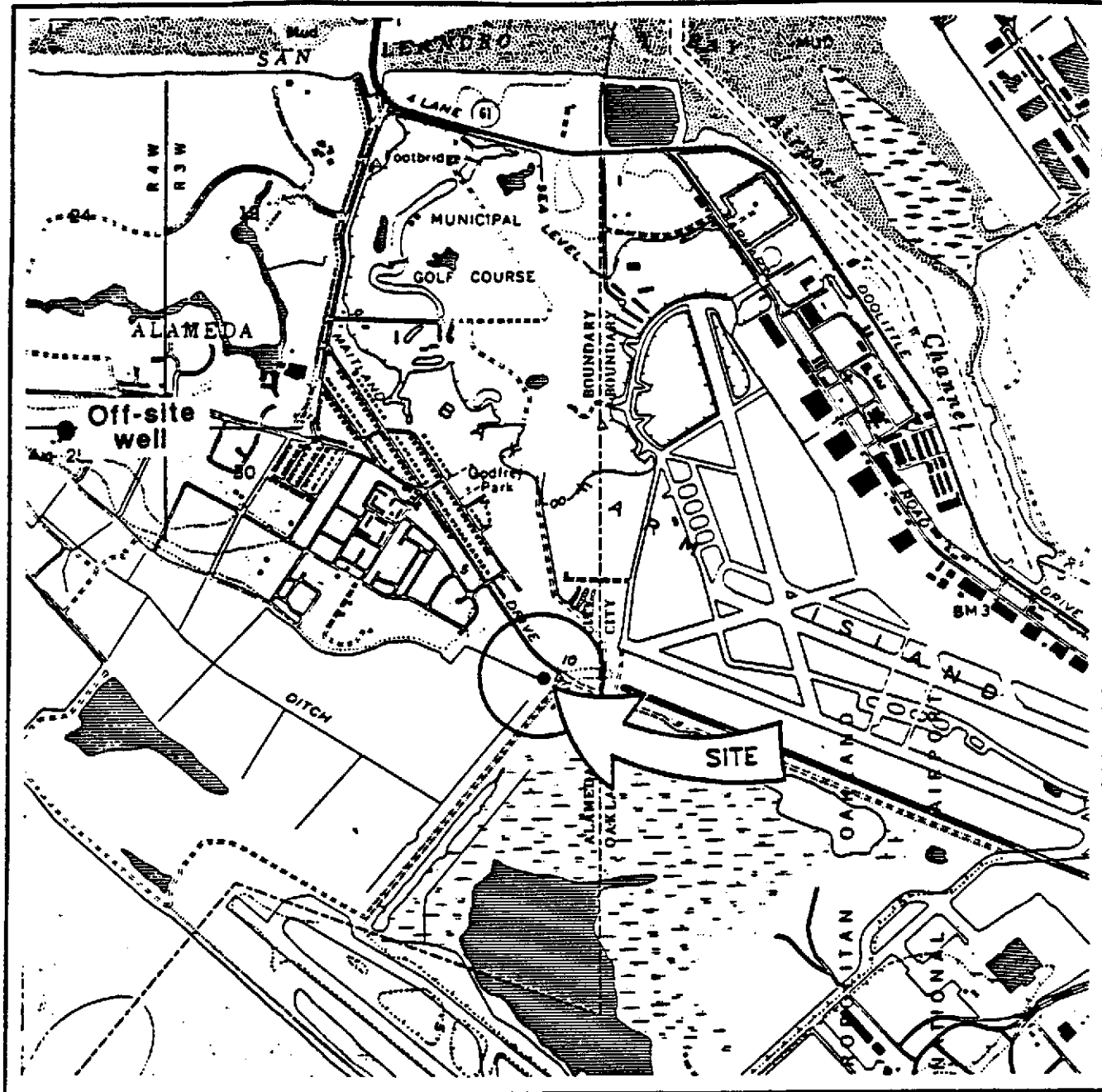
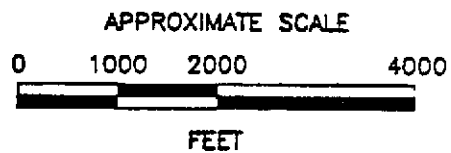


Figure 2-1 - Sample Locations
 Former Gun Club
 500 Maitland Drive, Alameda

May 27, 1994	Drawn By: MCK	Project No.: 6140-1
--------------	---------------	---------------------



SOURCE: U.S. GEOLOGICAL SURVEY
 7.5-MINUTE QUADRANGLE
 SAN LEANDRO, CALIFORNIA
 PHOTOREVISED 1980

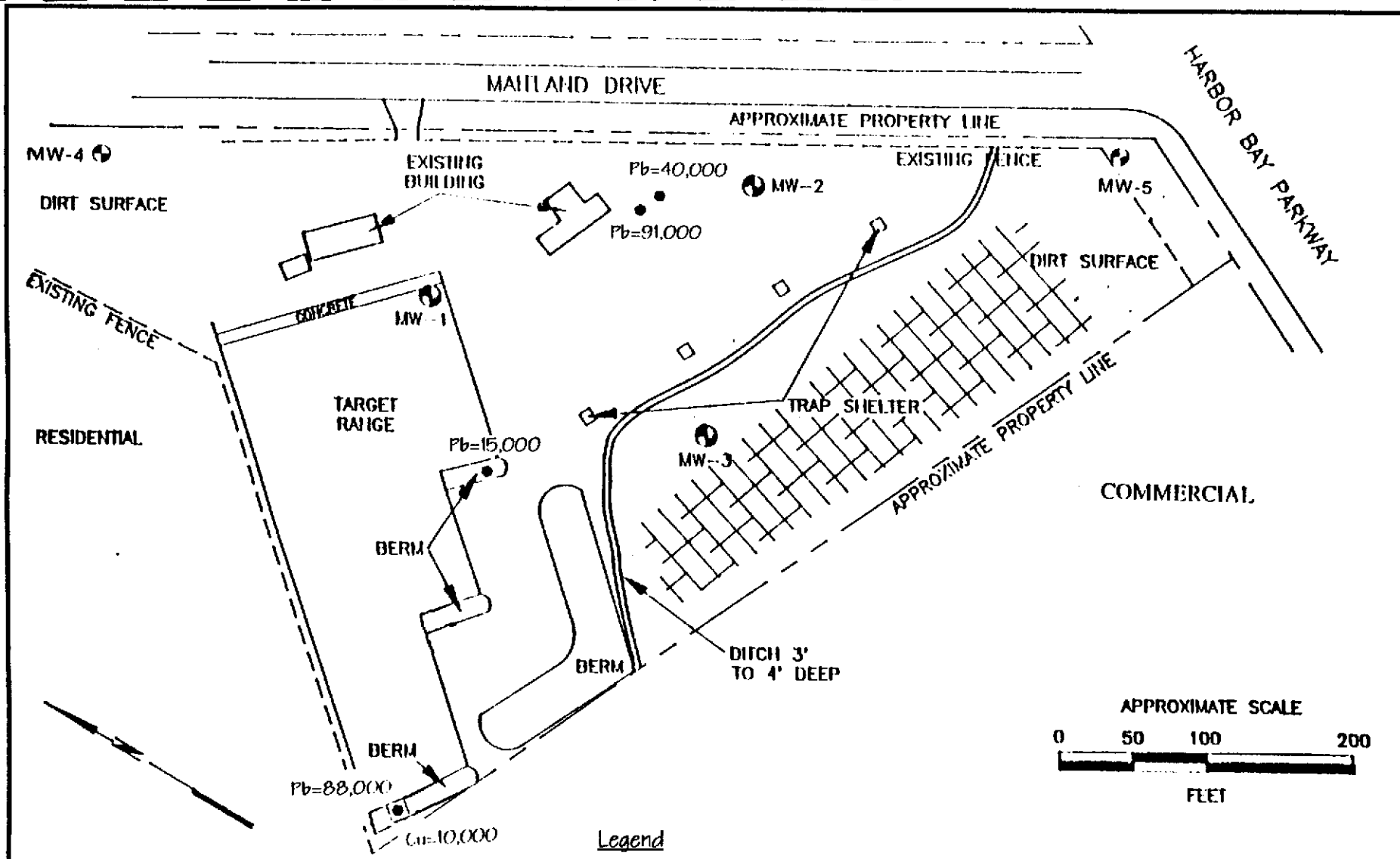


**Figure 2-2 - Location
 of Off-Site Well
 Former Gun Club
 500 Maitland Drive
 Alameda, California**

June 29, 1994

Drawn By: MCK

Project: 6140-1



Lead Hot Spot (Pb)	●
Copper Hot Spot (Cu)	□
Clay Pigeon Debris Area	▤

Figure 2-3
Hot Spot Locations and
Concentrations (mg/Kg)
 Former Gun Club
 500 Maitland Drive, Alameda

May 27, 1994

Drawn By: MCK

Project No.: 6140-1

3.0 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the type and magnitude of exposures to COPCs that could be present at or migrate from the site during or after construction of the storage complex. Formulation of exposure pathways is the essence of the assessment. An exposure pathway describes the mechanism through which a chemical released from the source reaches a receptor. It generally consists of:

- a contaminated environmental medium
- a receptor
- a point of contact with the contaminated medium (exposure point either on site or off site which necessitates an understanding of the fate and transport of the contaminants)
- a feasible route of exposure (such as ingestion or inhalation) at the contact point.

All elements must be present to have a complete exposure pathway.

3.1 Site Characterization

The site is located at the northwest corner of Maitland Drive and Harbor Bay Parkway on the Bay Farm Island portion of Alameda. The site is bordered to the north by a residential neighborhood, to the west by a Harbor Bay Business and Research Park, to the south by Harbor Bay Parkway and to the east by the Alameda Municipal Golf Course. It is approximately one mile east of the San Francisco Bay, one and one-half mile south of the San Leandro Channel and one mile west of Airport Channel in San Leandro Bay. It is northwest of and within a mile of the runways and hangars of the Oakland International Airport. Figure 3-1 shows the general site location. The following section summarizes the physical setting of the site.

3.1.1 Physical Setting

Climate. The climate is characterized by near-shore Mediterranean conditions. The mean annual temperature in Alameda (recorded in Oakland) is 50°F with a maximum temperature of about 100°F. Annual rainfall is about 18 inches, most of which falls between October and March (City of Alameda Library, personal communication, July 6, 1994). In the summer, drought conditions exist and precipitation is rare. Summer fog, from later morning through the night to late afternoon is common near the water.

Prevailing winds are from the west/northwest blowing to the east/southeast, off the bay onto land. The mean wind speed is estimated as 11 miles per hour (mph) (Dept. of Commerce, 1988).

Topography. The Site is generally flat with an elevation of 4.7 feet (m.s.l.) at the intersection of Maitland Drive and Harbor Bay Parkway. Elevation varies slightly more than one foot over the site (RESNA, 1992). The property is approximately 5 acres in size and lies about 1 mile from the Bay.

Soils. The site was filled during the early 1960's to an elevation which minimized standing water. The Site is underlain by interbedded gravely sand fill ranging in thickness from three to five feet. Below five feet, silty sand to sandy silt was encountered that increased in clay content with depth. Sandy clays continued to the bottom of the soil borings which were drilled to a depth of 14 to 16 feet below ground surface (bgs).

The permeability of the fill is considered high, however, the soil porosity is not known. No information is available on the organic carbon content of soil at the site nor the average moisture content of soil in the unsaturated zone (above about 4.5 feet).

Hydrogeology. The stratigraphy at the project site includes 5 feet of sandy fill directly below the surface. The fill is underlain by loose to medium dense, poorly graded (well sorted), fine to medium-grained sand. These deposits, similar to the Merritt Sand, reportedly extend to a depth of approximately 45 to 50 feet bgs within the area. At these depths, interbedded sands, silty clays, and clays are encountered. These interbedded deposits form the upper portion of the Posey Formation.

The Merritt Sands form the uppermost water-bearing zone at the project site. The aquifer is unconfined and can be recharged through infiltration. However, most of the outcrop areas for this unit (restricted to a portion of downtown Oakland and on the island of Alameda) are paved or covered by buildings. The aquifer is considered capable of producing groundwater to water supply wells but is not considered a drinking water source because of the aquifer's limited areal distribution and thickness resulting in limited yield. The aquifer is susceptible to water quality degradation through salt water intrusion due to proximity to San Francisco Bay. There are no public water supply systems currently extracting water from the Merritt-Posey aquifer (ACFCWCD, 1988).

Groundwater level measurements made in the wells at the site are summarized in Table 3-1. Groundwater levels at the site vary according to the time of year and have ranged from 2.00 to 5.73 feet bgs. The groundwater elevation for the water level data has been determined on the basis of surveyed elevation at the top of well casing. The groundwater elevation data indicate that the direction of groundwater flow at the site is generally toward the east, at an average gradient of approximately 0.0078 foot per foot (ACC, 1994). This gradient, shown on Figure 3-2, was confirmed by a 24-hour tidal study using the existing monitoring wells on the property. The tidal study indicated a slight tidal influence at the site. MW-2, the most downgradient well, experiences the greatest fluctuation in groundwater elevation at a difference of 0.07 foot in elevation between high and low tide.

Groundwater Use. East Bay Municipal Utilities District (EBMUD) supplies water to the City of Alameda. The records of the Alameda County Public Works Department indicate that 34 wells are located within a one-half mile radius of the project site. No municipal or domestic wells were identified within a one-mile radius of the site. The majority of these wells (53% or 18 wells) are monitoring or test wells, constructed for the purpose of investigating known or suspected releases of contaminants.

Fourteen wells are listed as irrigation wells, of which 9 are not permitted. Appendix B presents the inventory list of wells identified during the 1994 well search (ACC, 1994).

The closest identified well to the project site is an irrigation well (shown on Figure 3-1) located at 935 Magnolia Drive, approximately 900 feet northwest of the site (ACC, 1994). It is not known if this or any of the irrigation wells identified in the well survey are currently in use.

Surface Water. The San Francisco bay lies approximately one-mile to the west/southwest of the site. Bay water has no known domestic, industrial or agricultural uses within the project area.

Precipitation either infiltrates into the subsurface onsite or leaves the site as runoff. A small, man-made ditch (two feet to five feet across by 3 to 4' deep) lies just west of the trap shelters. This ditch empties into the City of Alameda stormwater system on the west side of Maitland Drive. At the corner of Maitland Drive and Harbor Bay Parkway, a catch basin directs flow underground where it empties into the Golf Course drainage system and then to the San Leandro Channel. The channel empties into the bay.

No water was detected within this ditch in June 1994. Water has been documented within the ditch during the rainy season. It is anticipated water within the onsite drainage ditch is a mixture of precipitation and surface expression of groundwater. The groundwater gradient, determined during the 1994 tidal study, indicates groundwater flows to the southeast near the ditch and that the ditch intercepts flow during a portion of the year (ACC, 1994). The gradient pattern is shown on Figure 3-2.

Ecology. The area surrounding the site is developed for residential and commercial use. The site is currently overgrown with trees, shrubs and weedy herbaceous vegetation. No wildlife surveys are available for the site. It is anticipated that the site could provide habitat for a variety of birds and small mammals. The Bay shoreline is fill and no wetlands are present. The aquatic community associated with the Bay (near the FDR fishing pier) consists of a variety of free floating plankton (microscopic plants and animals), fish, and benthic (bottom dwelling) invertebrates (such as mussels, clams, barnacles).

No plant or animal species officially protected under State Native Plant Protection Act, the State Endangered Species Act or Federal Endangered Species Act have been noted within the area surrounding the site. No wildlife reserves, national or state parks are located near the site.

3.1.2 Land Use and Demographics

Historical Conditions. The historical information on the site was obtained as part of a Phase I Environmental Assessment conducted in 1990 by Kleinfelder. Much of bayward edge of Bay Farm Island is fill. Available reports show that a number of sunken ships underlie a portion of the south and western sides of the Island. They were originally used

updated

*is it
filled
with
h₂O or
dry -
can it
be covered
how long?*

as a seawall and later were covered with fill material. The area occupied by the Alameda Municipal Golf Course was used as a dump from the late 1800s until the late 1940's. The portion of the Golf Course across Maitland Drive and adjacent to the site was used for dumping vegetative debris (tree limbs, stumps, etc.) from the 1950s until the late 1980's.

The Gun Club was founded in 1926 and was originally named the Island City Revolver Club. It was reportedly open only during the summer months during the first few years because it was under water the remainder of the year. The oldest aerial photograph available of the site is from 1947. The site appears to be undeveloped and covered by native vegetation. The adjacent properties to the east and south were also undeveloped. The Bay was located immediately west and south of the site defined by a sharp boundary which indicates fill material. No wetlands were apparent on this photograph. The next available photograph, taken in 1950, showed dirt roads crossing the site, although the site and adjacent properties were still undeveloped. By 1957, the Alameda Municipal Golf Course had been constructed directly northeast of the site and the San Francisco Bay was now several hundred feet from the site. The next available photograph was taken July 1968. The retaining walls on the pistol/rifle range were under construction and a building was located on the west side of Maitland Drive. Three clay pigeon launch and shooting areas were present. The property to the north had been developed as a residential area, filling of the bay continued to the west and the property to the south remained unchanged. During the 1960's fill was added to the property at irregular intervals to eliminate standing water onsite. Fill was supplied by builders who wanted to dispose of excess soil from their construction sites. The last locations filled were the trap field and rifle range. By 1979 the pistol/rifle range was completed. No other changes were evident. Four years later construction of the fourth shooting area had begun south of the existing ranges. By 1988, the site and surrounding area were developed into its current state.

Current Conditions. The site is currently unpaved and overgrown with a few boarded up wood frame buildings. The property is completely fenced. The fence has been damaged in several locations and the buildings show signs of vagrancy. Dumping of miscellaneous waste has occurred on the property in the area located between the rifle range and the trap field. The surface of the trap range contains several inches of broken clay pigeons.

Figure 3-3 identifies current land use adjacent to the site. To the northeast, across Maitland Drive is the Alameda Municipal Golf Course and residential homes. Northwest of the site, immediately adjacent to the property fence line are residences. Harbor Bay Parkway touches the site at its southeastern edge and abruptly diverges from the property. The area between the property and the Parkway to the southwest is open space. Due west of the Site is the Harbor Bay Business and Research Park.

The project site is within an area designated for commercial recreation use under the City of Alameda General Plan (City of Alameda, 1991). The City's zoning designation for the project site is Community Shopping/Commercial Zone (CM/PD). The site lies under the straight-out take-off tracks from Metropolitan Oakland International Airport (MOIA) within the Inner Portion of the Alameda County Land Use Commission (ALUC) safety zone. As such, current zoning regulations allow nonresidential use such as warehousing, nonintensive industry and equipment storage.

This site is within census tract #4283 in the City of Alameda. Approximately 11,254 persons live and 6,591 persons are in the labor force within this census tract according to the 1990 census and projections (MTCA library, personal communication, June 28, 1994; ABAG, personal communication, June 28, 1994). This census tract incorporates the entire Bay Farm Island.

No child care facilities, schools, hospitals, or senior care facilities are located in the area surrounding the project site.

Potential Future Conditions. Future land uses are limited to nonintensive industry, warehousing and equipment storage and other nonresidential use permitted in Alameda, subject to height restrictions. The City of Alameda's General Plan designates the area for ~~residential~~.

3.2 Potential Fate and Transport of COPCs

The fate and transport of COPCs in soil and groundwater at the site are controlled by dissolution, advection, diffusion, dispersion, volatilization, sorption, precipitation and chemical transformations. Table 3-2 provides chemical specific data that can be used to estimate the fate and potential transport of COPCs.

Volatilization from soil and ground water is not likely to be a significant transport mechanism for COPCs. According to CalEPA (CalEPA, 1994), chemicals are considered volatile if their vapor pressure is greater than 10^{-3} mm Hg or their Henry's Law Constant is greater than 10^{-5} atm-m³/mole. Chemicals with values less than or equal to these are considered non-volatile, therefore, volatilization is not considered a significant transport mechanism. Of the COPCs identified, acenaphthene, anthracene, naphthalene, and phenanthrene are considered marginally volatile using these parameters.

Volatilization dissipates contaminants by release to the atmosphere. This process may also disperse constituents by diffusing them throughout void spaces in the unsaturated zone. Infiltration from precipitation could result in the partition of constituents from void spaces to ground water, however, partitioning to ground water is controlled predominantly by the concentrations of the constituent in soil. None of the COPCs considered marginally volatile have been detected in groundwater at the site. ~~Further, once the site is paved, the potential for volatilization to the atmosphere and partition of constituents in void spaces to groundwater will be effectively eliminated.~~

Sorption to organic matter generally retards the transport of PNAs to and in ground water. The concentrations of PNAs detected in soil are much lower than their solubility limit, therefore, it is unlikely groundwater would act as a major mechanism of transport. If the PNAs detected in soil were to reach groundwater, migration to the bay is not likely as the direction of groundwater flow is to the east, toward the San Leandro channel, approximately 1.5 miles from the site.

We don't want it going to San Leandro Channel.

Water solubility?

The fate of copper and lead are dependent upon the medium they are in and the physical/chemical parameters and changes that occur within the medium. Metals in soil may undergo a solubility transformation in response to a change in pH, ~~however, the soils at the project site do not exhibit a tendency to leach.~~ ~~Near surface soil samples analyzed for TTLC and STLC lead do not provide a clear picture of concentration versus leachable concentration.~~ Figure 3-4 presents the TTLC concentrations for lead in near surface soil versus STLC concentrations, not including the lead hot spots. The 40,000 mg/kg TTLC lead concentration has a corresponding 210 mg/L STLC concentration, however, the 91,000 mg/kg TTLC lead concentration has a corresponding 5.4 mg/L STLC concentration. The other two hot spot samples were not analyzed for STLC. Subsurface samples for lead exhibited less tendency to leach, as shown by Figure 3-5.

do you have a table of STLC values included?

Near surface and subsurface soil samples analyzed for TTLC and STLC copper exhibit a similar pattern of concentration versus leachable concentration (see Figures 3-6 and 3-7). All subsurface soil samples resulted in STLC concentrations above the detection limit.

Dissolved metals in ground water will be transported in the direction of ground water flow. Depending upon the subsurface conditions and the chemical form of the metal (complexes), concentrations may be attenuated by sorption to organic matter as groundwater moves away from the site. Three groundwater samples exhibited soluble copper concentrations higher than total concentrations. Soluble lead was detected during the May 1994 sampling only. As with copper, these data are questionable because soluble concentrations are equal to or greater than total concentrations.

except on re-analyses?

For inorganics, mechanisms of transport are most likely restricted to migration within the medium. Metals in soils may be transported by air through wind entrainment or by water through overland flow. The presence of an impermeable cover will effectively eliminate both transport pathways.

3.3 Description of the Development Plan

The development plan for the site proposes the construction of storage buildings and an RV parking lot on top of an asphalt pavement. The storage buildings would be one-story, pre-fabricated structures with a maximum height of approximately 15 feet. The foundation for the structures will consist of a concrete slab on grade. The onsite surface drainage ditch will be transferred to a culvert or placed in a pipe. The entire site will be graded and paved with asphalt. ~~It is anticipated that limited excavation of soil will be required prior to asphalt paving. Minor trenching (less than 2 feet deep) will be required to install underground utility conduits (sewer and electrical). Light~~

around the perimeter and within the property at 30 foot intervals. Perimeter fencing will complete the development. It is anticipated that construction will require 8 months for completion.

3.3.1 Description of the Storage Facility Operations

It is anticipated that the storage facility will be staffed ~~10 hours a day, seven days a week~~. *ASSUMED* *mentioned in Risk Assessment*
~~Employees will work a maximum of 40 hours each week.~~ *each employee?* Facility users or customers would have access only during the hours that the facility is staffed. Security for the facility will be provided by contract. Employees of the security company are anticipated to remain onsite for less than one-half hour at regular intervals 24-hours each day.

It is anticipated that customers would spend, as a reasonable maximum, 4 hours a month at the facility.

3.3.2 Uncontained Media

Contaminated soil will be contained under the proposed development plan by the asphalt covering. Surface water infiltration through contaminated soil will be effectively eliminated, therefore, the driving force for the downward migration of contaminants to groundwater will be removed.

Groundwater, at a depth of 2 to 5 feet below ground surface, could act as a horizontal transport mechanism for contaminants in subsurface soil. The proposed development plan does not contain groundwater flow-through.

3.4 Potential Exposures

From the discussions above on the physical setting and proposed land use, the following types of potential exposures were identified.

3.4.1 Short-term Exposure During Construction

Activities that involve earth-work during construction of the storage facility could release COPCs present in onsite media. Earth-work would be required for grading and removal of buildings and organic debris (i.e. tree roots); installation of onsite utilities; and installation of light standards. It is estimated that these activities ~~will last for 1 month~~, after which the surface of the site would be paved with asphalt over aggregate base.

~~Constituents in soil are most likely to be release in the particulate form.~~ Although four of the PNAs are slightly volatile, the potential for volatilization during earth work is minimal. The potential for direct contact with ground water during construction is minimal, however, saturated soil could be encountered.

It is not possible to determine the duration of exposure to soil, therefore, it is assumed that releases from soil and exposure could occur over the entire 1 month period prior to asphalt paving. After paving, no further release of constituents from soil is anticipated.

Potential exposures may occur both on and off the site during construction. Construction workers are the primary onsite receptors. A construction worker would have the potential for exposure to COPCs in soil over the 1 month period. Other workers onsite could include employees of the various utilities, city, county and state inspectors, and the design consultants, however, the receptor with the greatest duration of exposure is the construction worker.

Construction workers could be exposed to COPCs in soil through:

- incidental ingestion of soil from hand-to-mouth activities (i.e., smoking) during work on-site
- inhalation of particulates from exposed soil
- direct contact with soil

As stated above, construction workers would not be directly exposed to ground water during excavation activities.

Offsite receptors could include employees and customers of the business and research park to the west of the site and residents to the north. Winds blow primarily to the east/southeast, therefore, no off site receptors could be exposed to COPCs in soil that have migrated from the site via wind entrainment as dust. In addition, during construction dust suppression techniques will be used to reduce or eliminate the off site transport of soil particulates. The off site pathway will not be evaluated further in this assessment.

3.4.2 Potential Long-term Exposure After Completion of the Storage Facility

Once the storage facility is constructed, the potential for the release of COPCs in soil will be effectively eliminated. Paving the site will eliminate the potential for:

- direct exposure to COPCs in soil,
 - downward migration of COPCs in near surface soil to groundwater
- It is unlikely that any maintenance activities would require trenching and excavation that could allow for contact with soil or the release of particulates.

~~Because soil is left in-place the potential exists for future releases and subsequent exposure should the asphalt cover crack. It is anticipated that the surface cover will not retain its integrity over time.~~ Cracks in the asphalt paving would not necessarily result in exposure of soil due to the aggregate base separating the asphalt from the underlying soil. Further, entrainment of soil particulates as dust would not be expected from cracks in the asphalt. Routine maintenance of the facility will include regular inspection and repair of the asphalt pavement.

*will
Crack
but
will no
exposure*

*But what about PNA if
they calculate slightly.*

However, the Alameda County Health Department has requested an evaluation of long-term exposure of on-site workers to dust arising from near surface soil. For this pathway, it is assumed that the cracks in the asphalt cover could result in the entrainment of soil particles into the breathing zone of onsite employees. Employees could then inhale COPCs in near surface soil.

~~Elimination of the onsite drainage ditch~~ will stop the discharge of groundwater to the surface with subsequent offsite flow into the stormwater system. It will also allow groundwater flow across the site to return to its natural gradient to the east-southeast. The Alameda Golf Course is located northeast of the site. The Oakland Airport property is located east/southeast of the site. It is unlikely that either facility would install a well for any purpose in the future. Therefore, future use of groundwater that flows through the site is not likely to occur.

3.4.3 Potential Current Exposures

An evaluation of potential current exposures was done for comparative purposes. The site is currently fenced, unpaved and covered with overgrown vegetation. No authorized activities currently occur on site. The only potential for exposure onsite is through trespassing, most likely, adolescents from the general vicinity. Vagrancy has been noted within the buildings onsite (Kaltreider, personal communication, 1994). Trespassers could be exposed to COPCs in soil through ingestion and dermal contact. Inhalation of soil as dust is not a likely route of exposure because of the density of vegetation onsite. Exposure to groundwater in the ditch could occur through incidental ingestion and dermal contact during those portions of the year when water is present in the ditch. All exposures associated with trespassers would be of limited duration and will not be evaluated further in this assessment.

No current offsite exposures are known or anticipated to occur. Because of the density of vegetation onsite, wind entrainment of soil with subsequent off site migration is not likely to occur. Groundwater flow under the site is to the east and the closest known well is 900 feet north of the site, therefore, no current exposure to groundwater leaving the site is known to occur. Groundwater may also migrate offsite as surface water, however, within 10 yards of its exit from the site, it is directed underground into the City of Alameda stormwater system. No exposure to water within this short above ground portion of the City's stormwater system is known to occur.

3.5 Quantification of Exposure

The previous sections identified the potential short- and long-term exposures and receptors during construction of the storage facility as well as the potential current exposures. This section presents the mechanism to quantify exposure by estimating constituent concentrations at the exposure points and the magnitude of exposure or intake for each receptor. Exposure may not be quantified for all receptors identified nor for all potential pathways. The reason for not quantifying all pathways is presented.

Exposure point concentrations are derived by the direct use of data or through the use of simple mathematical models if the point of potential contact was not sampled. Development of long-term exposure point concentrations from short-term monitoring data includes an underlying assumption about the representativeness of the monitoring data. No physical, chemical, or biological processes that could result in the reduction of constituent concentrations over time were included in the estimation of exposure point concentrations. Exposure point concentrations are assumed to remain constant at levels reflected in the monitoring data for an indefinite period of time. This general assumption of steady-state conditions also applies to sources and contaminant release mechanisms. These assumptions result in a conservative evaluation of long-term exposure concentrations.

Intake is estimated by combining exposure point concentrations with the variables that describe exposure:

- rate of contact with the medium the constituent is in
- frequency of contact
- duration of contact
- body weight of the exposure individual

The EPA directs exposure be quantified in a manner that will produce estimates of the reasonable maximum exposure (RME). This is a conservative estimate of exposure that is within the range of possible exposure but higher than the average exposure. It considers the upper bound situation described by the 90th or 95th percentile of the actual distribution of all input parameters. Using the RME approach, individual parameters used in quantifying exposure may not all be at their maximum values, but when combined will result in an estimation of the RME (EPA, 1989). Use of the RME also satisfies the CalEPA guidance for screening level evaluations for a Preliminary Environmental Assessment (PEA) (CalEPA, 1994).

3.5.1 Determination of Exposure Point Concentrations

An exposure point concentration is the estimated concentration of each constituent in each medium at the location of potential contact with a receptor. Exposure point concentrations will be estimated for the following receptors:

- the short-term onsite construction worker
- the long-term storage facility worker (at the request of the Alameda County Health Department)

Short-term Onsite Construction Worker. The construction worker could be exposed to soil during grading and other earth moving activities. For lead and copper in near surface soil, Table 2-4, the 95th percentile upper confidence limit (95UCL) of the site wide mean, not including the hot spots, will be used as the exposure point concentration. These concentrations are presented on Table 3-3. For the PNA's, the maximum detected value from the clay pigeon debris area will be used as the exposure point concentration. Maximum concentrations are used because the 95UCLs are all greater than the maximum detected values (see Table 2-4), which presumably is a result of the low number of

95th UCL
PNA's
max detected value
clay pigeon debris area

why did PNA's max detected value clay pigeon debris area.

positive detections (all less than 50 %). PNA exposure point concentrations are presented on Table 3-3.

check?

A construction worker could be exposed to soil from the lead and copper hot spots for a very short duration. These maximum concentration of lead detected from the four hot spots will be used to represent the concentration a worker could be exposed to for a maximum of one days time. The copper hot spot concentration will also be used to represent a one-day exposure. These concentrations are presented on Table 3-3.

Constituents that strongly adsorb to soil, such as lead, copper and the PNAs, are carried with soil particles and can be entrained into the breathing zone by heavy equipment and excavation activities. Exposure point concentrations of COPCs as particulates in air resulting from soil concentrations are estimated using a simplified mass load approach. This approach is recommended for use by CalEPA screening guidelines and has been used to model airborne concentrations of chemicals resulting from excavations (NRC, 1986; Healy, 1980). It assumes a given amount of dust is present in ambient air (dust load). It also assumes:

- airborne dust concentrations are equal to assumed dust load
- all dust is from the site
- chemical concentrations on the dust are equal to the soil concentration

To calculate the airborne concentration of a given chemical, the following equation was used:

$$C_a = DL \times C_s \times CF \quad (1)$$

where:

- C_a = Concentration of chemical in air (mg/m^3)
- DL = Dust load (assumed) (ug/m^3)
- C_s = Site-wide exposure point concentration of chemical in soil (mg/kg) (does not include hot spots)
- CF = Conversion factor ($1E-09 \text{ kg}/ug$)

500 ug/m³

of 10⁻⁶

The dust load is given by CalEPA guidance (CalEPA, 1994) as $50 \text{ ug}/m^3$. This value is the annual average respirable portion (PM_{10}) of suspended particulate matter. The dust load for construction activities is assumed to be 10 times this value; $500 \text{ ug}/m^3$ will be used for this scenario. It is unlikely that the entire workday would experience a constant dust load of $500 \text{ ug}/m^3$, however, this should represent a conservative estimate of dusty conditions for the duration of construction.

Table 3-3 presents the estimated onsite particulate concentrations during construction of the storage facility.

Dust from soil in the lead and copper hot spots will use the values given on Table 3-3 as the $C+$ variable in equation 1 above. This concentration will represent a one-day exposure period. Table 3-3 presents the onsite dust concentration using the hot spot soil concentrations.

Long-term Storage Facility Worker It is unlikely that a worker at the future storage facility could be exposed to COPCs in soil even if cracks in the asphalt paving go unrepaired. However, in response to the request from the Alameda County Health Department, the inhalation route will be evaluated for this receptor. Dust exposure point concentrations will be estimated as described above, using the 95UCL of the site wide mean for lead and copper (without the hot spots) from Table 2-2 and the maximum site wide concentration for PNAs from Table 2-3. The dust load will be assumed to be 50 ug/m³, the annual average respirable portion (PM₁₀) of suspended particulate matter. Table 3-3 presents the estimated maximum onsite particulate concentrations after construction of the storage facility and assuming cracking of the asphalt cover.

*Lead - 95 UCL
of site wide
PNA - Max
site wide
now?*

*need to
make an
assumption*

3.5.2 Estimation of Chemical Intake

Chemical intakes were estimated following EPA (1989) guidance. Calculation of chemical intake through ingestion or inhalation requires multiplying the exposure point concentration of each constituent by the media intake factor derived for the exposure route. Calculations of chemical intake include the use of EPA standard default parameters (EPA, 1991a), DTSC suggested parameters (CALEPA, 1992a) and professional judgment regarding likely exposure conditions.

The quantity of a medium (e.g., air or soil) taken into the body through an exposure route (e.g., inhalation, ingestion) and available for absorption is termed the media intake factor. It is normalized for time and body weight and expressed in units of media per unit of body weight per unit of time. The general equation used for calculating intake of media is as follows:

$$\text{Media Intake} = \text{IR} \times \text{EF} \times \text{ED} \times \text{ET} / \text{BW} \times \text{AT} \text{ (units of media/kg body weight/day)}$$

Where:

- IR = Intake rate (e.g., inhalation in m³ of air per day)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- ET = Exposure time (hours/day)
- BW = Body weight (kg)
- AT = Averaging time (days)

The averaging time (AT) used in determining chemical intake depends on the toxic effect of the chemical under consideration. Intake of constituents that produce carcinogenic effects is calculated by averaging the dose over a lifetime (70 years x 365 days/year) because carcinogenicity is not assumed to have a threshold mechanism (EPA, 1986a). The media intake is termed lifetime average daily intake (LDI) for constituents with carcinogenic effects.

70 x 365

Intake of constituents that produce noncarcinogenic effects is averaged over the period of exposure (ED x 365 days/year). The media intake is termed chronic average daily intake (CDI) and is calculated for exposure durations equal to or longer than 7 years but shorter than a lifetime. Subchronic daily intake (CDI_{sub}) is calculated in the same manner as the CDI but is for exposure durations less than 7 years (EPA, 1989). All short-term exposures are considered subchronic.

The chemical dose or intake a receptor receives is expressed as milligrams of chemical per kilogram of body weight per day (mg chemical/kg-day). Chemical intake is described by the following equation:

$$\text{Chemical Intake} = C_i \times \text{Media Intake Factor}$$

where:

C_i = Exposure point concentration of chemical i (i.e., mg of chemical per cubic meter of air [mg/m³] or milligram of chemical per kilogram of soil [mg/kg])

Media Intake Factor = LDI or CDI.

3.5.3 Estimation of Dermal Dose

Dermal contact with constituents in soil results in an absorbed dose of the constituent rather than an intake of the media. The methodology for determining dermal dose is different from that described above. Mechanisms to quantify the contribution of dermal dose to the total body burden are not well established and considerable uncertainty surround those estimates. Numerous parameters are required and many assumptions must be made to obtain a dose estimate.

Dermal dose from contact with soil is estimated with the following equation:

$$DD = (C_s \times CF_s \times ABS \times SA \times AF \times EF \times ED) / (BW \times AT)$$

where:

DD = Dermal dose (mg/kg/day)
 C_s = Chemical concentration in soil (mg chemical/kg soil)
 CF_s = Conversion factor (10⁻⁶ kg soil/mg soil)
 ABS = Absorption factor (unitless)
 SA = Surface area exposed for contact (cm²)
 AF = Adherence factor of soil to skin (mg/cm² skin)
 EF = Exposure frequency (days/year)
 ED = Exposure duration (years)
 BW = Body weight (kg)
 AT = Averaging time (days)

Soil adherence values (AF) have been estimated by a variety of investigators (Driver et al., 1989; Sedman, 1989). A variety of factors come into play in determining soil accumulation, including soil particle size, soil type, individual behavior (hand washing),

Chemical Intake

① 0.15 / Week
② 0.01 P19

climate, etc. No single number is really appropriate because, in addition to the factors presented above, only a small portion of the compound is in direct contact with the skin (Hawley, 1985). EPA (1992) recommends 1 mg/cm² for a reasonable upper bound value.

Absorption factors (ABS) from soil to skin are not readily available for most compounds. EPA summarized the literature pertaining to absorption of benzo(a)pyrene and determined that the percutaneous absorption ranged from around 1% to over 93% (EPA, 1992). EPA did not recommend an absorption factor for PNAs. For this assessment, a dermal absorption factor was derived from a study by Wester et al (1990), which reported an in vivo percutaneous absorption in rhesus monkeys of 13.2 +/- 3.4 percent from soil. For this assessment, the average in vivo absorption from soil plus two standard deviations (30 percent) was used to evaluate the RME exposure to PNAs.

PNA
PNAS

Dermal absorption of metals is thought to be negligible (<1%) and will not be estimated for this assessment (EPA, 1992).

0.01

3.5.4 Estimation of Lead Exposure

Exposure to lead in environmental media cannot be evaluated by calculating a chemical intake or dermal dose. This assessment uses the DTSC spread sheet (blood lead beta test version) for evaluating health risk from inorganic lead in soil and particulates from environmental exposures. Inputs to the DTSC spreadsheet are the concentrations of lead in soil and dust, water, and air. DTSC default concentration for lead in water and air are used (CalEPA, 1992b). The output is a percentage of the exposure population with a given blood lead level.

3.4.5 Intake and Dose Parameters

Parameters required to estimate both media intake and dermal dose are discussed below.

Short-term Onsite Construction Workers. Onsite construction workers are assumed to be predominantly adult males older than 19 years who weight an average of 70 kg and have an average life span of 70 years (EPA, 1991a). They could be exposed to COPCs in near surface soil for a maximum of 20 days [5 days/week x 4 weeks/month x 1 month]. It is assumed that workers could be exposed to the hot spots for a duration of one day or less.

Need a table of all exposure factors - lead - same

During the time onsite, it is assumed that workers wear long pants, a T-shirt, and safety shoes with socks. They may contact soil directly with their head, neck, arms and hands. It is assumed that workers weigh an average of 70 kg and the mean body surface area for an adult male is 19,400 cm² (EPA, 1992). The assumed body parts exposed represent about 25% of the total surface area or 4850 cm².

23000 cm²
1992
25% = 5000 cm²/day

Workers are assumed to inhale 20 m^3 of air/workday as an average reasonable maximum exposure (CalEPA, 1992a). Workers may incidentally ingest soil and dust through accidental hand-to-mouth contact at an average rate 50 mg/day (CalEPA, 1992a).

Table 3-4 presents a summary the exposure parameters for soil ingestion and particulate inhalation for the short-term onsite construction worker. Appendix C, Tables C-1 through C-4 present chemical intake through ingestion and inhalation. Table 3-5 presents the exposure parameters for dermal contact.

Long-term Storage Facility Worker The storage facility worker is assumed to be older than 18 years, weigh an average of 70 kg and has an average life span of 70 years (EPA, 1991a). The worker could be exposed to dust from soil for a maximum of 250 days/year for a reasonable maximum of 25 years (EPA, 1991a). Further, it is assumed the worker inhales 15 m^3 of air/8 hour workday as a reasonable maximum (CALEPA, 1992a). how?

Table 3-4 presents a summary the exposure parameters for dust inhalation. Appendix C, Table C-5 presents chemical intake through inhalation.

20 m^3

$20 \text{ m}^3 / \text{day}$
90% dust
proportion

15 m^3

Table 3-1
Groundwater Depth Information

Well No.	Sample Date	Well Elevation (MSL)	Depth to Groundwater (ft.)	Groundwater Elevation (MSL)
MW-1	05/11/94	5.05	2.59	2.46
MW-2	05/11/94	5.60	4.17	1.43
MW-3	05/11/94	4.76	2.75	2.01
MW-4	05/11/94	2.87	2.13	0.74
MW-5	05/11/94	3.47	2.00	1.47

Note: All measurements in feet
MSL = Mean Sea Level

Table 3-2
Physical/Chemical of COPCs

Constituent	MW ^a (ug/mole)	VP @ 20-25°C ^a (mm Hg)	Air Diffusion Coef. @ 20C ^b (cm ² /sec)	Henry's Law Constant ^a (atm-m ³ /mole)	log Kow ^a	Density/ Specific Gravity ^a (units)	Solubility ^a (mg/l)	Koc ^b
Inorganics								
Copper	63.54							
Lead	207.19							
PNAs								
Acenaphthene	154.21	0.00155		7.92 x 10 ⁻⁵	3.92		3.47	18
Anthracene	178.24	1.95 x 10 ⁻⁴		6.51 x 10 ⁻⁵	4.45	1.283	0.045	18600
Benzo(a)anthracene	228.3	1.1 x 10 ⁻⁷		6.6 x 10 ⁻⁷	5.61	1.274	0.014	1380000
Benzo(a)pyrene	252.32	5.49 x 10 ⁻⁹		<2.4 x 10 ⁻⁶	5.99	1.351	0.0038	3.98E+5
Benzo(g,h,i)perylene	276.34	1.01 x 10 ⁻¹⁰		1.4 x 10 ⁻⁷	7.1		0.00026	7.76E+6
Benzo(b)fluoranthene	252.32	5 x 10 ⁻⁷		1.2 x 10 ⁻⁵	6.57		0.0012	549540
Benzo(k)fluoranthene	252.32							
Chrysene	228.3	6.3 x 10 ⁻⁹		7.26 x 10 ⁻²⁰	5.6	1.274	0.006	245470
Dibenzo(a,h)anthracene	278.36	≈ 10 ⁻¹⁰		7.33 x 10 ⁻⁹	6.36	1.282	0.005	1.66E+6
Indeno(1,2,3-c,d)pyrene	276.34	10 ⁻¹⁰		2.96 x 10 ⁻²⁰	7.7	-	0.062	3.09E+7
Naphthalene	128.18	0.23	0.85	4.6 x 10 ⁻⁴	3.36	1.162 @ 20/4	30	549
Phenanthrene	178.24	6.8 x 10 ⁻⁴		3.9 x 10 ⁻⁵	4.568	1.179 @ 25/4	0.994	5248
Pyrene	202.26	6.85 x 10 ⁻⁷		1.09 x 10 ⁻⁵	4.88	1.271 @ 23/4	0.013	45708

^a Source: Montgomery, J.H. and L.M. Welkom. 1990. Groundwater Chemicals Desk Reference, Lewis Publishers, Inc. Chelsea, MI.

^b Source: Anderson, M.R. 1992. Development of Generic Soil Cleanup Levels Based on Analysis of the Leachate Pathway. Environmental Cleanup Division, Oregon Department of Environmental Quality, Portland, OR.

**Table 3-3
Exposure Point Concentrations**

why? only soil for use + road

Constituent	Short-term During Construction				Long-term After Construction
	Near Surface Soil Concentration (mg/kg)	Estimated On Site Dust Concentration* (mg/m ³)	Hot Spot Near Surface Soil Concentration (mg/kg)	Estimated Hot Spot Dust Concentration ^a (mg/m ³)	Estimated On Site Dust Concentration ^b (mg/m ³)
Inorganics					
Copper	65.4	3.3E-05 ²⁰	10000	5.0E-03	3.3E-06
Lead	331.7	1.7E-04	91000	4.6E-02	1.7E-05
PNAs					
Acenaphthene	33	1.7E-05			1.7E-06
Anthracene	26	1.3E-05			1.3E-06
Benzo(a)anthracene	260	1.3E-04			1.3E-05
Benzo(b)fluoranthene	380	1.9E-04			1.9E-05
Benzo(k)fluoranthene	220	1.1E-04			1.1E-05
Benzo(g,h,i)perylene	200	1.0E-04			1.0E-05
Benzo(a)pyrene	410	2.1E-04			2.1E-05
Chrysene	140	7.0E-05			7.0E-06
Dibenzo(a,h)anthracene	210	1.1E-04			1.1E-05
Dibenzofuran	2.2	1.1E-06			1.1E-07
Indeno(1,2,3-c,d)pyrene	20	1.0E-05			1.0E-06
Naphthalene	14	7.0E-06			7.0E-07
Phenanthrene	72	3.6E-05			3.6E-06
Pyrene	120	6.0E-05			6.0E-06

a Dust load onsite during constru 500 ug/m³
 b Dust load onsite after construct 50 ug/m³

Table 3-4

Exposure Parameters and Media Intake Factors

EXPOSURE SCENARIO	EXPOSURE PARAMETER						MEDIA INTAKE			
	IR (units/day)	Units	EF (days/yr)	ED (yrs)	BW (kg)	ATc (days)	ATnc (days)	CDI	LDI	Units
Short-Term Construction Worker										
Soil ingestion	RME	100 mg 50 mg/day	20	1	70	25550	365	3.91E-02	5.59E-04	(mg/kg-day)
Particulate inhalation	RME	20 m ³ /day	20	1	70	25550	365	1.57E-02	2.24E-04	(m ³ /kg-day)
Hot spot soil ingestion	RME	100 mg 50 mg/day	1	1	70	25550	365	1.96E-03	2.80E-05	(mg/kg-day)
Hot spot particulate inhalation	RME	20 m ³ /day	1	1	70	25550	365	7.83E-04	1.12E-05	(m ³ /kg-day)
Long-term Storage Facility Worker										
Particulate inhalation	RME	20 m ³ /day 15 m ³ /day	250	25	70	25550	9125	1.47E-01	5.24E-02	(m ³ /kg-day)

IR - Intake rate
 EF = Exposure frequency
 ED = Exposure duration
 BW = Body weight
 ATc = Averaging time for carcinogenic compounds
 ATnc = Averaging time for noncarcinogenic compounds

CDI = Chronic Daily Intake (for noncarcinogenic effects)
 LDI = Lifetime Daily Intake (for carcinogenic effects)

Table 3-5

Dermal Exposure Parameters and Absorbed Dose

EXPOSURE SCENARIO Exposure Route	EXPOSURE PARAMETERS							ABSORPTION	
	SA (cm ² skin-day/yr)	AF (mg/cm ² skin)	EFs (days/yr)	ED (yrs)	BW (kg)	ATc (days)	ATnc (days)	CDA (mg/kg-day)	LDA (mg/kg-day)
Short-term Construction Worker									
Dermal Dose from Soil Adult RME	4850	1	20	1	70	25550	365	3.80E+00	5.42E-02

SA = Surface area exposed for contact, head, hands, and forearms.

AF = Adherence factor

ABS = Absorption factor

ED = Exposure duration

BW = Body weight

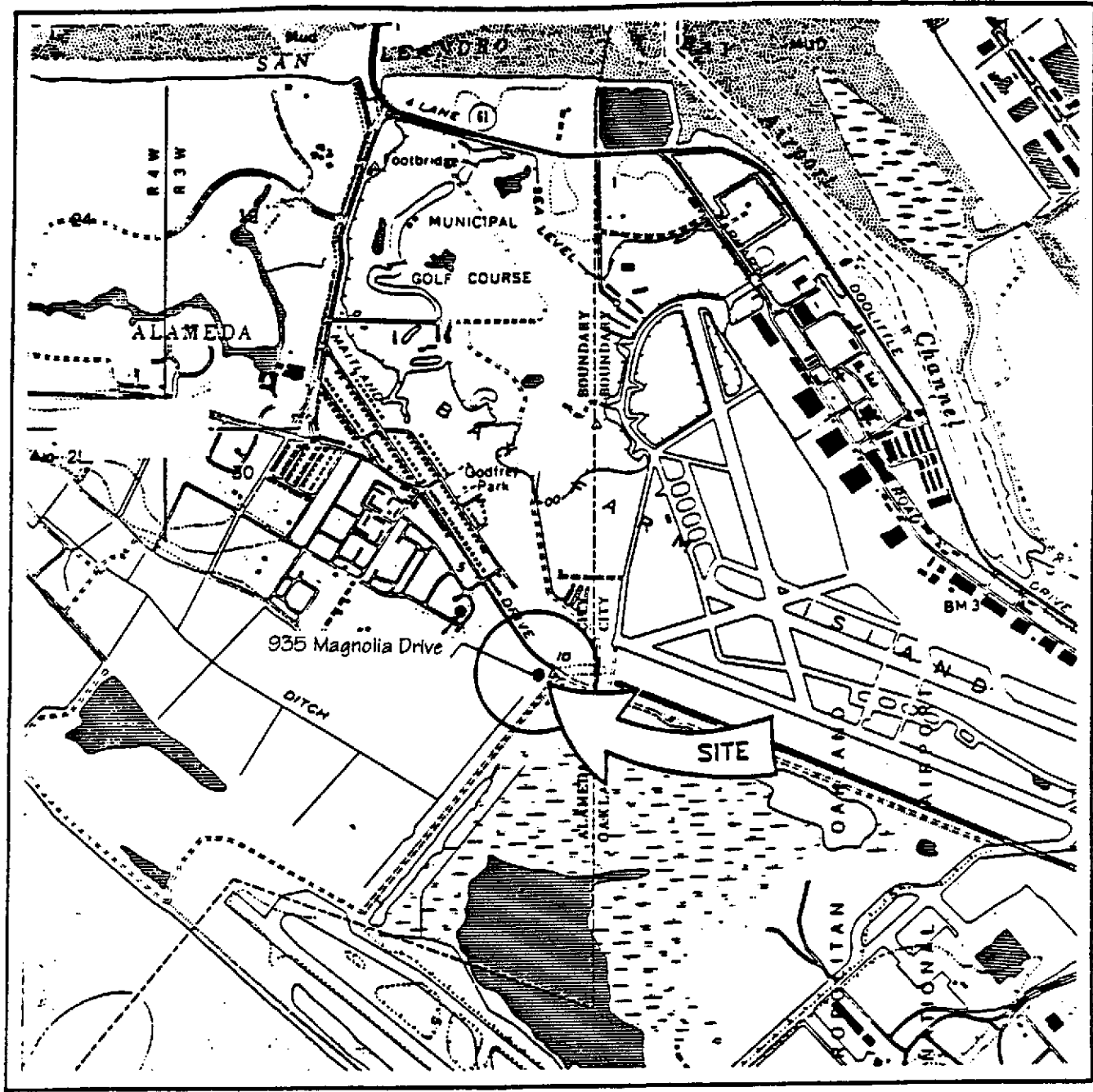
ATc = Averaging time for carcinogenic compounds

ATnc = Averaging time for noncarcinogens

CDA = Chronic Daily Absorption (for noncarcinogenic effects)

LDA = Lifetime Daily Absorption (for carcinogenic effects)

Handwritten notes:
4850 (with arrow pointing to SA)
20 (circled, with arrow pointing to EFs)



SOURCE: U.S. GEOLOGICAL SURVEY
 7.5-MINUTE QUADRANGLE
 SAN LEANDRO, CALIFORNIA
 PHOTOREVISED 1980

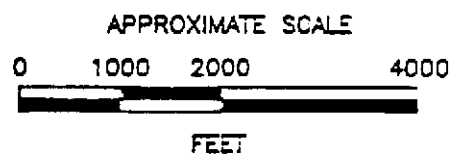
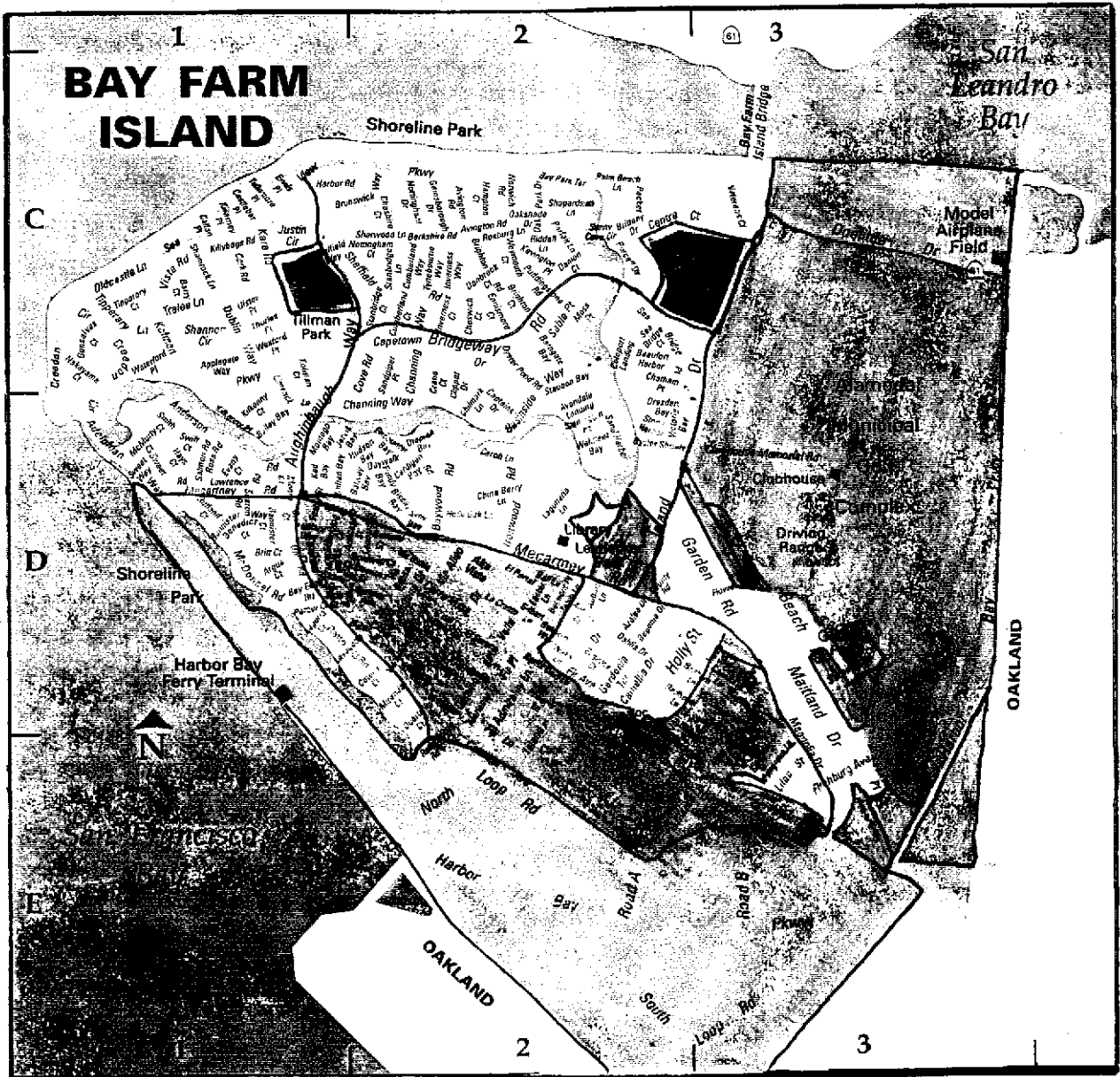


Figure 3-1
General Site Location
 Former Gun Club
 500 Maitland Drive
 Alameda, California

June 29, 1994	Drawn By: MCK	Project: 6140-1
---------------	---------------	-----------------



LEGEND

-  Business Park
-  Public/Institutional Schools
-  Parks & Public Open Space
-  Alameda Municipal Golf Course
-  Medium Density Residential
-  Low Density Residential

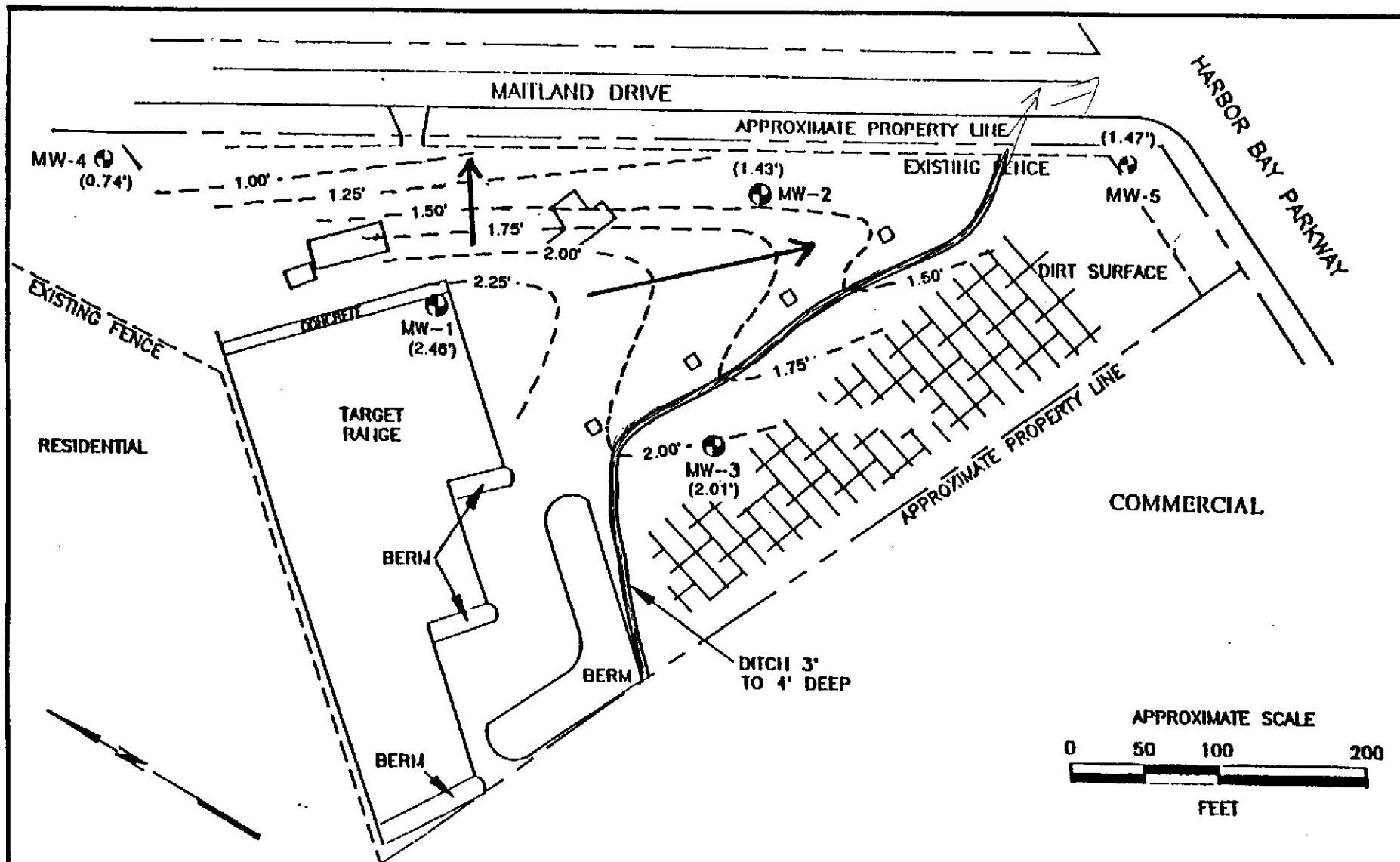
Scale: 1" = 1,800'

Figure 3-3
Surrounding Land Use
 Former Gun Club
 500 Maitland Drive
 Alameda, California

June 29, 1994

Drawn By: MCK

Project: 6140-1



Legend

Monitoring Well MW-1

Elevations in Feet Above Mean Sea Level

Figure 3-2 - Groundwater Gradient
 Former Gun Club
 500 Maitland Drive, Alameda

May 27, 1994	Drawn By: MCK	Project No.: 6140-1
--------------	---------------	---------------------

Figure 3-4
TTLC versus STLC for Lead in Near Surface Soil Samples

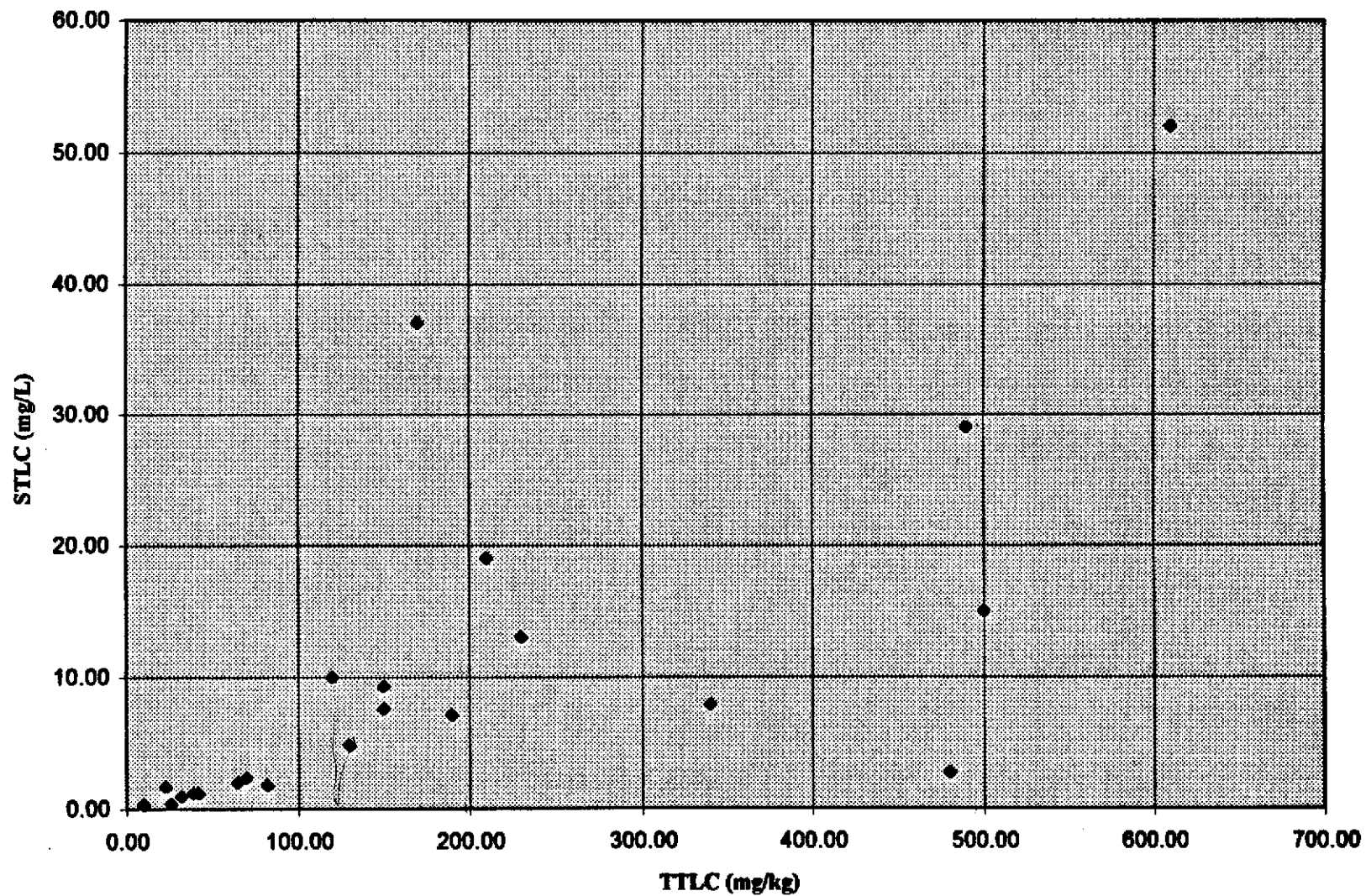


Figure 3-5
TTLC versus STLC for Lead in Subsurface Soil Samples

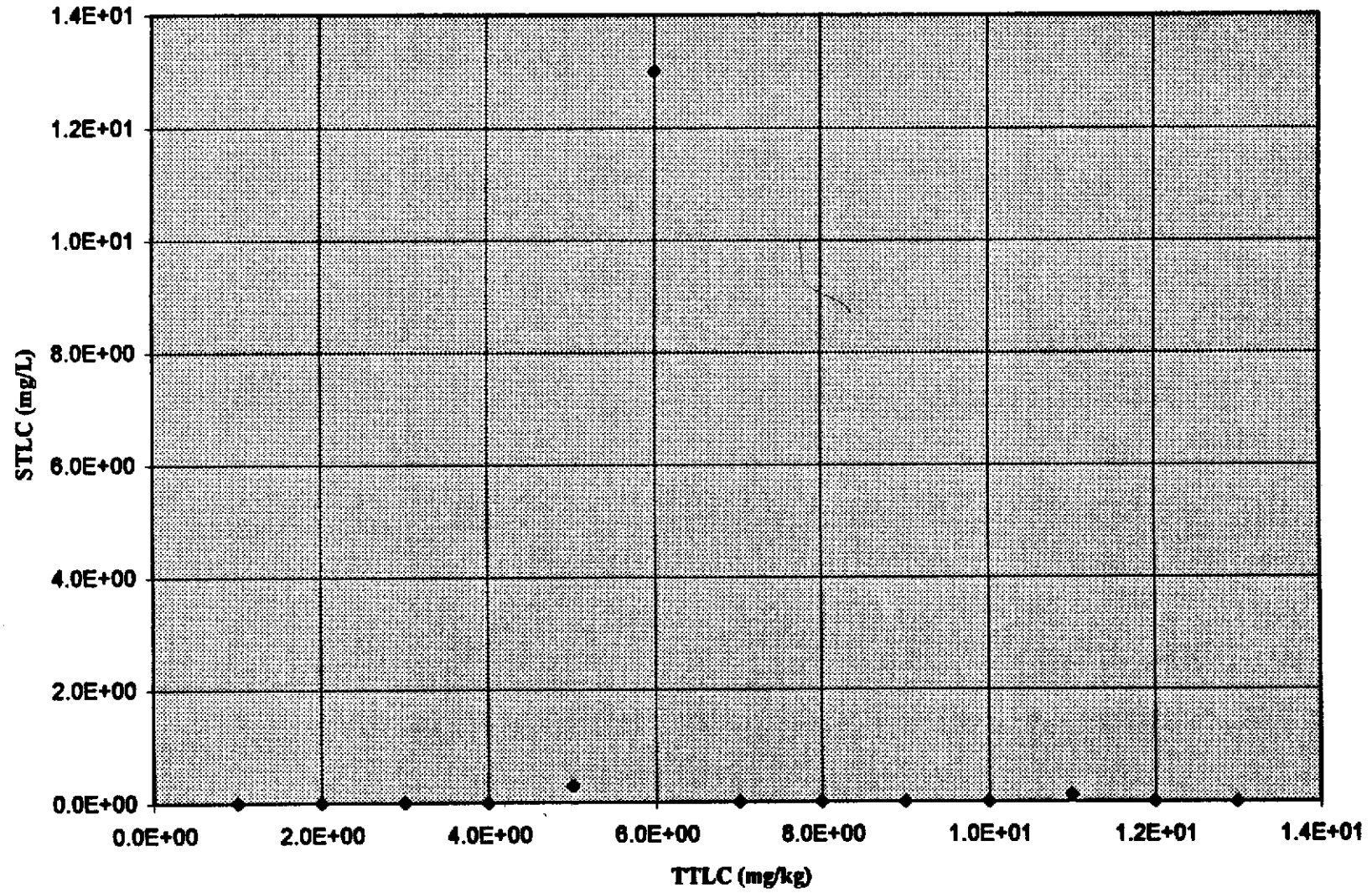


Figure 3-6
TTLC versus STLC for Copper in Near Surface Soil Samples

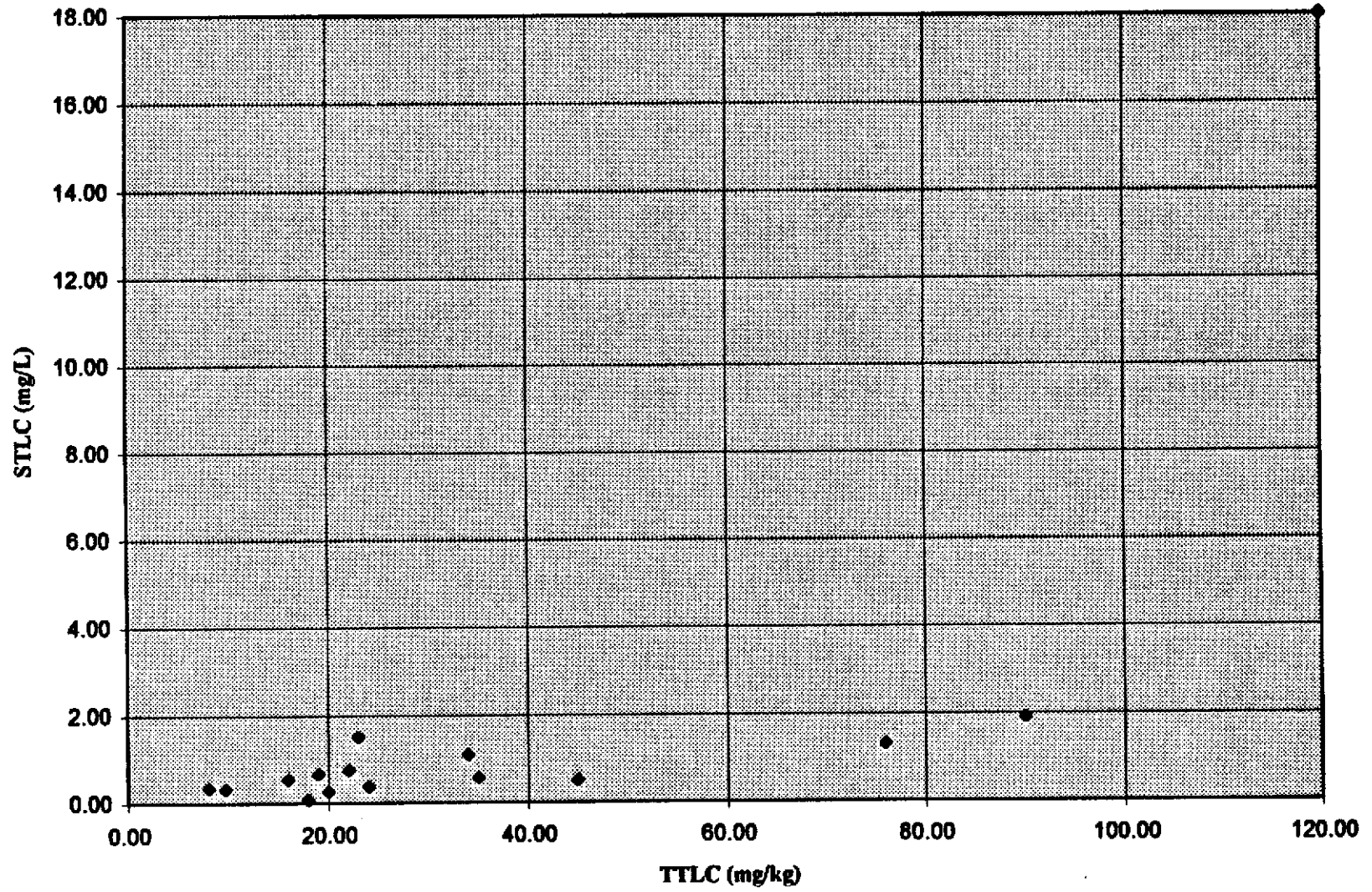
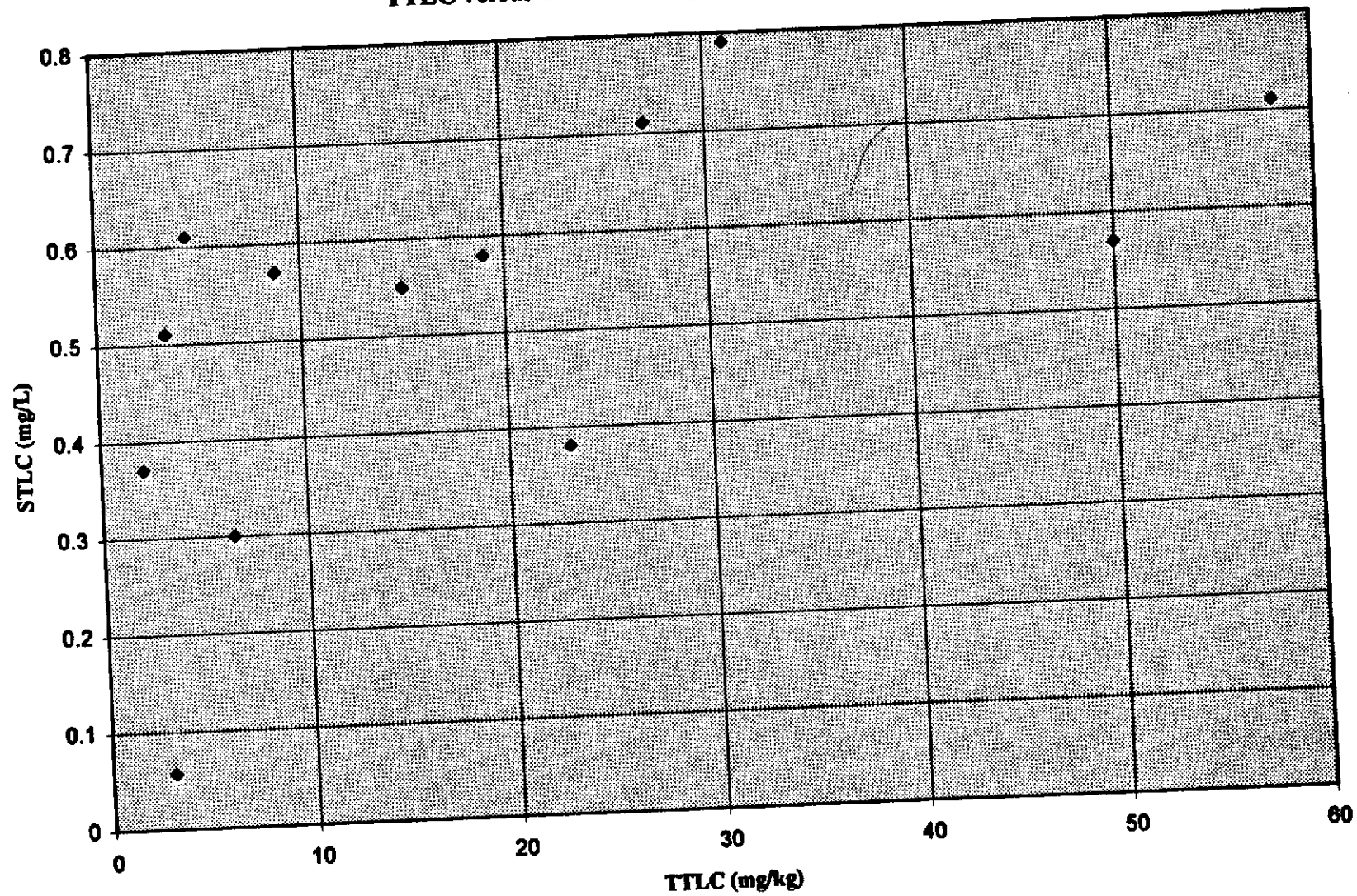


Figure 3-7
TTLC versus STLC for Copper in Subsurface Soil Samples



4.0 TOXICITY ASSESSMENT

An assessment of the potential for COPCs at the site to cause adverse effects in exposed individuals is presented below. The means of quantifying toxicity is discussed below and toxicity profiles are presented for the COPCs in Appendix D.

4.1 Quantifying Toxicity for Human Health

Several different numerical values can be used to describe a compounds toxicity. As a first step, the effects of exposure to compounds are divided into two broad categories, noncarcinogenic or carcinogenic, based on the end point of toxicity. Some constituents detected at the site produce effects in both categories.

4.1.1 Carcinogenic Effects

Carcinogens are constituents that cause or induce cancer. The EPA Human Health Assessment Group (HHAG) uses a weight-of-evidence classification system to identify compounds as carcinogens. Information used in developing the classification includes: (1) evaluation of the quality of data from human studies of the association between cancer incidence and exposure, (2) long-term animal studies, (3) combining the two types of studies to obtain an overall human carcinogenic weight-of-evidence, (4) assessing all other types of information such as short-term tests for genotoxicity, metabolic and pharmacokinetic properties, and structure-activity relationships determine if a modification of the weight-of-evidence is necessary. Five categories of carcinogens are used:

- Group A - Human Carcinogen. Sufficient evidence from human epidemiological studies to support a causal association between exposure and cancer.
- Group B - Probable Human Carcinogen. This includes compounds for which limited evidence of carcinogenicity in humans exists based on epidemiological studies (B1) and those compounds for which sufficient evidence of carcinogenicity in animals exists however, adequate evidence of carcinogenicity in humans is not available (B2).
- Group C - Possible Human Carcinogen. This includes those compounds for which there is limited evidence of carcinogenicity in animals.
- Group D - Not Classifiable as to Human Carcinogenicity. This includes those compounds for which there are inadequate animal evidence of carcinogenicity.
- Group E - Evidence of Noncarcinogenicity in Humans. This includes compounds for which there is no evidence for carcinogenicity in at least two adequate animals tests in different species or in both adequate epidemiological and animal studies (EPA, 1986a).

Toxicity is dependent upon the dose or concentration of a substance. The toxicity value used to describe the dose response relationship for a carcinogen is called the slope factor (SF). The EPA Carcinogen Assessment Group (CAG) has developed slope factors for compounds classified as A, B1, B2 and selected C carcinogens by route of exposure. The slope factor is used for estimating the upper bound excess lifetime cancer risk associated with lifetime exposure to potential human carcinogens. The slope factor is expressed in units of $(\text{mg/kg body weight/day})^{-1}$.

Slope factors are derived by calculating the 95 percent upper confidence limit (95 UCL) on the slope of the linearized portion of the dose-response curve obtained from a multistage cancer model. This dose-response curve is usually obtained from animal studies. Adjustments from high dose to low dose are obtained by extrapolation from the linearized model. For practical reasons, low levels of risk cannot be measured directly with animal studies. Some adjustments are made to account for interspecies differences but in general, it is believed that there is only a 5 percent chance that the probability of a response could be greater than the estimated value for the experimental data used. This is a conservative approach and may overestimate the actual risk (EPA, 1986a). The actual risk is expected to be between zero and the calculated value. The slope factor may also be derived from dose-response data of human epidemiological studies fitted to dose-time-response curves. Factors derived in this manner also use conservative assumptions and consequently, are unlikely to underestimate true risk.

A critical assumption built into the use of slope factors is that cancer risk is probabilistic and any exposure leads to a risk. Based on available data, EPA assumes a non-threshold mechanism for carcinogenesis. Therefore, any amount of exposure to a carcinogenic compound poses a potential for generating a carcinogenic response in the exposed organism.

The EPA formed the Carcinogen Risk Assessment Verification Endeavor (CRAVE) Work group to verify carcinogenic slope factors. Once verified they are entered into the EPA's Integrated Risk information System (IRIS) database. This database contains only verified toxicity values. The EPA Office of Research and Development updates the information in IRIS as new slope factors are verified (EPA, 1994a). The Standards and Criteria Work Group, convened by the California Office of Environmental Health Hazard Assessment (OEHHA) and the DTSC has compiled a list of cancer potency factors for use in risk assessments conducted in the state (DTSC, 1992). Slope factors from OEHHA and IRIS will be used in this assessment.

If a toxicity value is not available on the most recent OEHHA list or the EPA IRIS files, then the EPA Quarterly Update of the Health Effects Assessment Summary Table (HEAST) is consulted (EPA, 1994b). HEAST often has unverified toxicity values which may be used.

Not all compounds classified as carcinogens have slope factors specific to the exposure route. At the present, published slope factors are available for the ingestion and inhalation routes only. When an inhalation slope factor is not available, the PEA screening guidance suggests using oral slope factor to evaluate the inhalation pathway. This assessment follows that guidance, however, the use of oral slope factors for estimating carcinogenic effects through inhalation is highly uncertain.

Oral slope factors are used to estimate risk from dermal exposures. The oral slope factor must be adjusted from an administered dose to an absorbed dose. Oral slope factors can only be used to evaluate the risks associated with dermal exposure to carcinogens that cause cancer through systemic action (such as benzene). Oral slope factors cannot be used

to evaluate the risks associated with dermal exposure to carcinogens that cause skin cancer through direct action at the point of contact. Benzo(a)pyrene and other carcinogenic PNA compounds are examples of direct action carcinogens (EPA, 1989, 1992). Oral slope factors will not be used to evaluate dermal toxicity of carcinogenic PNAs in this assessment.

*Dermal exposure
10-4 of
NO!*

For many compounds, sufficient toxicological information is not available to determine the dose response. Slope factors are not available for all chemicals classified as carcinogenic. Table 4-1 lists slope factors, EPA weight-of-evidence classification, and the type of cancer produced for constituents identified as COPCs that are potentially carcinogenic through oral or inhalation routes of exposure.

4.1.2 Noncarcinogenic Effects

Noncarcinogenic effects include a variety of health impacts, such as central nervous system disorders, kidney damage, liver damage, etc. It is believed that thresholds exist for noncarcinogenic effects, although not for carcinogenic effects. Organisms have been shown to have adaptive mechanisms that must be overcome before a toxic effect can be detected.

Toxicity values for compounds that exhibit noncarcinogenic effects are termed reference doses (RfDs). RfDs are determined by the U.S. EPA RfD Work Group or from Health Effects Assessment documents (HEAs) developed by EPA's Office of Research and Development. Development of an RfD is based on the assumption that thresholds exist. The RfD is developed from the no-observed-adverse-effect level (NOAEL) for the most sensitive, or critical toxic effect and application of uncertainty factors and modifying factors. Uncertainty factors are used to reflect the type of data available and modifying factors reflect professional judgment of the entire data base available for a compound. Confidence in the RfD is a summary of all factors that are incorporated into setting an RfD.

The chronic RfD is considered to be the level unlikely to cause significant adverse health effects associated with a threshold mechanism of action in humans for an exposure periods between seven years and a lifetime. The reference dose can be used as a comparison against a dose obtained through exposure; the likelihood of adverse health effects in addition to the critical toxic effect increases as the frequency of exposures exceeding the RfD increases and as the dose exceeding the RfD increases (EPA, 1989).

Subchronic RfDs have been developed for select compounds to characterize the potential noncarcinogenic effects of shorter-term exposures, those between two weeks and seven years. Short-term exposures would include those obtained when an activity is conducted over a specific age period.

The RfD is expressed in the units of milligram of compound per kilogram of body weight per day (mg/kg-day). They are developed for the route of exposure (i.e., inhalation, ingestion), the critical effect (i.e., developmental) or the length of exposure under

evaluation (i.e., chronic, subchronic, single event). Chronic reference doses are listed on Table 4-2. The PEA guidance manual suggests using oral RfD to evaluate the inhalation pathway when inhalation RfDs are not available (CalEPA, 1994). This assessment follows that guidance, however, the use of oral reference doses for estimating noncarcinogenic effects through inhalation is highly uncertain.

Reference doses are not available for the dermal pathway. Limited toxicity information is available on the dermal route of exposure with which to calculate a toxicity value from dermal absorption. The use of oral reference doses for estimating noncarcinogenic effects through dermal absorption is highly uncertain. The response of a system to an oral dose may differ significantly from the response to a dermal dose. The mechanisms of metabolism and distribution differ significantly between the two routes (EPA, 1992). Potential noncarcinogenic health impacts from dermal absorption of compounds will not be evaluated in this assessment.

4.1.3 Developmental Effects

It has been established that a number of chemicals detected in environment media are capable of causing developmental toxicity in humans (e.g., lead, ionizing radiation) while other are suspected of causing human toxicity based on animal studies. Developmental toxicity is that which causes adverse effects prior to conception, during pregnancy and in childhood (EPA, 1991b). Developmental toxicity is expressed as one or more of a number of possible end points that may be used to evaluate the potential of a chemical to cause abnormal development. It generally occurs in a dose-related manner and may result from short-term exposure. The type of effects may vary depending on the timing of exposure because of a number of critical periods of development for various organs and functional systems. Even a single exposure event at a critical time may be sufficient to result in an adverse effect on a developing organism. The four major manifestations of development toxicity are death, structural abnormality, altered growth, and functional deficit (EPA, 1991b).

Developmental RfDs (RfD_{dt} for oral routes or RfC_{dt} for inhalation) are being formulated by EPA to assess the potential effects resulting from a short duration of exposure. The most sensitive developmental effects (the critical effect) from the most appropriate and or sensitive mammalian species is used for deriving the RfD_{dt} or RfC_{dt} (EPA, 1991b). Developmental RfDs are not yet available for the chemicals considered COPCs in this assessment. Lead and carcinogenic PNAs have the potential for developmental toxicity. Lead has the potential to cause neurological damage, low birth weight, and growth deficits. Although specific effects of carcinogenic PNAs have not been isolated, all have been implicated as developmental toxicants.

4.2 Issues Related to Carcinogenic PNAs

Benzo(a)pyrene is the only high molecular weight PNA of known carcinogenic potential to be assigned a carcinogenic potency value. Because of this, all carcinogenic PNAs were assigned the same potency value as benzo(a)pyrene. The assumption that all carcinogenic

PNAs have potencies equivalent to that of benzo(a)pyrene is not supported by the scientific literature. Comparative potency studies have shown that benzo(a)pyrene is one of the most potent carcinogens tested and other carcinogenic PNA compounds are considerably less potent (Clement, 1988). EPA has recently drafted guidance on the use of relative potency values for carcinogenic PNAs (EPA, 1993). This assessment utilizes the relative potency approach for PNAs, using the cancer slope factor developed for benzo(a)pyrene and multiplying it by the relative potency value listed on Table 4-3 for each carcinogenic PNA listed as a COPC at the site.

Of the noncarcinogenic PNAs, data on the toxicity of phenanthrene are insufficient to support the development of an RfD (EPA, 1994b). This compound cannot be quantitatively evaluated in this assessment.

4.3 Issues Related to Lead

Recent toxicological and epidemiological research indicate low-level lead exposure has a continuum of adverse health effects; it does not appear to have a threshold below which no adverse health effects occur; and it may be carcinogenic at high level exposures. Blood lead levels as low as 10 to 15 micrograms lead per deciliter (ug/dl) blood in children are believed to be associated with adverse health effects, a substantial decrease in what had been thought to present a risk (25 ug/dl) (EPA, 1988). Data are currently not available to adequately define the dose-response relationship of toxic effects of lead below blood lead levels of 10 ug/dl (EPA, 1990b).

Toxic effects of lead are correlated with blood lead levels rather than exposure levels of daily intake. Consequently, toxicity values (RfDs and slope factors) are not available with which to evaluate lead in the same manner as other inorganic chemicals.

The DTSC has developed a model relating incremental blood lead increase to a concentration in a medium, using contact rates and empirically determined ratios. Background sources are considered using norms developed from survey data. These are referred to as default values. Default values are used for lead in air, drinking water, and diet. The ambient air lead concentration is assumed to be 0.18 ug/m³, from all non-specific sources. The federal action concentration for lead at the tap of 15 ug lead/liter water is used as the drinking water concentration and the dietary component is assumed to be 10 ug /kg. Defaults are also used for contact rates, such as soil ingestion, dust inhalation and dermal absorption (CalEPA, 1992b). Respirable dust is set to 500 ug/m³ for the short-term construction worker and 50 ug/m³ for the long-term facility worker.

**Table 4-1
Toxicity Values for Chemicals with Carcinogenic Effects**

Constituent	Carcinogenic Slope		Factor (mg/kg-d) ¹		Weight of Evidence Classification	Type of Cancer/ Tumor Site	
	Oral	S	Inhalation	S		Oral	Inhalation
Inorganics							
Lead					B2		
PNAs							
Benzo(a)anthracene	0.73	RP	0.73	PEA	B2	Fore stomache and dermal	Respiratory tract
Benzo(b)fluoranthene	0.73	RP	0.73	PEA	B2		
Benzo(k)fluoranthene	0.073	RP	0.073	PEA	B2		
Benzo(a)pyrene	7.3	I	7.3	PEA	B2		
Chrysene	0.0073	RP	0.0073	PEA	B2		
Dibenzo(a,h)anthracene	7.3	RP	7.3	PEA	B2		
Indeno(1,2,3-c,d)pyrene	0.73	RP	0.73	PEA	B2		

S = Source of toxicity value.

I = EPA IRIS files, searched November, December 1993 and January 1994

C = California Office of Environmental Health Hazard Assessment, June 1992 California Cancer Potency Factors

RP = Based on relative potency to Benzo(a)pyrene using EPA's relative potency values.

PEA = Screening guidance which requires the oral value to be used for inhalation if an inhalation value is not available.

**Table 4-2
Toxicity Values for Chemicals with Non-Carcinogenic Effects**

Constituent	Reference Dose (mg/kg-d)		Confidence and Uncertainty		Critical Effects
	Oral	S	Inhalation	S	
Inorganics					
Copper	0.04	W	0.04	PEA	Gastrointestinal effects Data inadequate to calculate RfD
Lead					
PNA's					
Acenaphthene	0.06	I	0.06	PEA	Hepatotoxicity None observed
Anthracene	0.3	I	0.3	PEA	
Dibenzofuran					Data inadequate to calculate RfD Decreased body weight
Naphthalene	0.04	H	0.04	PEA	
Phenanthrene					Data inadequate to calculate RfD Kidney effects
Pyrene	0.03	I	0.03	PEA	

I = EPA IRIS files, searched January 1994.

C = California Office of Environmental Health Hazard Assessment, June 1992 California Cancer Potency Factors.

H = EPA, 1993 Health Effects Assessment Summary Tables (HEAST).

W=Value generated from drinking water criteria of 1.3 mg/l.

RP = Based on relative potency to Benzo(a)pyrene using EPA's relative potency values.

PEA = Screening guidance which requires the oral value to be used for inhalation if an inhalation value is not available.

Table 4-3

Estimated Relative Potency of PNAs

PNA	RELATIVE POTENCY
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Benzo(a)pyrene	1.0
Chrysene	0.001
Dibenzo(a,h)anthracene	1.0
Indeno(1,2,3-cd)pyrene	0.1

(EPA, 1993).

5.0 RISK CHARACTERIZATION

In accordance with DTSC and EPA's guidelines for evaluating the potential toxicity of complex mixtures, this assessment assumes that the effects of all constituents are additive through a specific route of exposure (CalEPA, 1992a and EPA, 1986b). Limitations to this approach include risk estimates that becomes increasingly conservative; equal weighting between classes of carcinogens; and lack of consideration of synergism's between carcinogens. These limitations will be discussed further in the uncertainty section.

The total risk from all pathways for each receptor will be combined. A receptor is assumed to have the potential to be exposed through all pathways of the scenario.

5.1 Methodology for Quantitative Risk Estimation

The methodology used to quantify public health risk is based on EPA (EPA, 1989) and DTSC guidance (CalEPA, 1992a). The assessment of health risk from exposure to inorganic lead in soils is evaluated with the use of the DTSC lead spreadsheet (CalEPA, 1992b).

5.1.1 Cancer Risk

Risks are estimated as probabilities for constituents which elicit a carcinogenic response. The excess lifetime cancer risk is the incremental increase in the probability of getting cancer compared to the background probability or that with no exposure to site constituents. A risk of 1×10^{-6} for example, represents the probability that one person in one million persons exposed to a carcinogen over a lifetime (70 years) will develop cancer. Estimates of risk using the slope factors developed by EPA are generally upper-bound estimates; actual risks at the site would not be greater than the risks estimated in this assessment and are likely to be much lower, even zero.

Excess lifetime cancer risk is estimated with the multistage model:

$$R = 1 - \exp^{-SF \times LDCI}$$

where:

- R = Excess Lifetime Cancer Risk (probability)
- exp = Base of Natural Logarithm (2.71828)
- SF = Slope Factor (mg/kg-day)⁻¹ from linearized multistage model
- LDCI = Lifetime Daily Chemical Intake (mg/kg-day)

For low intakes where the estimated cancer risk is lower than 10^{-2} , it can be assumed that the dose-response relationship will be in the linear portion of the dose-response curve, and the equation becomes:

$$R = SF \times LDCI$$

Intake of environmental media is assumed to be in the linear portion of the dose-response curve, and the above equation was used to estimate carcinogenic risk (EPA, 1986a).

Using this assumption, risk is directly related to the intake.

Only LDCIs are used in conjunction with slope factors to obtain excess lifetime cancer risk estimates as slope factors are based on average lifetime exposures. Slope factors are derived for specific routes of intake. As per the PEA guidance, oral slope factors will be used for the inhalation pathway when inhalation slope factors are not available (CalEPA, 1994).

5.1.2 Noncarcinogenic Hazard Quotient

The potential for noncarcinogenic health effects is estimated by comparing a chronic daily chemical intake (CDCI) of a compound through a specific exposure route to the chronic (or subchronic) reference dose (RfD) for that exposure route. For example, intakes through the inhalation route are compared to inhalation RfDs. The ratio of the intake to reference dose (CDI/RfD) for an individual chemical is termed the hazard quotient (HQ). A HQ greater than 1 indicates the potential for adverse health effects, as the RfD is exceeded by the intake (EPA, 1986b).

These ratios are calculated for each chemical that elicits a noncarcinogenic health effect when an RfD is available for the constituent and the route of exposure. Noncarcinogenic risk is not a probability. It is usually presented in scientific notation to distinguish it from cancer risk estimates and to aid in the readability of small numbers. For example, the number 0.0000001 is expressed in scientific notation as 1.0E-07.

If all individual HQs are below 1, an additional step is performed to calculate the hazard index (HI). The HI considers exposure to a mixture of constituents having noncarcinogenic effects based on the assumption that the effects of chemical mixtures are additive (EPA, 1986b). Synergistic or antagonistic interactions between constituents may be taken into account if sufficient information exists, but in the absence of such information, interactions are assumed to be additive. The HI is calculated by summing all HQs for all noncarcinogenic constituents through an exposure pathway:

$$\begin{aligned} \text{HI} &= \text{HQ}_1 + \text{HQ}_2 + \dots + \text{HQ}_j \\ &= (\text{CDI}_1/\text{RfD}_1) + (\text{CDI}_2/\text{RfD}_2) + \dots + (\text{CDI}_j/\text{RfD}_j) \end{aligned}$$

where:

$$\begin{aligned} \text{HQ}_j &= \text{Hazard Quotient of the } j^{\text{th}} \text{ chemical} \\ \text{CDI}_j &= \text{Chronic Daily Chemical Intake of the } j^{\text{th}} \text{ chemical} \\ \text{RfD}_j &= \text{Reference Dose for the } j^{\text{th}} \text{ chemical} \end{aligned}$$

HI values greater than 1 indicate the transition between acceptable and unacceptable levels of exposure. The next step is to segregate the individual constituents present in the environmental medium under evaluation on the basis of organ-specific toxic effect or nutritional need. These segregated fractions are then summed and the HI from each fraction evaluated. If the HI for the segregated fraction exceeds 1, a potential health risk from exposure will be concluded.

Subchronic exposures are considered to be from 2 weeks to 7 years (EPA, 1989). Daily intakes calculated for short-term exposures for construction workers are considered subchronic, however, intakes are compared to chronic rather than subchronic RfDs. This is a conservative comparison as chronic RfDs are more stringent than subchronic RfDs. If the HQ derived using the chronic RfD is less than 1, concern for potential adverse health effects from exposure is low (EPA, 1989).

5.2 Risk Estimation for Short-term Construction Worker

Incidental ingestion of site-wide soil (not including the hot spots) by construction workers results in an excess lifetime cancer risk of 3×10^{-6} at the RME. Benzo(a)pyrene is responsible for 60 % of the total risk. Table 5-1 presents the risk from this exposure route. A cancer risk cannot be estimated from ingestion of soil at inorganic hot spots. Copper is not an oral carcinogen and risk of lead is not evaluated through chemical intake.

A noncancer health impact is not anticipated for construction workers as the HI is 0.0003 ($2.6E-04$), as shown on Table 5-2. Copper is included in this HI although the oral RfD is uncertain. Intake of copper from its hot spot results in a hazard quotient of $5E-04$, which is considerably below one. Table 5-3 presents the variables used in the calculation of the hazard quotient.

Inhalation of particulates that arise from site-wide soil containing COPCs during construction activities, using RME intake parameters, is estimated to result in an excess lifetime cancer risk of 6×10^{-7} . Dibenzo(a,h)anthracene and benzo(a)pyrene are responsible for 90% of the total risk. Table 5-4 presents the risk from this exposure route. A cancer risk cannot be estimated from inhalation of particulates from soil at the inorganic hot spots. Copper is not an inhalation carcinogen and risk of lead is not evaluated through chemical intake.

A noncancer health impact from inhalation of particulates is not anticipated for the construction workers as the HI is $5E-05$, well below one. Table 5-5 presents the hazard quotients for each constituent and the total HI for this exposure route. Copper is included in the calculation of the HI although the RfD used is uncertain. Oral RfDs are used when inhalation RfDs are not available, per DTSC guidance (CalEPA, 1994). Inhalation of copper from its hot spot results in a hazard quotient of $1E-04$. Table 5-6 presents the input variables for the calculation.

The potential cumulative excess lifetime cancer risk to on-site construction workers, using reasonable maximum exposures, is estimated as 4×10^{-6} . Cumulative risk is the total of all quantified potential exposure routes within a scenario as presented in Table 5-7 below. None of the exposure routes quantified present a noncarcinogenic health risk. Each route results in a HI less than one. The cumulative HI for all exposure routes within this scenario is also less than one, indicating a noncarcinogenic health risk is not likely to occur. Table 5-7 presents the noncarcinogenic hazard indices for each exposure route.

Table 5-7**Summary of Risk by Exposure Route for the Short-term Construction Worker**

Exposure Route	Excess Lifetime Cancer Risk @ RME	Hazard Index @ RME
Inadvertent ingestion of soil	3×10^{-6}	2.6E-04
Inhalation of particulates from soil	6×10^{-7}	5.0E-05
CUMULATIVE	4×10^{-6}	3.1E-04

Carcinogenic PNAs drive the risk estimates. Maximum concentrations used in this analysis are not indicative of site-wide exposure that could occur during construction activities. PNA compounds are localized in the clay pigeon debris area and exposures to these concentrations would be less than the total construction period used in this assessment, therefore, true risk would be lower than risks estimated.

The output of the DTSC lead spreadsheet is presented in Table 5-8. The 99th percentile blood lead level is 6.0 ug/dl for adults. This value includes background exposure in food, air and water and is less than the recommended upper limit of 30 ug/dl for adults (FDA, 1990). Soil ingestion is responsible for 11% of the total intake and inhalation of dust from on-site soil for 21% of the total intake. These values suggest intake of lead does not present a significant health risk. Evaluation of exposure to lead in soil at the hot spots cannot be performed using the DTSC lead spreadsheet.

5.3 Risk Estimation for Long-term Storage Facility Worker

Inhalation of particulates that arise from soil exposed as a result of cracks in the asphalt, using RME intake parameters, is estimated to result in an excess lifetime cancer risk of 1×10^{-5} . Dibenzo(a,h)anthracene and benzo(a)pyrene are responsible for 90% of the total risk. Table 5-9 presents the risk from this exposure route.

A noncancer health impact is not anticipated for facility workers from inhalation of particulates as the HI is 5E-05, well below one. Table 5-10 presents the hazard quotients for each constituent and the total HI for this exposure route. Copper is included in the calculation of the HI for inhalation although it does not have the oral RfD. The oral RfD use is uncertain. Oral RfDs are used when inhalation RfDs are not available, per DTSC guidance (CalEPA, 1994).

The output of the DTSC lead spreadsheet is presented in Table 5-11. The 99th percentile blood lead level is 3.2 ug/dl for adults. This value includes background exposure in food, air and water and is less than the recommended upper limit of 30 ug/dl for adults (FDA, 1990). Dust inhalation accounts for 15% of the total intake. Soil ingestion was not included in the calculation because it was not considered an exposure route for this receptor. The contact rate was set to zero in the DTSC spreadsheet. These values suggest intake of lead does not present a significant health risk for the future facility worker through inhalation of dust.

5.4 Risk of Failure

The only foreseeable type of containment failure is cracking of the asphalt over time. However, this is not a foreseeable risk due to the 6-8 inch Class II Engineered baserock between the existing soil and asphalt cap.

Although asphalt cracking is likely to occur, regular inspection and maintenance will reduce the potential for exposure to COPCs in soil under the asphalt cover. Regular maintenance will also reduce the potential for infiltration through the cover, retarding movement of COPCs in near-surface soil. Risk of containment failure has been evaluated assuming dust exposure by the long-term storage facility worker.

Table 5-1
Short-term Construction Worker Scenario
Excess Lifetime Cancer Risk from Ingestion of Near Surface Soil (w/out hot spots)

Constituent	Oral Slope Factor (mg/kg-day) ⁻¹	Lifetime Daily Chemical Intake ^a (mg/kg-day)	Excess Lifetime Cancer Risk
Inorganics			
Copper		3.66E-08	
Lead		1.85E-07	
PNAs			
Acenaphthene		1.85E-08	
Anthracene		1.45E-08	
Benzo(a)anthracene	0.73	1.45E-07	1 x 10 ⁻⁷
Benzo(b)fluoranthene	0.73	2.12E-07	2 x 10 ⁻⁷
Benzo(k)fluoranthene	0.073	1.23E-07	9 x 10 ⁻⁹
Benzo(g,h,i)perylene		1.12E-07	
Benzo(a)pyrene	7.3	2.29E-07	2 x 10 ⁻⁶
Chrysene	0.0073	7.83E-08	6 x 10 ⁻¹⁰
Dibenzo(a,h)anthracene	7.3	1.17E-07	9 x 10 ⁻⁷
Dibenzofuran		1.23E-09	
Indeno(1,2,3-c,d)pyrene	0.73	1.12E-08	8 x 10 ⁻⁹
Naphthalene		7.83E-09	
Phenanthrene		4.03E-08	
Pyrene		6.71E-08	
Total Risk			3 x 10⁻⁶

^a LDCI taken from Appendix C Table C-1.

Table 5-2
Short-term Construction Worker Scenario
Non-Cancer Risk from Ingestion of Near Surface Soil (w/out hot spots)

Constituent	Oral Chronic RfD ^a (mg/kg-day)	Chronic Daily Chemical Intake ^b (mg/kg-day)	Noncancer HQ
Inorganics			
Copper	0.04	2.56E-06	6.4E-05
Lead		1.30E-05	
PNAs			
Acenaphthene	0.06	1.29E-06	2.2E-05
Anthracene	0.3	1.02E-06	3.4E-06
Benzo(a)anthracene		1.02E-05	
Benzo(b)fluoranthene		1.49E-05	
Benzo(k)fluoranthene		8.61E-06	
Benzo(g,h,i)perylene		7.83E-06	
Benzo(a)pyrene		1.60E-05	
Chrysene		5.48E-06	
Dibenzo(a,h)anthracene		8.22E-06	
Dibenzofuran		8.61E-08	
Indeno(1,2,3-c,d)pyrene		7.83E-07	
Naphthalene	0.04	5.48E-07	1.4E-05
Phenanthrene		2.82E-06	
Pyrene	0.03	4.70E-06	1.6E-04
Hazard Index			2.6E-04

a Chronic RfDs used even though exposure is less than 7 years.

b CDCI taken from Appendix C Table C-1.

Table 5-3
Short-term Construction Worker Scenario
Non-Cancer Risk from Ingestion of Hot Spot Near Surface Soil

Constituent	Oral RfD ^a (mg/kg-day)	Chronic Daily Chemical Intake ^b (mg/kg-day)	Noncancer HQ
Inorganics			
Copper	0.04	1.96E-05	4.9E-04
Lead		1.78E-04	
Hazard Index			4.9E-04

a Chronic RfDs used even though exposure is less than 7 years.

b CDCI taken from Appendix C, Table C-2.

Handwritten: 4.9E-04

Table 5-4
Short-term Construction Worker Scenario
Excess Lifetime Cancer Risk from Inhalation of Dust (w/out hot spots)

Constituent	Inhalation Slope Factor (mg/kg-day) ⁻¹	Lifetime Daily Chemical Intake ^a (mg/kg-day)	Excess Lifetime Cancer Risk
Inorganics			
Copper		7.31E-09	
Lead		3.71E-08	
PNAs			
Acenaphthene		3.69E-09	
Anthracene		2.91E-09	
Benzo(a)anthracene	0.73	2.91E-08	2 x 10 ⁻⁸
Benzo(b)fluoranthene	0.73	4.25E-08	3 x 10 ⁻⁸
Benzo(k)fluoranthene	0.073	2.46E-08	2 x 10 ⁻⁹
Benzo(g,h,i)perylene		2.24E-08	
Benzo(a)pyrene	7.3	4.58E-08	3 x 10 ⁻⁷
Chrysene	0.0073	1.57E-08	1 x 10 ⁻¹⁰
Dibenzo(a,h)anthracene	7.3	2.35E-08	2 x 10 ⁻⁷
Dibenzofuran		2.46E-10	
Indeno(1,2,3-c,d)pyrene	0.73	2.24E-09	2 x 10 ⁻⁹
Naphthalene		1.57E-09	
Phenanthrene		8.05E-09	
Pyrene		1.34E-08	
Total Risk			6 x 10⁻⁷

^a LCDI taken from Appendix C, Table C-3.

Table 5-5
Short-term Construction Worker Scenario
Non-Cancer Risk from Inhalation of Dust (w/out hot spots)

Constituent	Inhalation RfC ^a (mg/kg-day)	Chronic Daily Chemical Intake ^b (mg/kg-day)	Noncancer HQ
Inorganics			
Copper	0.04	5.12E-07	1.3E-05
Lead		2.60E-06	
PNAs			
Acenaphthene	0.06	2.58E-07	4.3E-06
Anthracene	0.3	2.04E-07	6.8E-07
Benzo(a)anthracene		2.04E-06	
Benzo(b)fluoranthene		2.97E-06	
Benzo(k)fluoranthene		1.72E-06	
Benzo(g,h,i)perylene		1.57E-06	
Benzo(a)pyrene		3.21E-06	
Chrysene		1.10E-06	
Dibenzo(a,h)anthracene		1.64E-06	
Dibenzofuran		1.72E-08	
Indeno(1,2,3-c,d)pyrene		1.57E-07	
Naphthalene	0.04	1.10E-07	2.7E-06
Phenanthrene		5.64E-07	
Pyrene	0.03	9.39E-07	3.1E-05
Hazard Index			5.2E-05

a Oral RfDs used for inhalation RfDs per DTSC guidance.

b CDCI taken from Appendix C, Table C-3.

Table 5-6
Short-term Construction Worker Scenario
Non-Cancer Risk from Inhalation of Hot Spot Dust

July 2001
Appendix

Constituent	Inhalation RfC ^a (mg/kg-day)	Chronic Daily Chemical Intake ^b (mg/kg-day)	Noncancer HQ
Inorganics			
Copper	0.04	3.91E-06	1E-04
Lead		3.56E-05	
Hazard Index			1E-04

a Oral RfD used for inhalation RfD per DTSC guidance.
b CDCI taken from Appendix C, Table C-4.

Table 5-7

Summary of Risk by Exposure Route for the Short-term Construction Worker

Exposure Route	Excess Lifetime Cancer Risk @ RME	Hazard Index @ RME
Inadvertent ingestion of soil	3 x 10 ⁻⁶	2.6E-04
Inhalation of particulates from soil	6 x 10 ⁻⁷	5.0E-05
CUMULATIVE	4 x 10 ⁻⁶	3.1E-04

*No
dwn*

*PHS
AL*

Table 5-8
Lead Risk Assessment Spreadsheet
California Department of Toxic Substances Control
Short-term Construction Worker Scenario

3/10/01
10/2/01 - EPA - children
3/14/01 - EPA - workers

INPUT						
Medium		Level				
LEAD IN AIR	ug/m ³	0.18 ^a				
LEAD IN SOIL	(ug/g)	331.7 ^b				
LEAD IN WATER	(ug/L)	15 ^a				
PLANT UPTAKE? 1=YES 0+NO		0				
AIRBORNE DUST	ug/m ³	500 ^b				
EQUATIONS, ADULTS						
Pathway	ug/dL	Route-specific Constant	Concen. in Medium	Contact Rate	Percent of Total	
SOIL CONTACT:	0.06 =	1.00E-04 (ug/dL/(ug/day) ^a	332 ug/g ^a	1.85 ^a g soil/day (5 g/m ² * 0.37 m ²)	2	
SOIL INGESTION:	0.29 =	0.018 (ug/dL/(ug/day) ^a	332 ug/g ^a	0.05 ^b g soil/day	11	
INHALATION:	0.57 =	1.64 (ug/dL/(ug/day) ^a	0.35 ug/m ³		21	
WATER INGESTION:	0.84 =	0.04 (ug/dL/(ug/day) ^a	15 ug/L ^a	1.4 ^a L water/day	32	
FOOD INGESTION:	0.88 =	0.04 (ug/dL/(ug/day) ^a	10 ug Pb/kg die	2.2 ^a kg diet/day	33	
OUTPUT						
Age-Group		Percentiles				
		50th	90th	95th	98th	99th
BLOOD Pb, ADULT	(ug/dL)	2.6	4.1	4.7	5.4	6

a Default value
b Site specific value

Table 5-9

Long-term Storage Facility Worker

Excess Lifetime Cancer Risk from Inhalation of Dust Emitted from Cracks in the Asphalt

Constituent	Inhalation Slope Factor (mg/kg-day) ⁻¹	Lifetime Daily Chemical Intake ^a (mg/kg-day)	Excess Lifetime Cancer Risk
Inorganics			
Copper		1.71E-07	
Lead		8.69E-07	
PNAs			
Acenaphthene		8.65E-08	
Anthracene		6.81E-08	
Benzo(a)anthracene	0.73	6.81E-07	5 x 10 ⁻⁷
Benzo(b)fluoranthene	0.73	9.96E-07	7 x 10 ⁻⁷
Benzo(k)fluoranthene	0.073	5.77E-07	4 x 10 ⁻⁸
Benzo(g,h,i)perylene		5.24E-07	
Benzo(a)pyrene	7.3	1.07E-06	8 x 10 ⁻⁶
Chrysene	0.0073	3.67E-07	3 x 10 ⁻⁹
Dibenzo(a,h)anthracene	7.3	5.50E-07	4 x 10 ⁻⁶
Dibenzofuran		5.77E-09	
Indeno(1,2,3-c,d)pyrene	0.73	5.24E-08	4 x 10 ⁻⁸
Naphthalene		3.67E-08	
Phenanthrene		1.89E-07	
Pyrene		3.15E-07	
Total Risk			1 x 10⁻⁵

a LDCI taken from Appendix C, Table C-5.

Table 5-10
Long-term Storage Facility Worker
Non-Cancer Risk from Inhalation of Dust Emitted from Cracks in the Asphalt

Constituent	Inhalation RfC ^a (mg/kg-day)	Chronic Daily Chemical Intake ^b (mg/kg-day)	Noncancer HQ
Inorganics			
Copper	0.04	4.80E-07	1.2E-05
Lead		2.43E-06	
PNAs			
Acenaphthene	0.06	2.42E-07	4.0E-06
Anthracene	0.3	1.91E-07	6.4E-07
Benzo(a)anthracene		1.91E-06	
Benzo(b)fluoranthene		2.79E-06	
Benzo(k)fluoranthene		1.61E-06	
Benzo(g,h,i)perylene		1.47E-06	
Benzo(a)pyrene		3.01E-06	
Chrysene		1.03E-06	
Dibenzo(a,h)anthracene		1.54E-06	
Dibenzofuran		1.61E-08	
Indeno(1,2,3-c,d)pyrene		1.47E-07	
Naphthalene	0.04	1.03E-07	2.6E-06
Phenanthrene		5.28E-07	
Pyrene	0.03	8.81E-07	2.9E-05
Hazard Index			4.9E-05

a Oral RfDs used for inhalation RfDs per DTSC guidance.

b CDCI taken from Appendix C, Table C-5.

Table 5-11
Lead Risk Assessment Spreadsheet
California Department of Toxic Substances Control
Long-term Storage Facility Worker

INPUT						
Medium		Level				
LEAD IN AIR	ug/m ³	0.18 ^a				
LEAD IN SOIL	(ug/g)	331.7 ^b				
LEAD IN WATER	(ug/L)	15 ^a				
PLANT UPTAKE? 1=YES 0+NO		0				
AIRBORNE DUST	ug/m ³	50 ^b				
EQUATIONS, ADULTS						
Pathway	ug/dL	Route-specific Constant	Concen. in Medium	Contact Rate	Percent of Total	
SOIL CONTACT:	0.06 =	1.00E-04 (ug/dL/(ug/day) ^a	332 ug/g ^a	1.85 ^a g soil/day (5 g/m ² * 0.37 m ²)	3	
SOIL INGESTION:	0.00 =	0.018 (ug/dL/(ug/day) ^a	332 ug/g ^a	0 ^b g soil/day	0	
INHALATION:	0.32 =	1.64 (ug/dL/(ug/day) ^a	0.2 ug/m ³		15	
WATER INGESTION:	0.84 =	0.04 (ug/dL/(ug/day) ^a	15 ug/L ^a	1.4 ^a L water/day	40	
FOOD INGESTION:	0.88 =	0.04 (ug/dL/(ug/day) ^a	10 ug Pb/kg die	2.2 ^a kg diet/day	42	
OUTPUT						
Age-Group		Percentiles				
		50th	90th	95th	98th	99th
BLOOD Pb, ADULT	(ug/dL)	2.1	3.3	3.7	4.3	4.8

^a Default value

^b Site specific value

6.0 UNCERTAINTIES

This section provides a discussion of uncertainties in the risk assessment. Quantitative risk estimates derived in this assessment are conditional estimates that include a number of assumptions about land use, exposures, and toxicity. None of the risk estimates can be separated from these assumptions or the uncertainties inherent in the numerical values of the parameters used to calculate them. The calculated cancer risks and noncancer hazards are contingent on the assumptions and parameter assignments made in deriving them and should not be interpreted as "true" risks.

Uncertainties associated with each step in the risk assessment process and their potential effect on the numerical risk estimates are discussed qualitatively below.

6.1 Uncertainties Associated with Data Evaluation and COPC Selection

Uncertainties are associated with the collection, analysis and evaluation of environmental data. Environmental sampling may not have accurately characterized chemical concentrations. Sampling at discrete locations and at discrete times may not be fully representative of potential exposures. Samples locations were selected because the area was likely to be contaminated. This would result in overestimates of risk from using these data as representative of the entire site. For environmental media with time-varying chemical concentrations (i.e., organic concentrations in soil), long-term exposure conditions may not be accurately characterized by a single point-in-time measurement. Therefore, estimated exposure point concentrations are subject to temporal variability and uncertainty. Risk calculated from these data could be overestimated or underestimated.

The procedures used to analyze chemicals in environmental media may have introduced errors. A series of samples (laboratory blanks, system blanks, etc.) are designed to detect errors introduced in this manner. These data were not reviewed for this assessment. This assessment assumes all data are of acceptable quality. This assumption can introduce uncertainty into the resulting risk estimates.

6.2 Uncertainty Associated with the Exposure Assessment

Quantitative estimates of intake derived in the exposure assessment section are conditional estimates that include numerous conservative assumptions on the type of exposures that may occur, the frequency and duration of those exposures, and the concentration of constituents at the point of exposure. The standard approach used in risk assessment is to provide a conservative estimate of risk. Thus, the emphasis is on "reasonable maximum exposure". Relatively conservative assumptions are used for many of the various factors used to calculate risks. This has a compounding effect, resulting in a more conservative total than any single assumption. No attempt is made in this assessment to quantify this compounding effect on the cumulative risk estimates made.

One of the major areas of uncertainty in exposure assessment is the prediction of human activities that lead to contact with environmental media and exposure to constituents.

Activities that differ from those used in the exposure assumptions could lead to higher or lower intakes than those estimated. If some of the activities do not occur or occur for shorter periods of time than the estimates, the intake would be lower than that presented and would over estimate the resulting risk. The degree to which the exposure parameters assumed in this assessment actually represent real-world conditions is uncertain.

Some pathways that could result in exposures were not included in this assessment. Dermal exposures were not quantified. Dermal exposures have a high degree of uncertainty associated with the assumptions and parameters used to estimate absorption. Although the accuracy of the risks estimated in this assessment is affected because the dermal pathway was not included, the high degree of uncertainty associated with this pathway justified their exclusion. Risk estimates are underestimated because of the exclusion of the dermal pathway.

Derivation of exposure point concentrations, those obtained by direct use of monitoring data and those obtained by the use of conservative models, is a large source of uncertainty. The data for inorganic constituents were statistically tested for distribution form. If the "hot spots" were not included in the analyses, the distribution of lead and copper were found to be lognormal. However, for the organic constituents, the limited number of positive data points constrained the usefulness of the statistical method and the exposure point concentration was taken as the maximum value reported. Use of the maximum reported value as the exposure point concentration overestimates the intake over the long-term, resulting in an overestimate of the calculated risk.

The use of 1/2 the CRL as a surrogate in the derivation of exposure point concentrations introduces additional uncertainty. The resulting estimates are biased, however, it cannot be determined if the bias produced is high or low. If zero were substituted for all values below detection, the estimates of the mean would be low. Use of the detection limit in place of the undetected values results in estimates that are above the true value.

The method of estimating on-site exposure point concentrations of constituents on dust arising from soil has large uncertainties. The soil data include all particle sizes and depths up to 1 foot. Particle sizes and depths more appropriate to resuspension of particulates could have higher or lower concentrations of constituents. The assumption that dust concentrations remain at a constant level of 500 ug/m³ during construction overestimates the amount of dust in the air and consequently, the concentrations of constituents present in dust.

In addition, the assumption that dust at a level of 50 ug/m³ could arise from cracks in the asphalt cover is very unlikely. The risk estimates arising from this assumption are highly uncertain.

6.3 Uncertainties Associated with the Toxicity Assessment

Use of reference doses and cancer slope factors are subject to several types of uncertainties. Typically the studies from which these values are derived involve

conditions that are not identical to the type of exposures of interest involving chemicals in the environment. Extrapolations from animal experiments are frequently required to derive a toxicity value for use in risk assessments. These extrapolations can include the following uncertainty:

- from high experimental doses to low doses for environmental exposures
- from animals used in experimental studies to humans
- from short-term exposure to long-term exposures
- from relatively homogeneous experimental populations to individuals who can vary substantially in their individual dose-response reactions
- from continuous experimental doses to intermittent human exposures (e.g., through the use of calculated "lifetime average exposure")

The methods used to derive slope factors and reference doses are intended to be conservative in recognition of these types of uncertainties. For carcinogens, a slope factor at the estimated 95 percent upper confidence limit is used. Carcinogenic slope factors assume no threshold for effects. If there are in fact thresholds for carcinogenicity, the slope factor could be altered considerably. For noncarcinogens, uncertainty factors are applied to either the "no observed effect" level or even the "lowest observed effect" levels to obtain a reference dose.

The overall quality of the toxicology database contains numerous uncertainties including:

- lack of consistency between different experimental studies
- small numbers of studies
- lack of available information on multiple species and multiple routes of administration
- lack of a demonstration of clear dose-response relationship
- lack of plausible biological mechanism of action
- lack of direct evidence of effects in humans

For ingestion exposures, the availability of chemicals once in the body is assumed to be the same as that in the studies from which toxicity factors were developed. Most toxicity parameter values are calculated to be used with administered doses rather than absorbed doses but still reflect the bioavailability in the as-administered form. The risks are likely to be overestimated if bioavailability from media is less than from the form of administered doses in toxicological studies.

Of the carcinogenic PNA compounds, only benzo(a)pyrene has a slope factor. The use of relative potency values may under or over-estimate risks from exposure to these compounds.

Toxicity of each chemical was assumed to be additive. Interactions between chemicals, synergisms or antagonisms, were not accounted for due to the limited toxicity information on these types of interactions. Interactions could result in over- or underestimates of the risk.

The uncertainty factors used to derive RfDs for evaluating noncarcinogenic effects are reported on Table 4-2 along with EPAs assigned confidence level in the RfD value. All chemicals in this table have a medium to low degree of confidence associated with the oral RfD. The uncertainty factor built into the RfD varies depending on the chemical. The degree of confidence in the toxicity value applies to the uncertainty of the subsequent estimation of risk.

Copper does not have a verified reference dose, however, the federal MCL is used in this assessment to estimate an oral RfD. This adds uncertainty to the noncancer hazard index calculated using this value.

6.4 Uncertainty in Risk Characterization

Uncertainties associated with risk estimation are those that have been built into the process of deriving risk estimates, as previously discussed. These estimates cannot be separated from the assumptions used to derive them and should not be interpreted as absolute or "true" risks, but only as estimates based on conservative assumptions.

Risk was not estimated for developmental toxicants because developmental toxicity values are not available. The lack of these values introduces a separate source of uncertainty into the estimation of the potential for adverse health effects from exposure to constituents detected at the site.

The potential for adverse health effects from subchronic exposure to noncarcinogenic chemicals was evaluated with chronic reference doses. Calculated HQ's are over-estimated using this approach. As this is a conservative approach, it serves to reinforce the outcome of the noncarcinogenic analysis. The uncertainty associated with estimation of the potential for noncarcinogenic effects is not increased by using this method.

The inability to evaluate lead in the same manner as other chemical constituents introduces uncertainty into the total risk estimate. However, an evaluation of lead using pharmacokinetic uptake indicates intake of lead through inhalation and incidental ingestion would not present a health risk.

As per PEA guidance, the use of oral slope factors to evaluate the inhalation pathway introduces a large degree of uncertainty into the risk estimates for the inhalation pathway. Assuming the inhalation route results in an effect to the same organ system as the ingestion route ignores the route-of-entry effects where the toxic effect is to the respiratory system or exchange boundary. Also, no metabolic, pharmacokinetic or surface area adjustments have been made to the slope factor which could result in an overestimate of the internal dose. Risk estimates for the inhalation pathway using oral slope factors should be considered highly uncertain.

The lack of quantification of risk from dermal contact with carcinogenic PNAs adds to the uncertainty of the risk estimates. However, no mechanism currently exists to quantify cancer risk from dermal contact with carcinogenic PNAs.

7.0 SUMMARY AND CLEANUP STRATEGIES

This section summarizes the data used in this risk assessment, the exposure scenarios formulated to evaluate the short- and long-term risk associated with site development, the toxicity evaluation and the risk estimates. Potential cleanup strategies are then discussed.

7.1 Data Evaluation and Selection of COPCs

Data available from past investigations at the site were used in the risk assessment. An evaluation of the data according to EPA protocols was not conducted because of the lack of documentation. It is assumed that all data collected are usable for the assessment. Sample locations provided sufficient site coverage. Analyses conducted were for compounds known to have been used at the site. Analytical methods were comparable between all investigation, therefore, the data sets could be combined for use in this risk assessment.

PNAs in soil are highest in the clay pigeon debris area of the site. Only one well on-site had a measurable concentration of a PNA (pyrene).

Chemicals were analyzed for on the basis of activities conducted at the site. COPCs were selected based on chemicals detected and frequency of detection. The COPCs identified for use in this risk assessment are listed on Table 2-6.

7.2 Exposure Assessment

The exposure assessment identified receptors considering the proposed site development plan and current use of the property. The type and magnitude of exposures that could occur during and after construction of the storage facility were categorized into those associated with construction (short-term) and those that may remain after construction is completed (residual or long-term).

7.2.1 Exposure Scenarios

Construction workers are the primary receptors for short-term exposures. Workers could be exposed through inadvertent ingestion of soil, inhalation of particulates and direct dermal contact with soil while dirt moving activities are taking place and prior to completion of the asphalt cover. Off site receptors were not evaluated because they are not anticipated to be exposed relative to construction workers at the site.

Although no exposures are anticipated after completion of the storage facility, the Alameda County Health Department requested an analyses of the long-term exposure to dust arising from soil at the site.

7.2.2 Confidence in Exposure Estimates

The quantitative estimates of exposure included a number of conservative parameters and assumptions. The most conservative and uncertain input to estimating exposure is the use of maximum detected values at the site as exposure point concentrations. Use of maximum values detected over-estimates the concentration at all points of exposure. In addition, simple models were used to conservatively estimate the concentration of constituents on airborne particulates. These conservative exposure point concentrations were then combined with conservative assumptions of the daily intake of media that contain COPCs, the frequency of contact with these media and the duration of contact. The "actual" exposures experienced by receptors likely will be considerably less than those estimated in this assessment.

7.3 Toxicity Assessment

The toxicity assessment identified the potential for health effects and the critical toxicity value for each COPC. Health effects from exposure to compounds are divided into two broad groups; carcinogenic effects and noncarcinogenic or systemic effects. Compounds classified as carcinogenic have the potential to cause cancer. They may also elicit a noncarcinogenic effects. Compounds that are noncarcinogenic or systemic toxicants may adversely affect the function of an organ or organ system. The carcinogenic potential of each COPC, according to the route of exposure, was determined based on regulatory agency recommendations.

Critical toxicity values were obtained from EPA and DTSC for use in this risk assessment. Toxicity values are required to quantify the probability of cancer from exposure to compounds identified as carcinogenic and the likelihood of adverse health affects from exposure to noncarcinogenic compounds. Cancer slope factors for the route of exposure (ingestion or inhalation) are the toxicity values for carcinogenic compounds. Noncancer affects are evaluated with a toxicity value termed a reference dose (RfD).

Adverse health effects from exposure to lead were evaluated using the DTSC lead spreadsheet model.

7.4 Risk Characterization

Risk characterization is the process of combining the toxicity information with the exposure estimates to quantify risk. Excess lifetime cancer risk is estimated by multiplying the compound intake by the cancer slope factor. If exposure to more than one carcinogen occurs, the resulting risk are assumed to be additive to account for multiple compound exposure. The potential for occurrence of adverse systemic effects is estimated by dividing the compound intake by the compounds RfD. If the resulting quotient is less than one, the potential for adverse systemic effects is low. If the quotient exceeds one, it is an indication that adverse effects could occur. In general, the substantial safety margin incorporated into the RfD suggests that adverse health effects are unlikely even with quotients that are greater than one.

Toxic effects of lead exposure are correlated with blood lead levels rather than exposure estimates. The potential for adverse effects from lead exposure were evaluated using the DTSC lead spreadsheet. The spreadsheet calculates percentile blood lead levels for adults. Calculated blood lead levels below the target level of 30 ug/dl for adults are without significant adverse effects (FDA, 1990).

7.4.1 Risk Estimates

For the short-term construction worker scenario, the maximum excess lifetime cancer risk from all exposure routes was estimated as 4×10^{-6} , primarily due to ingestion of PNAs in soil through inadvertent means and inhalation of soil as particulates. Noncancer adverse effects are not anticipated as the HI was substantially less than one. Calculated blood lead levels were 6.0 ug/dl for 99th percent of the construction workers, substantially less than the 30 ug/dl level of concern. The estimate cancer risk is within the EPA acceptable risk range of 10^{-4} to 10^{-6} (EPA, 1990c) and less than the 10^{-5} level considered by DTSC to represent no significant risk for Proposition 65 regulations (California Code of Regulations, Title 22, Section 12711(a)(1)).

Excess lifetime cancer risk from inhalation of particulates that may be emitted through cracks in the asphalt cover was estimated to be a maximum of 1×10^{-5} for the on-site storage facility worker. Noncancer adverse effects are not anticipated. This is within the EPA acceptable risk range of 10^{-4} to 10^{-6} (EPA, 1990c) and at the 10^{-5} level considered by DTSC to represent no significant risk for Proposition 65 regulations (California Code of Regulations, Title 22, Section 12711(a)(1)).

7.5 Cleanup Strategies

By conducting a risk assessment for the proposed development, a rational basis has been established for determining cleanup levels that consider human health and beneficial uses.

Risk characterization estimated a 4×10^{-6} cancer risk for the short-term construction worker, primarily due to inadvertent ingestion of PNAs in soil and inhalation of soil as particulates while working on-site. This estimated risk used very conservative assumptions on the amount of dust in the air and the amount of soil a worker would ingest on a daily basis. In addition, it assumed no personal protection would be worn and no engineering or work practice controls would be instituted to reduce the potential for exposure to soil. In reality, various methods to reduce or eliminate contact with soil will be practiced. Workers will be required to keep the soil wet to inhibit wind entrainment of soil, thereby eliminating inhalation of soil as particulates. Only workers trained in the proper use of personal protection and work practice controls, such as the use of gloves while on-site to reduce the potential for direct contact, hand washing at every break to control inadvertent ingestion of soil, and the elimination of on-site smoking be control the inadvertent ingestion, will be allowed on-site. The controls should effectively reduce the estimated risks from exposure to soil to below the 10^{-6} level. This scenario does not provide a basis upon which to recommend a cleanup level for PNAs in soil.

Cooper in soil does not pose a potential noncancer threat to the short-term construction worker as the calculated hazard quotient is substantially less than one. No recommendation concerning cleanup of copper in soil is made on the basis of this scenario.

Calculated blood lead levels were 6.0 ug/dl for 99th percentile, substantially less than the 30 ug/dl level of concern established by the FDA. The 95UCL of the mean lead concentrations, not considering hot spots, was used to determine potential blood lead levels. There is no mechanism to determine potential affects of lead from a limited exposure duration (1 day, 1 month, etc.). The elimination or reduction in the potential for contact with soil during construction (through engineering and work practice controls and personal protection) should serve to diminish the potential for adverse effects from exposure to lead at hot spot concentrations. No recommendation concerning cleanup of lead in soil is made on the basis of this scenario.

The Alameda County Health Department requested an evaluation of long-term exposure of on-site workers to dust arising from near surface soil. In order to quantify exposure, the following assumptions were made:

- no maintenance of the asphalt cover would occur.
- cracks would develop in the asphalt cover over time.
- cracks would be of sufficient size to allow for the release of soil as dust.
- dust levels would remain constant at 50 ug/m³ throughout the 40 hour work week.

Routine maintenance of the facility will include regular inspection and repair of the asphalt pavement. Therefore, even if cracking does occur, it would not necessarily result in exposure of soil due to the aggregate base below the asphalt and as repairs will be made on a routine basis. The cancer risk of 1×10^{-5} (driven by PNA compounds) for the on-site storage facility worker, calculated with these assumptions, is grossly over-estimated. As the estimate is with the EPA's acceptable risk range of 10^{-4} to 10^{-6} and it is not a accurate estimate of the true risk posed by the site due to the uncertainty of the assumptions required to make the estimate, no recommendation concerning cleanup of PNAs in soil is made.

Copper does not present a potential noncancer adverse effect as the calculated hazard quotient is well below one, therefore, not recommendation concerning cleanup of copper in soil is made.

Inhalation of lead on dust generated from near surface soils does not present a significant health risk for the future facility worker. The 99th percentile blood lead level is 3.2 ug/dl for adults. This value includes background exposure in food, air and water and is less than the recommended upper limit of 30 ug/dl for adults (FDA, 1990). Dust inhalation accounts for 15% of the total intake. This evaluation of lead did not consider lead at hot spot concentrations. This presents an uncertainty in the estimated blood lead levels for the future facility worker. If the maximum hot spot concentration is used in the DTSC Leadsread model and the ingestion rate is set to zero because inhalation is the only route evaluated, the 99th percentile blood lead level is 61.7 ug/dl with inhalation responsible for

28 percent and soil contact responsible for 65 percent. Although this drastically over-estimates the potential blood lead levels as it is unlikely that a worker could be exposed to dust arising from a lead hot spot on a long-term basis, it dramatically indicates the potential effects that lead at hot spot concentrations could have. For this reason, it is recommended that the lead hot spots be removed and a cleanup level for lead set at 1200 mg/kg (EPA, 1994).

The level of 1200 mg/kg has been generated by EPA using a simple linear equation for a non-residential setting where children are not present. In determining this level, EPA considered protection of the fetus in working pregnant women as fetal effects are considered the critical effect. A target fetal blood lead level of 10 ug/dl was set since it is believed that the fetus is at least as sensitive as the child. Fetal blood leads may approximate roughly 85 percent of maternal blood lead levels, therefore, a target upperbound adult blood lead level of 11.8 ug/dl is derived. The equation developed by EPA also requires adult absorption, the mean background blood lead, the inverse clearance factor and adult intake rates. Adult absorption is estimated as 10 percent based on studies by Rabinowitz et al., (1980); the mean background blood lead level for adults from sources other than soil (e.g., air, water, and food) is 2.8 ug/dl based on Amnest et al. (1984); the inverse clearance factor of 0.44 is based on a clearance of lead from blood and extracellular fluid of 2.25 dl/day (Rabinowitz et al., 1974, 1976; Chamberlain et al., 1978; O'Flaherty, 1993; and Leggett, 1993); and adult intake of 50 mg of soil/day (EPA, 1991a). The equation is as follows:

$$C_s = \frac{PbB_c - PbB_s}{Abs_a * Ir_a} * ICF$$

where:

- C_s = Soil lead concentration
- PbB_c = Blood lead level of concern for adults
- PbB_s = Blood lead level for adults from all other sources
- Abs_a = absorption by adults
- Ir_a = Adult ingestion rate
- ICF = Inverse clearance factor

Although this equation has not undergone the same degree of scientific scrutiny as the EPA IEUBK model and it involves considerable uncertainty (the fetus may be more sensitive than children, background blood lead levels may not be accurate for all populations, etc.) it can serve as a useful tool for determining an appropriate cleanup level for lead in a non-residential setting.

Groundwater has not been addressed in any of the exposure scenarios evaluated because it is not used and no exposures were hypothesized. Based on the scenarios evaluated, exposure to groundwater is not anticipated to occur in the future, therefore cleanup levels are not recommended.

Remediation of soil would not improve the beneficial uses of groundwater. Drinking water is not considered a potentially beneficial use of the groundwater at the site. Groundwater flows to the east toward the municipal golf course and the Oakland International Airport property. No drinking water or irrigation supply wells lie in the downgradient direction, nor it is likely that any would be installed in this location. Municipal water is supplied to

the City of Alameda. In addition, TDS in groundwater beneath the site ranges from 1200 to 4800 mg/L. This exceeds the federal secondary maximum contaminant level of 500 mg/L and would be undesirable as a drinking water.

A concern for shallow groundwater quality beneath the site is the potential for migration and release of constituents to the bay. Natural attenuation and adsorption to soil along the flow path would significantly reduce copper and lead concentrations before groundwater reached the bay.

Protection of groundwater quality from degradation by overlying soils will be accomplished through paving the site which will eliminate infiltration and the potential for leaching of constituents in soil to groundwater. In the over 30 years since the site has been in use and fill has been in-place, groundwater quality has not been significantly degraded. Concentrations of copper and lead in groundwater under the site are variable. For copper, 36 percent of the analyses were not above the detection limit and 43 percent of the analyses for lead were not above detection. Of the positive detects, 11 percent of the copper samples are lower than the background sample concentration and 38 percent of the lead samples are lower than the background concentration. Only one PNA compound was ever positively detected in groundwater.

Paving the site and piping the drainage ditch will eliminate the potential for release of near surface soils to off-site surface waters.

8.0 REFERENCES

- ACC Environmental Consultants. 1994. Subsurface Site Investigation, Former Island Gun Club, 500 Maitland Drive, Alameda, CA.
- Alameda City Library. 1994. Personal communication, reference librarian, July 6, 1994.
- Alameda County Flood Control and Water Conservation District (ACFCWCD). 1988. Geohydrology and Groundwater Quality Overview of the East Bay Plain Area, Alameda, County, California. 205(j) Report, submitted to the California Regional Water Quality Control Board, San Francisco Bay Region, 83 p. + appendices.
- Association of Bay Area Governments (ABAG). 1994. Personal communication June 28, 1994 with the Regional Data Center for 1990 Census Information, Oakland, CA.
- California Environmental Protection Agency. 1992a. Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities. Department of Toxic Substances Control (DTSC), Sacramento, CA.
- California Environmental Protection Agency. 1992b. LeadSpread, beta test version spreadsheet. Department of Toxic Substances Control (DTSC), Sacramento, CA.
- California Environmental Protection Agency (CalEPA). 1994. Preliminary Endangerment Assessment Guidance Manual. Department of Toxics Substances (DTSC), Sacramento, CA.
- City of Alameda. 1991. Alameda General Plan. City Planning Department, Alameda, CA.
- Chamberlain, A.C., M.J. Heard, P.Little, D. Newton, A.C.Wells and R.D Wiffen. 1978. Investigations into lead from motor vehicles. Harwell, United Kingdom, United Kingdom Atomic Energy Authority, report no. AERE-R9198.
- Clement. 1988. Multi-pathway Health Risk Assessment Input Parameters Guidance Document. South Coast Air Quality Management District, El Monte, CA.
- Department of Commerce. 1988.
- Department of Toxic Substances Control (DTSC). 1992. California Cancer Potency Factors, June 18, 1992. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA.

- Driver, J.H., J.J. Konz, and G.K. Whitmyre. Soil Adherence to Human Skin. Bull. Environ. Contam. Toxicol. 43:814-820.
- EPA. 1986a. Guidelines for Carcinogen Risk Assessment. Federal Register 51(185):33991-34003.
- EPA. 1986b. Guidelines for the Health Risk Assessment of Chemical Mixtures. Federal Register 51(185):34014-34025.
- EPA. 1988. Drinking Water Regulations: Maximum Contaminant Levels Goals and National Primary Drinking Water Regulations for Lead and Copper. Federal Register 53 (160):31516.
- EPA. 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). EPA/540/1-89/002, Office of Emergency and Remedial Response, Washington, DC.
- EPA. 1990a. Guidance for Data Useability in Risk Assessments, Interim Final. EPA/540/G-90/008, Office of Emergency and Remedial Response, Washington, DC.
- EPA. 1990b. Technical Support Document on Lead, Final Draft. ECAO-CIN-757, Environmental Criteria and Assessment Office, Cincinnati, OH.
- EPA. 1990c. National Oil and Hazardous Substance Pollution Contingency Plan (NCP). 40 CFR Part 300; Federal Register 53:51394.
- EPA. 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors". OSWER Directive 9285.6-03, Washington, DC.
- EPA. 1991b. Guidelines for Developmental Toxicity Risk Assessment; Notice. Federal Register 56(234):63798-63826.
- EPA. 1992. Dermal Exposure Assessment: Principles and Applications, Interim Report. EPA/600/8-91/011B, Office of Research and Development, Washington, DC.
- EPA. 1993. Provisional Guidance for Quantitative Risk Assessment for Polycyclic Aromatic Hydrocarbons. EPA/600/R-93/089, Office of Research and Development, Washington, DC.
- EPA. 1994a. Integrated Risk Information System (IRIS), on-line January 1994. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH.

- EPA. 1994b. Health Effects Assessment Summary Tables, Annual FY-1994. OERR 9200.6-303(91-1), Office of Emergency and Remedial Response, Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH.
- EPA. 1994c. Draft Memorandum, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. Office of Solid Waste and Emergency Response, June 3, 1994, Washington, DC.
- Exceltech. 1991. Limited Environmental Site Assessment of 500 Maitland Drive, Alameda, CA. For Doric Construction, Alameda, CA.
- Food and Drug Administration (FDA). 1990. Memorandum to Elizabeth Campbell, Division of Regulatory Guidance, from the Contaminants Team, Division of Toxicological Review and Evaluation. U.S. Department of Health and Human Services.
- Hawley, J.K. 1985. Assessment of Health Risk from Exposure to Contaminated Soil. *Risk Anal.* 5:289-302.
- Healy, J.W. 1980. Review of resuspension models. Transuranic Elements in the Environment, DOE-TIC-22800, National Technical Information Center, Springfield, VA.
- Kaltreider, M. 1994. Personal communication, Misty Kaltreider, ACC Environmental Consulting, Alameda, CA.
- Kleinfelder, Inc.. 1990. Phase I Environmental Assessment Report, Island City Gun Club, 500 Maitland Drive, Alameda, CA. Prepared for Harbor Bay Isle Associates.
- Land, C.E.. 1971. Confidence intervals for linear functions of the normal mean and variance. *Ann. Math. Stat.* 42:1187-1205.
- Land, C.E.. 1975. Tables of confidence limits for linear functions of the normal mean and variance. In: *Selected tables in mathematical statistics, volume III*, American Mathematical Society, Providence, RI. pp. 385-419.
- Leggett, R.W. 1993. An age-specific kinetic model of lead metabolism in humans. *Environ. Health Perspect.* 101(7):599-615.
- Metropolitan Transportation Commission Association (MTCA). 1994. Personal communication with reference librarian, June 28, 1994, Oakland, CA.
- Nuclear Regulatory Commission (NRC). 1986. Update, Part 61 Impact Analysis Methodology. NUREG, CR-4370, vol I and II, Washington, DC.

- O'Flaherty, E.J. 1993. Physiologically based models for bone-seeking elements. IV. Kinetics of lead disposition in humans. *Toxicol. Appl. Pharmacol.* 118(1):16-29.
- Rabinowitz, M.B., G.W Wetherill and J.D. Kopple. 1974. Studies of Human Lead Metabolism by Use of Stable Isotope Tracers. *Environ. Health Perspect.* 7:145-153.
- Rabinowitz, M.B., G.W Wetherill and J.D. Kopple. 1976. Kinetic Analysis of Lead Metabolism in Healthy Humans. *J. Clin. Invest.* 58:238-248.
- Rabinowitz, M.B., J.D. Kopple and G.W Wetherill. 1980. Effect of Food Intake and Fasting on Gastrointestinal Lead Absorption in Humans. *Am.J.Clin. Nutr.* 33:1784-1788.
- RESNA. 1993. Letter Report Regarding Investigation for Further Delineation of Lead-bearing Soil at Former Island Gun Club, 500 Maitland Drive, Alameda, CA.
- RESNA. 1992. Phase II Soil and Groundwater Investigation for Harbor Bay Isle Associates, 500 Maitland Drive, Alameda, CA.
- Sedman, R.M. 1989. The Development of Applied Action Levels of Soil Contact: A Scenario for the Exposure of Humans to Soil in a Residential Setting. *Environ. Health Perspec.* 79:291-313.
- Washington Department of Ecology. 1992. MTCASat, a statistical software package. Toxics Cleanup Program, Olympia, WA.
- Wester, R.C., H.I. Maiback, D.A.W. Bucks, L. Sedjk, J. Melendres, C.Ciao, and S. Dizio. 1990. Percutaneous Absorption of [¹⁴C]DDT and [¹⁴C]Benzo(a)pyrene from Soil. *Fund. and Applied Tox.* 15:510-516.

APPENDIX A

Available Data

Appendix A Table A-1
Near Surface Soil Data

Date of collectio	Sample No.	Depth (ft)	Lead		Copper		Acenaphthene (mg/kg)	Anthracene (mg/kg)	Benzo(a)anthracene (mg/kg)	Benzo(b)fluoranthene (mg/kg)	Benzo(k)fluoranthene (mg/kg)	Benzo(g,h,i)perylene (mg/kg)	Benzo(a)pyrene (mg/kg)	Chrysene (mg/kg)	Dibenz(a,h)anthracene (mg/kg)	Dibenzofuran (mg/kg)	Indeno(1,2,3-c,d)pyrene (mg/kg)	2-Methylnaphthalene (mg/kg)
			TTLc (mg/kg)	STLc (mg/L)	TTLc (mg/kg)	STLc (mg/L)												
2/90	S-43181	6"	33.00	--	33.00	--												
2/90	S-43182	6"	15000.00	--	170.00	--												
2/90	S-43183	6"	88000.00	--	10000.00	--												
2/90	S-43184	6"	150.00	--	21.00	--												
2/90	S-43185	6"	98.00	--	8.00	--												
2/90	S-43186	6"	37.00	--	10.00	--												
9/92	3	0-1	39.00	1.20	24.00	0.37												
9/92	7	0-1	42.00	1.20	78.00	1.30												
9/92	9	0-1	480.00	2.70	90.00	1.90												
9/92	18	0-1	23.00	1.70	9.80	0.32												
9/92	19	0-1	82.00	1.80	35.00	0.57												
9/92	22	0-1	170.00	37.00	20.00	0.26	2.4E+01	1.6E+01	1.4E+02			1.8E+02	1.4E+02	1.1E+02	1.5E+02	2.2E+00	2.0E+02	
9/92	24	0-1	210.00	19.00	18.00	0.08	3.3E+04	1.6E+01	1.6E+02	3.8E+02	2.2E+05	2.0E+02	4.1E+02	1.4E+02	2.1E+02	2.2E+00	2.0E+02	
9/92	27	0-1	150.00	9.30	45.00	0.50												
9/92	28	0-1	40000.00	210.00	19.00	0.68												
9/92	34	0-1	70.00	2.40	120.00	18.00	1.3E+00		9.1E+01	1.3E+01	6.2E+00	1.1E+01	1.6E+01	8.3E+00	9.7E+00		1.2E+01	
9/92	38	0-1	120.00	10.00	22.00	0.75	2.8E+01	2.6E+01	2.6E+02	2.0E+02	1.5E+05	1.2E+02		1.2E+02	1.5E+02	1.7E+00	1.5E+02	1.8E+00
9/92	43	0-1	340.00	7.90	34.00	1.10			2.7E-01	3.7E-01								
9/92	48	0-1	9.90	0.33	8.10	0.35												
9/92	54	0-1	32.00	0.98	18.00	0.54				1.2E-01								
9/92	61	0-1	230.00	13.00	23.00	1.50			3.0E-01	3.7E-01			1.2E-01	2.7E-01		1.5E-01		
12/92	1	0-1	610.00	52.00														
12/92	2	0-1	65.00	2.00														
12/92	3	0-1	130.00	4.80														
12/92	4	0-1	91000.00	5.40														
12/92	5	0-1																
12/92	6	0-1																
12/92	7	0-1	490.00	29.00														
12/92	8	0-1	500.00	15.00														
12/92	9	0-1	150.00	7.60														
12/92	10	0-1	190.00	7.10														
12/92	11	0-1	28.00	0.40														
9/92	CP	NA					2.2E+08	1.0E+05	1.3E+08	2.2E+08	9.8E+05	3.8E+05	2.7E+08	1.3E+08	1.5E+08		3.2E+05	

B = background soil location
CP = clay pigeon sample
NA = not applicable

Appendix A Table A-1
Near Surface Soil Data

Date of collectio	Sample No.	Depth (ft)	Naphthalene (mg/kg)	Phenanthrene (mg/kg)	Pyrene (mg/kg)	N-Nitrosodi-phenylamine (mg/kg)
2/90	S-43181	6"				
2/90	S-43182	6"				
2/90	S-43183	6"				
2/90	S-43184	6"				
2/90	S-43185	6"				
2/90	S-43186	6"				
9/92	3	0-1				
9/92	7	0-1				
9/92	8	0-1				
9/92	18	0-1				
9/92	19	0-1				
9/92	22	0-1	7.2E+00	4.7E+01		
9/92	24	0-1	8.9E+00	4.9E+01	1.2E+02	
9/92	27	0-1				
9/92	28	0-1				
9/92	34	0-1		2.0E+00	9.8E+00	
9/92	38	0-1	1.4E+01	7.2E+01	7.6E+01	
9/92	43	0-1				5.6E-01
9/92	48	0-1				
9/92	54	0-1				
9/92	61	0-1		3.2E-01		
12/92	1	0-1				
12/92	2	0-1				
12/92	3	0-1				
12/92	4	0-1				
12/92	5	0-1				
12/92	6	0-1				
12/92	7	0-1				
12/92	8	0-1				
12/92	9	0-1				
12/92	10	0-1				
12/92	11	0-1				
9/92	CP	NA	9.5E+04	3.7E+05	1.5E+08	

B = background soil location
CP = clay pigeon sample
NA = not applicable

Appendix A Table A-2
Subsurface Soil Data

Date of Collection	Sample No.	Depth (ft)	Lead		Copper		Benzo(a)anthracene (mg/kg)	Benzo(b)fluoranthene (mg/kg)	Benzo(k)fluoranthene (mg/kg)	Benzo(g,h,i)perylene (mg/kg)	Benzo(a)pyrene (mg/kg)	Chrysene (mg/kg)	Pyrene (mg/kg)
			TTLIC (mg/kg)	STLC (mg/L)	TTLIC (mg/kg)	STLC (mg/L)							
9/92	MW-1-1	3 1/2	<5.0	<0.1	31	0.79							
9/92	MW-1-2	5 1/2	<5.0	<0.1	3.4	0.51							
9/92	MW-2-1	3 1/2	<5.0	<0.1	58	0.71							
9/92	MW-2-2	5	<5.0	<0.1	3.1	0.057							
9/92	MW-3-2	2 1/2	15	0.29	50	0.57							
9/92	MW-3-2	5	290	13	19	0.58	2.6	3	1.3	2.8	3.7	2.1	2.5
9/92	MW-3-3	7	<5.0	<0.1	8.8	0.57							
5/94	MW-4-1	3 1/2	<5.0	<0.1	2.1	0.37							
5/94	MW-4-2	6	5.2	<0.1	4.5	0.61							
5/94	MW-4-3	9	<5.0	<0.1	6.4	0.3							
5/94	MW-5-1	4	5.4	0.12	23	0.38							
5/94	MW-5-2	6 1/2	<5.0	<0.1	27	0.71							
5/94	MW-5-3	9	<5.0	<0.1	15	0.55							

A "<" sign indicates the value reported is the detection limit.

**Appendix A Table A-3
Groundwater Data**

Date of Collection	Sample No.	Well Elevation (MSL)	Depth to Water (ft)	Groundwater Elevation (MSL)	Lead		Copper		Pyrene (mg/L)	TDS (mg/L)
					TTLc (mg/L)	STLC (mg/L)	TTLc (mg/L)	STLC (mg/L)		
9/92	MW-1	5.05	5 1/6	-0.13	0.013	<0.005	0.027	<0.01		2200
10/92			5 3/8	-0.33	<0.005	<0.005	0.028	0.022		2200
11/92			3 1/4	1.88	<0.01	<0.01	<0.01	<0.01		NR
12/92			3 1/2	1.55	NR	NR	NR	NR		1200
5/94			2 3/5	2.46	0.017	0.018	<0.01	<0.01		NR
9/92	MW-2	5.6	5 1/2	0.08	0.036	<0.005	0.12	0.016		4800
10/92			5 5/7	-0.12	0.0061	<0.005	0.0038	0.033		4800
11/92			4	1.5	<0.01	<0.01	<0.01	<0.01		NR
12/92			3 4/9	2.15	NR	NR	NR	NR		4100
5/94			4 1/6	1.43	<0.005	<0.005	<0.01	0.023		NR
9/92	MW-3	4.76	4 2/9	0.53	0.087	<0.005	0.31	<0.01		3000
10/92			4 2/5	0.36	<0.005	<0.005	0.033	0.027		1600
11/92			3 1/6	1.59	0.034	<0.01	0.01	0.056		NR
12/92			3	1.76	NR	NR	NR	NR		1400
5/94			2 3/4	2.01	0.082	0.083	0.043	0.03		NR
5/94	MW-4	2.87	2 1/8	0.74	<0.005	<0.005	<0.01	0.02		NR
5/94	MW-5	3.47	2	1.47	0.034	0.019	0.024	0.027	2.0E-02	NR
9/92	MW-12-ASD	-	-	-	0.02	<0.005	0.023	<0.01		400

A "<" sign indicates the value reported is the detection limit.

NR = Analysis not requested

MSL = Mean sea level

MW-12-ASD = offsite well

TDS = total dissolved solids

APPENDIX B

Well Survey

WELL INVENTORY LIST

WELL #	WELL OWNER	WELL ADDRESS	INSTALL DATE	TOTAL DEPTH	WELL USE	DIAM	DEPTH TO H2O
2S/3W 19F 1	BAY-FARM ISLAND SCHOOL	MAITLAND DR, ALA.	-	-	GEO	-	-
2S/3W 19F 2	ALAMEDA GOLF COURSE	MAITLAND & GOLF COURSE, ALA.	5/89	-	ABN	12	60
2S/3W 19H 9	WASTE MANAGEMENT OF N. AM	HARBOR BAY & DOOLITTLE DR, ALA.	10/89	15	MON	4	5
2S/3W 19H10	WASTE MANAGEMENT OF N. AM	HARBOR BAY & DOOLITTLE DR, ALA.	10/89	15	MON	4	4
2S/3W 19H11	WASTE MANAGEMENT OF N. AM	HARBOR BAY & DOOLITTLE DR, ALA.	10/89	12	MON	4	5
2S/3W 19H12	WASTE MANAGEMENT OF N. AM	HARBOR BAY & DOOLITTLE DR, ALA.	10/89	12	MON	4	3
2S/3W 19K 1	CITY OF ALAMEDA	MAITLAND & DOOLITTLE DR.	7/66	619	IRR	14	-
2S/3W 19K 2	ALAMEDA GOLF COURSE MW-1	1 MEMORIAL DR.	-	10	MON	2	-
2S/3W 19K 3	ALAMEDA GOLF COURSE MW-2	1 MEMORIAL DR.	-	10	MON	2	-
2S/3W 19K 4	ALAMEDA GOLF COURSE MW-3	1 MEMORIAL DR.	-	10	MON	2	-
2S/3W 19M 1	BAY FARM ISLAND	MAITLAND DR.	-	-	GEO*	-	-
2S/3W 19N 1	BAY FARM ISLAND	1 ISLAND DR.	-	744	IRR	14	-
2S/3W 19N 2	HARBOR BAY ISLE	SAN. SEWER-BAY FARM	5/75	-	GEO*	-	-
2S/3W 19N 3	BEDFORD PROPERTIES NW-1	3255 MCCARTNEY RD, ALA.	12/91	16	MON	2	7
2S/3W 19N 4	BEDFORD PROPERTIES MW-2	3255 MCCARTNEY RD, ALA.	12/91	16	MON	2	6
2S/3W 19N 5	BEDFORD PROPERTIES NW-3	3255 MCCARTNEY RD, ALA.	12/91	16	MON	2	7
2S/3W 19Q 3	CITY OF ALAMEDA (GOLF COURSE)	CLUBHOUSE ROAD, ALA.	6/86	14	MON	2	4
2S/3W 30A 1	ALAMEDA MUNICIPAL GOLF	GOLF COURSE BAY FARM ISLAND, AL	7/89	498	IRR	12	-

Well Inventory Definitions and Abbreviations

- Well #** Wells are numbered according to their location in the rectangular system of the Public Land Survey. The part of the number preceding the slash indicates the township; the part following the slash indicates the range and section number; the letter following the section number indicates the 40-acre subdivision; and the final digit is a serial number for wells in each 40-acre subdivision. Wells without a number are not listed registered with the Alameda County Public Works Agency.
- Total Depth** The depth of the well usually designates the complete well depth.
- Depth to H2O** Depth to water usually indicated the standing groundwater level in the well on the date of completion.
- Well Use** The well use as indicated the well driller's report is the reason for the excavation.
- GEO** Geotechnical boring - A temporary boring made to determine certain engineering properties of soils. An asterisk (*) indicates that the state well number assigned to the boring represents more than one boring at a particular site.
- ABN** Abandoned well - A well whose use has been permanently discontinued or which is in such a state of disrepair that no water can be produced. In the inventory, this may include wells which are covered or capped but not properly destroyed.
- MON** Monitoring or observation well
- IRR** Irrigation well - A water well used to supply water only for irrigation or other agricultural purposes.
- TES** Test well and test hole - A test well is constructed for the purpose of obtaining the information needed to design a well prior to its construction.

APPENDIX C

Chemical Intake

Appendix C Table C-1
Short-term Construction Worker Scenario
Ingestion of Soil

Constituent	Near Surface Soil Concentration (mg/kg)	Chronic Daily Chemical Intake (mg/kg-day)	Lifetime Daily Chemical Intake (mg/kg-day)
Inorganics			
Copper	65.4	2.56E-06	3.66E-08
Lead	331.7	1.30E-05	1.85E-07
PNAs			
Acenaphthene	33	1.29E-06	1.85E-08
Anthracene	26	1.02E-06	1.45E-08
Benzo(a)anthracene	260	1.02E-05	1.45E-07
Benzo(b)fluoranthene	380	1.49E-05	2.12E-07
Benzo(k)fluoranthene	220	8.61E-06	1.23E-07
Benzo(g,h,i)perylene	200	7.83E-06	1.12E-07
Benzo(a)pyrene	410	1.60E-05	2.29E-07
Chrysene	140	5.48E-06	7.83E-08
Dibenzo(a,h)anthracene	210	8.22E-06	1.17E-07
Dibenzofuran	2.2	8.61E-08	1.23E-09
Indeno(1,2,3-c,d)pyrene	20	7.83E-07	1.12E-08
Naphthalene	14	5.48E-07	7.83E-09
Phenanthrene	72	2.82E-06	4.03E-08
Pyrene	120	4.70E-06	6.71E-08

Media Intake Factor ^a	
CDI	3.91E-02 mg/kg-d
LDI	5.59E-04 mg/kg-d

^a From Table 3-4

Appendix C Table C-2
Short-term Construction Worker Scenario
Ingestion of Soil - Hot Spot Concentrations

Constituent	Hot Spot Near Surface Soil Concentration (mg/kg)	Chronic Daily Chemical Intake (mg/kg-day)	Lifetime Daily Chemical Intake (mg/kg-day)
Inorganics			
Copper	10000	1.96E-05	2.80E-07
Lead	91000	1.78E-04	2.54E-06

Media Intake Factor ^a	
CDI	1.96E-03 mg/kg-d
LDI	2.80E-05 mg/kg-d

^a From Table 3-4

**Short-term Construction Worker Scenario
Inhalation of Dust - Site Wide Concentrations**

Constituent	Estimated Onsite Air Concentration (mg/m ³)	Chronic Daily Chemical Intake (mg/kg-day)	Lifetime Daily Chemical Intake (mg/kg-day)
Inorganics			
Copper	3.3E-05	5.12E-07	7.31E-09
Lead	1.7E-04	2.60E-06	3.71E-08
PNA:			
Acenaphthene	1.7E-05	2.58E-07	3.69E-09
Anthracene	1.3E-05	2.04E-07	2.91E-09
Benzo(a)anthracene	1.3E-04	2.04E-06	2.91E-08
Benzob)fluoranthene	1.9E-04	2.97E-06	4.25E-08
Benzo(k)fluoranthene	1.1E-04	1.72E-06	2.46E-08
Benzo(g,h,i)perylene	1.0E-04	1.57E-06	2.24E-08
Benzo(a)pyrene	2.1E-04	3.21E-06	4.58E-08
Chrysene	7.0E-05	1.10E-06	1.57E-08
Dibenzo(a,h)anthracene	1.1E-04	1.64E-06	2.35E-08
Dibenzofuran	1.1E-06	1.72E-08	2.46E-10
Indeno(1,2,3-c,d)pyrene	1.0E-05	1.57E-07	2.24E-09
Naphthalene	7.0E-06	1.10E-07	1.57E-09
Phenanthrene	3.6E-05	5.64E-07	8.05E-09
Pyrene	6.0E-05	9.39E-07	1.34E-08

Media Intake Factor ^a		
CDI	1.57E-02	(m ³ /kg-day)
LDI	2.24E-04	(m ³ /kg-day)

^a From Table 3-4

**Short-term Construction Worker Scenario
Inhalation of Dust - Hot Spot Concentrations**

Constituent	Estimated Hot Spot Dust Concentration (mg/m ³)	Chronic Daily Chemical Intake (mg/kg-day)	Lifetime Daily Chemical Intake (mg/kg-day)
Inorganics			
Copper	5.0E-03	3.91E-06	5.59E-08
Lead	4.6E-02	3.56E-05	5.09E-07

Media Intake Factor ^a		
CDI	7.83E-04	(m ³ /kg-day)
LDI	1.12E-05	(m ³ /kg-day)

^a From Table 3-4

Appendix C Table C-5
Long-term Storage Facility Worker
Inhalation of Dust Emitted from Cracks in the Asphalt

Constituent	Estimated Onsite Air Concentration (mg/m ³)	Chronic Daily Chemical Intake (mg/kg-day)	Lifetime Daily Chemical Intake (mg/kg-day)
Inorganics			
Copper	3.3E-06	4.80E-07	1.71E-07
Lead	1.7E-05	2.43E-06	8.69E-07
PNAs			
Acenaphthene	1.7E-06	2.42E-07	8.65E-08
Anthracene	1.3E-06	1.91E-07	6.81E-08
Benzo(a)anthracene	1.3E-05	1.91E-06	6.81E-07
Benzo(b)fluoranthene	1.9E-05	2.79E-06	9.96E-07
Benzo(k)fluoranthene	1.1E-05	1.61E-06	5.77E-07
Benzo(g,h,i)perylene	1.0E-05	1.47E-06	5.24E-07
Benzo(a)pyrene	2.1E-05	3.01E-06	1.07E-06
Chrysene	7.0E-06	1.03E-06	3.67E-07
Dibenzo(a,h)anthracene	1.1E-05	1.54E-06	5.50E-07
Dibenzofuran	1.1E-07	1.61E-08	5.77E-09
Indeno(1,2,3-c,d)pyrene	1.0E-06	1.47E-07	5.24E-08
Naphthalene	7.0E-07	1.03E-07	3.67E-08
Phenanthrene	3.6E-06	5.28E-07	1.89E-07
Pyrene	6.0E-06	8.81E-07	3.15E-07

Media Intake Factor ^a		
CDI	1.47E-01	(m ³ /kg-day)
LDI	5.24E-02	(m ³ /kg-day)

^a From Table 3-4

APPENDIX D

Toxicity Profiles

Appendix D

Toxicity Profiles

Polynuclear Aromatic Hydrocarbons (PNAs)

Polynuclear aromatic hydrocarbons (PNAs) are a diverse class of compounds consisting of two or more fused aromatic rings. Although the health effects of the individual PNAs are not exactly alike, they are discussed as a group because the PNAs occur together in environmental media at the site and reliable health effects information exists on only a few of the compounds. The following compounds are included in this profile:

- Acenaphthene
- Anthracene
- Benzo(a)anthracene *
- Benzo(a)pyrene *
- Benzo(g,h,i)perylene *
- Benzo(b)fluoranthene *
- Benzo(k)fluoranthene *
- Chrysene *
- Dibenzo(a,h)anthracene *
- Indeno(1,2,3-c,d)pyrene *
- Naphthalene
- Phenanthrene
- Pyrene

For practical purposes, the PNAs are often separated into two categories, carcinogenic and noncarcinogenic. Carcinogenic PNAs are identified by an asterisk (*) in the above list (EPA, 1993). This is somewhat arbitrary, as many of the noncarcinogenic PNAs have been shown to act as promoters or co-carcinogens (ATSDR, 1989a).

Non-cancer adverse health effects have been observed in animals. PNAs affect proliferating tissues such as bone marrow, lymphoid organs, gonads and intestinal epithelium. Major target organs appear to be the hematopoietic and lymphoid systems in animals. The major noncancer effects in humans appear to be adverse hematological and dermal effects. Adverse dermatological effects such as destruction of sebaceous glands, skin ulceration, hyperkeratosis and alterations in growth of epidermal cells have been noted following dermal exposure. This follows the premise that PNA compounds affect

proliferating tissue as the skin undergoes rapid cell turnover. Anthracene has been associated with gastrointestinal toxicity in humans. Several other PNAs have been shown to alter enzyme activity in the intestinal mucosa, which could lead to adverse gastrointestinal effects.

Benzo(a)pyrene has been shown to produce developmental effects in animals. Other PNAs such as dibenzo(a,h)anthracene and chrysene have also been tested and resulted in developmental effects. Benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-c,d)pyrene are all genotoxic. The PNAs classified as carcinogenic have been shown to induce cancer in animals. The site of tumor induction is generally the point of first contact: stomach tumor following ingestion, lung tumors following inhalation and skin tumors from dermal contact. Evidence exists from occupational studies that specific PNAs are carcinogenic in humans (ATSDR, 1989a).

Copper

Little information of copper toxicity through ingestion is available. The only significant example of copper toxicity in humans is the onset of Wilson's disease, an autosomal recessive disorder that affects normal copper homeostasis. The system manifestation of Wilson's disease are hepatic and renal lesions and hemolytic anemia (ATSDR, 1989b). Oral exposures can result in gastrointestinal distress, hepatic and immunological effects. The dose required for effects is not known. Inadequate evidence of carcinogenicity or teratogenicity have been found for ingested copper (EPA, 1994).

Lead

Ingestion is the most significant route of lead uptake by humans. Gastrointestinal absorption varies with age, diet, and nutritional status as well as the chemical species. Absorption in adults is estimated as ranging from 7 to 15 percent, and in children from 40 to 50 percent. Fasting increases the amount of lead absorbed by a factor of three to five.

Bones and teeth account for about 95 percent of the total lead burden in adults. The remaining absorbed lead is distributed in soft tissue, primarily the blood, liver and kidneys. Elimination of lead in soft tissues occurs in a matter of weeks. Elimination half-times in blood of adults range from 15 to 35 days; however, following a decrease in uptake, lead in

bone slowly redistributes to blood. Bone can provide a store for continuous release of lead to soft tissues when uptake decreases. Metabolic stresses may accelerate the release of lead from bone.

Young children with blood lead levels of between 5 and 50 ug/deciliter (dl) show signs of impaired heme synthesis, altered nervous system activity, impaired growth, impaired mental development and impaired vitamin D metabolism. EPA concluded that 10 ug/dl was an appropriate level of concern for health effects (EPA, 1989). Lead can also affect the immune system and produce gingival lead lines. Epidemiological studies have indicated that chronic lead exposure may be associated with increased blood pressure in adult males.

Over a dozen epidemiological studies on lead exposure and cancer were reviewed by EPA (EPA, 1989). Long-term animal studies suggest strong evidence of carcinogenicity. These studies formed the basis for the classification of lead as a B2 carcinogen. Induction of kidney tumors is the primary result of the animal studies. Several nonpositive animal studies were found, although they were found to be of a duration too short for a cancer study or were conducted at doses well below the maximum tolerated dose and no tumor response would be expected. Ingestion studies found lead induced tumors at exposure levels well below the maximum tolerated dose, suggesting lead may act to induce cancer at a variety of sites at levels lower than those that cause kidney tumors (EPA, 1989).

The potency of different chemical forms of lead may vary due to absorption factors as well as other bioavailability and pharmacokinetic considerations. A potency estimate for lead has not been developed due to the difficulties in selecting an appropriate measure of dose. Factors such as nutrition and age must be taken into consideration for a potency estimate to be representative of the population. A pharmacokinetic model that estimates age-specific blood lead levels associated with levels of continuous exposure to lead sources is the methodology to use to estimate the impact of lead on health.