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HUMAN HEALTH RISK ASSESSMENT REPORT
SWMU 14 – FIRE TRAINING PIT AREA

NAVAL STATION ROOSEVELT ROADS
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CEIBA, PUERTO RICO

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TABLE OF CONTENTS

Page

LIST OF ACRONYMS AND ABBREVIATIONS iv

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1-1
1.1 Site History 1-1
1.2 Report Organization 1-2

2.0 BASELINE HUMAN HEALTH RISK ASSESSMENT 2-1
2.1 Hazard Identification 2-2
2.2 Dose Response Assessment 2-3
2.2.1 Noncarcinogenic Dose Response Assessment 2-4
2.2.2 Carcinogenic Dose –Response Assessment 2-4
2.3 Exposure Assessment 2-5
2.3.1 Conceptual Site Exposure Model 2-5
2.3.2 Exposure Parameters 2-6
2.3.3 Quantification of Exposure 2-9
2.4 Risk Characterization 2-11
2.4.1 Quantification and Characterization of Carcinogenic Risks 2-11
2.4.2 Quantification and Characterization of Noncarcinogenic Risks 2-12
2.4.3 Results of Risk Characterization 2-12
2.4.4 Uncertainty Analysis 2-13

3.0 CONCLUSIONS AND RECOMMENDATIONS 3-1

4.0 REFERENCES 4-1

TABLES

2-1 Comparing the Maximum Concentrations of Chemicals Detected in Surface Soil to Region III Risk Based Concentrations
2-2 Carcinogenic Toxicity Values
2-3 Potential Future and Current Exposures to Surface Soil
2-4 Exposure Parameters for Human Health Risk Assessment
2-5 Shapiro Wilkes Test Results and Identification of the Exposure point Concentration
2-6 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indicies (HIs) for Future Military Adult and Military Young Child Residents
2-7 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indicies (HIs) for Future Construction Workers
2-8 Incremental Lifetime Cancer Risks (ILCRs) and Hazard Indicies (HIs) Current Adult and Adolescent Trespassers
2-9 Incremental Lifetime Cancer Risks (ILCRs) and (HIs) for Current Commercial/Utility Workers

FIGURES

2-1 Sampling Locations – SWMU 14 Fire Training Pit Area
2-2 Exposure Pathways to Surface Soil

APPENDICIES

A RCRA Facility Investigation Data (Baker 1996).
B HHRA Risk Calculations

LIST OF ACRONYMS AND ABBREVIATIONS

AF	Adherence Factor
AT	Averaging Time
ATSDR	Agency for Toxic Substances and Disease Registry
BW	Body Weight
CDI	Chronic Daily Intake
COPC	Chemical of Potential Concern
CsF	Cancer Slope Factor
DAD	Dermal Absorbed Dose
DAF	Dermal Absorption Factor
ED	Exposure Duration
EF	Exposure Frequency
EFH	Exposure Factor Handbook
EPC	Exposure Point Concentrations
ET	Exposure Time
HEAST	Health Effects Assessment Summary Tables
HHRAP	Human Health Risk Assessment Protocol
HHRP	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
ICR	Increased Cancer Risk
IR	Ingestion Rate
IRH	Inhalation Rate
IRIS	Integrated Risk Information System
Kp	Dermal Permeability
MET	Meteorological Factor
NCEA	National Center for Exposure Assessment
NSRR	Navy Station Roosevelt Roads
PEF	Particulate Emission Factor
RBC	Region III Risk Based Concentration
RfD	Reference Dose
SA	Surface Area
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
VF	Volatilization Factor
WOE	Weight of Evidence

EXECUTIVE SUMMARY

Introduction

This Baseline Human Health Risk Assessment (HHRA) was designed for SWMU 14 located at Naval Station Roosevelt Roads (NSRR), Cieba, Puerto Rico. The objective of this HHRA is to assess the human health risks associated with exposures to surface soil contamination. Surface soil contamination was identified in the RCRA Facility Investigation Report, for Phase I Investigations at Operable Units 1, 6, and 7, prepared by Baker Environmental, Inc. (Baker, 1996), for the Atlantic Division (LANTDIV), Naval Facilities Engineering Command. The project was performed under Contract Task Order (CTO) 277 under the LANTDIV Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract Number N62470-89-D-4814.

This baseline human health risk assessment (HHRA) is being performed to evaluate constituents detected in surface soil samples collected during the Phase I RFI in 1996. During the development of the No Further Action Required documentation for SWMU 14 it was determined that the EPA approved original RFI document (Baker, 1996) contained omissions associated with the SWMU 14 data set. A HHRA was not performed in the original RFI since it was believed that none of the constituents analyzed for were detected in the surface soil samples obtained from SWMU 14. Therefore, this document presents the data set from the 1996 RFI investigation and the corresponding HHRA associated with this data set. This document will assist in the determination of whether or not further action is required for SWMU 14.

Site History

The Air Operations Department from the early 1960s through 1983 operated SWMU 14, the Fire Training Pit Area (approximately 40 feet in diameter). An estimated 120,000 gallons of waste solvents, fuels, oils were burned during fire training exercises. Additional items burned in this area-included wood, trash, plastic, fuel filter elements, oily rags and other debris.

The fires were extinguished using aqueous film-forming foam (AFFF) and potassium bicarbonate (Purple K). Aerial photographs indicated drainage from the pit to the ditch located along the adjacent runway shoulder. A new fire-training pit was built at the same location as the old pit in 1983; operations continue in this pit.

The new pit is a concrete structure, constructed below grade, with a concrete apron. A drainage system encircling the apron intercepts any overtopping which is directed to an oil/water separator.

Data Collection

A limited soil gas survey was conducted along the immediate perimeter of the Fire Training Pit. A total of 50 sampling nodes spaced along two concentric rings around the pit. The first ring was established three feet from the edge of the concrete apron while the second ring was established at a distance of 10 feet. Each ring contained 25 sampling notes (Baker 1996).

Each sampling node (generated by driving a metal pin one to two feet into the ground) was screened by inserting the tip of the photoionization detector (PID) and recording the results in a field log book. A total of five surface soil samples were collected at the locations which exhibited the highest PID reading which ranged from 21.14 parts per million (ppm) to 79.2 ppm. The five surface soil samples (14SS01 through 14SS05) were analyzed for VOCs, SVOCs, PCBs, and TPH (gas and diesel fractions (Baker 1996). Results of these analyses are located in Appendix A of this HHRA. Fourteen SVOCs, Aroclor-1260, diesel and gasoline were detected in surface soil.

Baseline Human Health Risk Assessment

This HHRA was conducted in accordance with United States Environmental Protection Agency (EPA) Regulations and is consistent with the following risk assessment guidance documents:

- Risk Assessment Guidance for Superfund (RAGS) Volume I Human Health Evaluation Manual Part A. USEPA1989.
- RAGS for Superfund Volume I Human Health Evaluation Manual Part B. USEPA 1991a.
- Supplemental Guidance to RAGS Standard Default Exposure Factors OSWER Directive 9285.6-03. USEPA 1991b.
- Dermal Exposure Guidance Document. USEPA 1992a.
- Supplemental Guidance to RAGS: Calculating the Concentration Term. USEPA 1992b.
- Exposure Factors Handbook Volume 1 and II. USEPA 1997a.
- Assessing Dermal Exposures to Soil. USEPA 1995b.

- Region III Risk Based Concentrations (RBC). USEPA 1999a.
- Integrated Risk Information System. USEPA 1999b.

This HHRA is organized in the following manner (National Academy of Sciences National Research Council, 1983):

Hazard Identification - This section provides a summary of the analytical data for surface soil, and identifies Chemicals of Potential Concern (COPC).

Dose-Response Assessment - In this section reference doses, and slope factors for each COPC are presented, and methods for assessing cancer and noncancer dose-response relationships are discussed.

Exposure Assessment - This section identifies potentially exposed populations, exposure pathways, and exposure parameters used for estimating site-specific risk.

Risk Characterization - This section presents the estimated risks for each scenario, and provides a qualitative uncertainty analysis.

Results of Risk Characterization

The carcinogenic risk for future military adult residents was 2.1×10^{-6} for ingestion of surface soil, 4.2×10^{-7} for dermal contact with surface soil, and 2.3×10^{-11} for inhalation of particulates as stated in Table 2-6. A total risk across all three pathways was 2.5×10^{-6}, which falls within USEPA acceptable risk range of 1×10^{-4} and 1×10^{-6}.

The carcinogenic risk for future military child residents was 2.0×10^{-5} for ingestion of surface soil, 6.7×10^{-7} for dermal contact with surface soil, and 5.9×10^{-11} for inhalation of particulates as stated in Table 2-6. A total risk across all three pathways was 2.0×10^{-5}, which falls within USEPA acceptable risk range of 1×10^{-4} and 1×10^{-6}.

The carcinogenic risk for future construction worker was 3.3 x 10^{-7} for ingestion of surface soil, 7.5 x 10^{-9} for dermal contact with surface soil, and 2.6 x 10^{-11} for inhalation of particulates as stated in Table 2-7. A total risk across all three pathways was 3.3 x 10^{-7}, which is less than the USEPA acceptable risk range of 1 x 10^{-4} and 1 x 10^{-6}.

The carcinogenic risk for current adult trespasser was 2.4 x 10^{-6} for ingestion of surface soil, 4.7 x 10^{-7} for dermal contact with surface soil, and 2.6 x 10^{-11} for inhalation of particulates as stated in Table 2-8. A total risk across all three pathways was 2.8 x 10^{-6}, which falls within USEPA acceptable risk range of 1 x 10^{-4} and 1 x 10^{-6}.

The carcinogenic risk for current youth trespasser was 1.1 x 10^{-6} for ingestion of surface soil, 1.7 x 10^{-7} for dermal contact with surface soil, and 7.8 x 10^{-12} for inhalation of particulates as stated in Table 2-8. A total risk across all three pathways was 1.3 x 10^{-6}, which falls within USEPA acceptable risk range of 1 x 10^{-4} and 1 x 10^{-6}.

The carcinogenic risk for current/future on-site workers was 8.3 x 10^{-6} for ingestion of surface soil, 1.7 x 10^{-6} for dermal contact with surface soil, and 3.7 x 10^{-10} for inhalation of particulates as stated in Table 2-9. A total risk across all pathways of exposure was 1.0 x 10^{-5}, which falls within USEPA acceptable risk range of 1 x 10^{-4} and 1 x 10^{-6}.

Conclusions and Recommendations

This section summarizes the results of the baseline HHRA and identifies environmental media and COPCs, which could potentially pose human health risks at the SWMU 14. Five surface soil samples were collected at the perimeter of the fire training pit, and were compared to Region III Residential RBC values. The following COPCs were identified.

- benzo(a)anthracene
- benzo(b)fluoranthene
- benzo(a)pyrene
- dibenz(a,h)anthracene
- indeno(1,2,3-c,d)pyrene

An exposure assessment was then conducted to determine human receptors, exposure pathways and exposure assumptions. Current land use scenarios that were evaluated include commercial/utility worker, and trespasser. Future land use scenarios evaluated include commercial/utility worker, trespasser, military resident, and construction worker. Each scenario evaluated the risk associated with ingestion of contaminants in surface soil, inhalation of particulates from surface soil, and dermal contact with surface soil.

The results of the HHRA did not indicate an unacceptable cancer risk for any of the exposure scenarios or pathways (i.e. ingestion, inhalation, dermal). Based on the results of this HHRA it is not likely that the COPCs detected in surface soils at SWMU 14 will pose a significant health risk to current or future receptors. Therefore, no further action is recommended for SWMU 14.

1.0 INTRODUCTION

This Baseline Human Health Risk Assessment (HHRA) was designed for SWMU 14 located at the Naval Station Roosevelt Roads (NSRR), Cieba, Puerto Rico. The objective of this HHRA is to assess the human health risks associated with exposures to surface soil contamination identified in the RCRA Facility Investigation Report for Phase I Investigations at Operable Units 1, 6, and 7 prepared by Baker Environmental, Inc. (Baker) for the Atlantic Division (LANTDIV), Naval Facilities Engineering Command. The project was performed under Contract Task Order (CTO) 277 under the LANTDIV Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract Number N62470-89-D-4814.

This baseline human health risk assessment (HHRA) is being performed to evaluate constituents detected in surface soil samples collected during the Phase I RFI in 1996. During the development of the No Further Action Required documentation for SWMU 14 it was determined that the EPA approved original RFI document (Baker, 1996) contained omissions associated with the SWMU 14 data set. A HHRA was not performed in the original RFI since it was believed that none of the constituents analyzed for were detected in the surface soil samples obtained from SWMU 14. Therefore, this document presents the data set from the 1996 RFI investigation and the corresponding HHRA associated with this data set. This document will assist in the determination of whether or not further action is required for SWMU 14.

1.1 Site History

SWMU 14, the Fire Training Pit Area (approximately 40 feet in diameter) was operated by the Air Operations Department from the early 1960s through 1983. An estimated 120,000 gallons of waste solvents, fuels, oils were burned during fire training exercises. Additional items burned in this area included wood, trash, plastic, fuel filter elements, oily rags and other debris.

The fires were extinguished using aqueous film-forming foam (AFFF) and potassium bicarbonate (Purple K). Aerial photographs indicated drainage from the pit to the ditch located along the adjacent runway shoulder. A new fire training pit was built at the same location as the old pit in 1983; operations continue in this pit.

The new pit is a concrete structure, constructed below grade, with a concrete apron. A drainage system encircling the apron intercepts any overtopping which is directed to an oil/water separator.

1.2 Report Organization

Section 1.0 of this document includes this introduction, SWMU 14 site history, and objectives of this report. Section 2.0 is the Baseline Human Health Risk Assessment (HHRA) which evaluates the human health risk associated with exposures to contaminants in surface soil. The conclusions of the HHRA are presented in Section 3.0. Section 4.0 provides references used in this report.

2.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

This HHRA was conducted in accordance with United States Environmental Protection Agency (EPA) Regulations and is consistent with the following risk assessment guidance documents:

- Risk Assessment Guidance for Superfund (RAGS) Volume I Human Health Evaluation Manual Part A. USEPA1989.
- RAGS for Superfund Volume I Human Health Evaluation Manual Part B. USEPA 1991a.
- Supplemental Guidance to RAGS Standard Default Exposure Factors OSWER Directive 9285.6-03. USEPA 1991b.
- Dermal Exposure Guidance Document. USEPA 1992a.
- Supplemental Guidance to RAGS: Calculating the Concentration Term. USEPA 1992b.
- Exposure Factors Handbook Volume 1 and II. USEPA 1997a.
- Assessing Dermal Exposures to Soil. USEPA 1995b.
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This HHRA is organized in the following manner (National Academy of Sciences National Research Council, 1983):

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Dose-Response Assessment - In this section reference doses, and slope factors for each COPC are presented, and methods for assessing cancer and noncancer dose-response relationships are discussed.

Exposure Assessment - This section identifies potentially exposed populations, exposure pathways, and exposure parameters used for estimating site-specific risk.

Risk Characterization - This section presents the estimated risks for each scenario, and provides a qualitative uncertainty analysis.

2.1 Hazard Identification

This section provides a summary of the analytical data for surface soil that was collected in the RFI investigation, and identifies those chemicals that may pose the most significant risk associated with SWMU 14.

Data Collection

A limited soil gas survey was conducted along the immediate perimeter of the Fire Training Pit. A total of 50 sampling nodes spaced along two concentric rings around the pit. The first ring was established three feet from the edge of the concrete apron while the second ring was established at a distance of 10 feet. Each ring contained 25 sampling nodes (Baker 1996).

Each sampling node (generated by driving a metal pin one to two feet into the ground) was screened by inserting the tip of the photoionization detector (PID) and recording the results in a field log book. A total of five surface soil samples (Figure 2-1) were collected at the locations which exhibited the highest PID reading which ranged from 21.14 parts per million (ppm) to 79.2 ppm. The five surface soil samples (14SS04 through 14SS08) were analyzed for VOCs, SVOCs, PCBs, and TPH (gas and diesel fractions (Baker 1996). Results of these analysis are located in Appendix A of this HHRA. Fourteen SVOCs, Aroclor-1260, diesel and gasoline range organics were detected in surface soil.

COPC Identification

USEPA Region III suggests that; "The baseline risk assessment process can be made more efficient by focusing on dominant contaminants and routes of exposure at the earliest feasible stage. The mechanisms recommended for this are (1) a re-ordering of the process of eliminating contaminants and routes of exposure, and (2) use of a risk-based concentration screen. Appropriately used, this process can dramatically reduce the effort of risk assessment, while not changing the result significantly (USEPA 1993)." Therefore, for this HHRA a risk based concentration screen was used to identify chemicals of potential concern (COPC).

COPCs are those constituents having the greatest potential to affect human health and the environment. They are selected by comparing the maximum constituent concentrations detected in the environmental samples to regulatory criteria. Chemicals exceeding regulatory criteria are retained as COPCs for further evaluation; chemicals detected at concentrations below these

criteria are not evaluated unless other circumstances (frequency of exposure or documented usage) warrant the reinclusion and further evaluation of chemicals selected as COPCs.

For this HHRA, COPCs were identified by comparing the chemicals in surface soil samples to Residential USEPA Region III Risk Based Concentrations (RBCs) (USEPA 1999a). RBCs are derived using conservative USEPA promulgated default values and the most recent toxicological criteria available. RBCs for potentially carcinogenic and noncarcinogenic chemicals are individually derived based on a target incremental lifetime cancer risk (ICR) of 1×10^{-6} and a target hazard quotient (HQ) of 1.0, respectively. For potential carcinogens, the toxicity criteria applicable to the derivation of the RBCs are chronic oral and inhalation cancer slope factors; for noncarcinogens they are oral and inhalation reference doses.

Fourteen SVOCs, Aroclor-1260, total petroleum hydrocarbons, diesel and gasoline range organics were detected in surface soil. The following chemicals exceeded the residential RBCs values, and were therefore retained as COPCs for further analysis:

- benzo(a)anthracene
- benzo(b)fluoranthene
- benzo(a)pyrene
- dibenz(a,h)anthracene
- indeno(1,2,3-c,d)pyrene

Table 2-1 presents the results of this sampling event and the identification of COPCs.

2.2 Dose Response Assessment

In this section the relationship between a dose of a chemical agent and frequency of an adverse effect in an exposed population was characterized. Dose-response information and toxicity criteria were obtained from the Integrated Risk Information System (IRIS) (USEPA, 1999b) and the Health Effects Summary Tables (HEAST) (USEPA 1997b).

2.2.1 Noncarcinogenic Dose Response Assessment

Potential noncarcinogenic health effects associated with exposures to COPCs identified in Section 2.1 are unknown (USPEA, 1999b). Noncarcinogenic effects for these COPCs have not been identified in IRIS or HEAST. Therefore, only the carcinogenic effects associated with exposure to the COPCs identified in Section 2.1 will be addressed in this HHRA.

2.2.2 Carcinogenic Dose –Response Assessment

The potential carcinogenic health effects associated with exposures to carcinogenic COPCs were evaluated using cancer slope factors (CSF) established by USEPA (1999b). The CSF is an estimate of an upper-bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level or dose of a potential carcinogen. The cancer slope factor is expressed as $(mg/kg/day)^{-1}$. CSFs for oral and inhalation pathways have been developed. The CSFs developed by USEPA for the COPCs and the USEPA Weight of Evidence (WOE) Classification for each COPC are presented in Table 2-2 of this HHRA. The WOE classifications are explained below:

Group A	Human Carcinogen (sufficient evidence of carcinogenicity in humans)
Group B1	Probable Human Carcinogen (limited evidence of carcinogenicity in humans)
Group B2	Probable Human Carcinogen (sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
Group C	Possible Human Carcinogen (limited evidence of carcinogenicity in animal or lack of human data)
Group D	Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
Group E	Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies)

According to USEPA guidance (1989), only those chemicals with Group A, B (B1 or B2), or C rankings need to be addressed for possible carcinogenic effects. All COPCs identified in Section 2.1 are considered B2 carcinogens, and were therefore retained for further analysis.

2.3 Exposure Assessment

The Exposure Assessment estimates the magnitude of actual and/or potential human exposure, the frequency and duration of those exposures, and the pathways (i.e., inhalation, ingestion, and dermal contact) by which people are potentially exposed (National Academy of Sciences National Research Council, 1983). In order for an exposure to occur, a complete pathway must exist with the following conditions:

- a source and mechanism of chemical release into the environment
- an environmental transport medium
- a point of potential human contact with the medium; and
- a human exposure route at the contact point.

Presented in Section 2.3.1 and 2.3.2 and Figure 2-2 of this HHRA are the potential exposure pathways and scenarios, and the exposure parameters that will be used to estimate human health risk associated with these pathways.

2.3.1 Conceptual Site Exposure Model

Current and potential future exposure scenarios are summarized in Table 2-3 of this HHRA. Current exposures at SWMU 14 are commercial/utility worker, and trespassers. Due to limited access to Roosevelt Roads, it is unlikely that trespassers would be able to enter the site; regardless it was evaluated. Future exposures on this site may consist of military residents, construction workers, trespassers, and commercial/utility worker.

The current/future potential land use scenarios evaluated adult exposures. In addition a residential child, 1-6 years old, and a youth trespasser between the ages of 7-17 years old was evaluated. Exposure routes (i.e. ingestion, dermal contact, and inhalation) for each exposure scenario are summarized in Table 2-3.

2.3.2 Exposure Parameters

The parameters used to quantify potential chemical uptake from each complete exposure pathway can be found in Table 2-4. Each parameter was chosen from values provided by USEPA in guidance documents (1989, 1991a, 1991b, 1992a, 1995, 1996, 1997a), and peer-reviewed literature (Wester et al., 1990; Kao 1985). The USEPA 1997 Exposure Factors Handbook (EFH) serves as the primary source for the exposure parameters identified in this HHRA.

Exposure Duration

An exposure duration (ED) of 4 years for both the future military residential adult and child was used for this HHRA (Rivera, 1999). The future construction worker ED was 1 year based on professional judgement. The current commercial/utility worker ED was 22 years (USEPA, 1997a). Current/Future trespasser EDs were set at 30 years for adults and 9 years for youth (USEPA, 1991a).

Exposure Frequency

An exposure frequency (EF) of 350 days was used for the future military residential adult and child (USEPA 1991a). 250 days per year was used for the commercial utility worker, and 180 days was used for the construction worker (USEPA, 1991a). An EF of 52 days per year was used for the adult and youth trespasser. This EF assumes that some type of trespassing activity occurs once a week (professional judgement).

Exposure Time

The future construction worker and current commercial/utility worker exposure time (ET) was 8 hours; this is assuming that both will be working outdoors the entire day (professional judgement). The EFH recommends that 2 hours per day be used for time spent outdoors at one's residence, therefore 2 hours per day was used for exposures to surface soil for the future military residential scenario (USEPA 1997a). An ET of 2 hours per day was likewise used for a trespasser. The base is secured and not accessible to trespassers, therefore assuming an ET of 2 hours per day is a conservative assumption.

Averaging Time

An averaging time (AT) of 25,550 days for exposures to carcinogenic chemicals in the environment was used for all scenarios (USEPA, 1989).

Body Weight

The USEPA standard body weight (BW) of 15 kg for children and 70 kg for adults was used in this HHRA (USEPA, 1991a). A body weight of 45 kg was used for the youth trespasser (USEPA, 1997a). This BW represents the mean body weight of both males and females between the ages of 7 and 17 years.

Ingestion Rate

The EFH recommends a soil ingestion rate of 50 mg/day for adults and 100 mg/day for children (USEPA 1997a). The current recommended incidental soil ingestion rate for an adult construction worker is 480 mg/day. It is thought that soil ingestion among adults occurs from hand to mouth contact or ingestion of soil on food. The value of 480 mg/day is based on several qualitative assumptions, including a soil to skin adherence factor of 3.5 mg/cm^2. John Kissel, the University of Washington, estimated more recent quantitative measures of soil to skin adherence values in a study funded by a USEPA grant (USEPA 1997a). The results of this study are presented in the EFH 1997. For a construction worker, a soil adherence factor of 0.43 mg/cm^2 per 8-hour day was reported. Therefore an adjusted soil ingestion rate for a construction worker was derived in the following manner:

$$\frac{480\ mg/day}{3.5\ mg/cm^2} = \frac{137\ cm^2}{day} * 0.43\ mg/cm^2 = 59\ mg/day$$

A soil ingestion rate of 60 mg/day for the construction worker was used.

Dermal Absorption Factor (DAF)

USEPA Region III recommends that the dermal exposure pathway not be evaluated for PAHs (USEPA, 1998). But this approach could underestimate the potential risk associated with the dermal route of exposure. For the purposes of this HHRA the dermal pathway will be evaluated to prevent the underestimation of potential human health risk.

For SVOCs (including PAHs) a DAF of 1.0% was used based on a study conducted by Wester et al 1990. In this study a dose of 10 mg/kg radiolabeled [^{14}C]benzo(a)pyrene in soil was applied to 1 cm^2 human cadaver skin. The soil was aged by at least 30 years and consisted of 26 percent sand, 26 percent clay, and 48 percent silt. Twenty-four hours following the administration of BaP in soil, 1.4 percent was observed in the skin and 0.01 percent was absorbed into the plasma receptor fluid. In the second part of the study acetone solutions were prepared at 10 ppm. After 24 hours, the skin adsorbed 23.7 percent of the [^{14}C]benzo(a)pyrene in acetone, and 0.09 percent in the plasma receptor fluid. The second part of the study indicates that the benzo(a)pyrene is more available for absorption in a solution when compared to benzo(a)pyrene in soil. Thus assuming 100% absorption of SVOCs from soil into the skin would grossly overestimate the risk associated with exposures to these chemicals.

In a similar study, Kao 1985 administered 10 µg of pure [^{14}C]benzo(a)pyrene/cm^2-skin to viable human skin. Twenty-four hours later 3.0 percent of the administered dose was observed in the skin; this is eight times less than the [^{14}C]benzo(a)pyrene applied to the cadaver skin in acetone suggesting that viable skin may limit the dermal absorption of BaP to cadaver skin. Thus it is reasonable to conclude that dermal bioavailability of BaP in soil is less than 1%.

Surface Area (SA)

A SA of 5,000 cm^2 for adult residents, commercial/utility workers, construction workers, and trespassers for contact with soil was used (USEPA 1997a). The EFH does not list body specific SAs for children, only total. Therefore, for military residential children it is assumed that 25% of the total body surface area will be exposured to surface soils. The total body surface area for a male child between the ages of 2-6 years old (50% percentile) is 7,000 cm^2, thus a SA of 1,700 cm^2 was used for children's exposure to surface soil (professional judgement). Similarly, the youth (ages 7-17 years old) trespasser total SA is 12,900 cm^2; 25% is equal to 3,200 cm^2 (USEPA 1997a).

Adherence Factor

The USEPA standard soil adherence factor (AF) of 0.2 mg/cm^2 for both children and adults was used for this HHRA (USEPA 1992a). An AF of 0.43 mg/cm^2 was used for the construction worker (USEPA, 1997b). The 0.43 mg/cm^2 is based on the Kissel et al 1996 work as cited in the EFH (USEPA, 1997a).

Inhalation Rate

An inhalation rate (IR_h) of 1.27 m^3/hr was used for the military adult residents, trespassers, and commercial/utility workers. This value represents long-term inhalation rates for a 12 hour day (USEPA, 1997a). Similarly an IR_h of 0.69 m^3/hr was derived for a child and youth (USEPA 1997a). An IR_h for construction workers assumes an average 4 hours of moderate work per day(1.5 m^3/hr*4 hours) and 4 hours of heavy work per day (2.5m^3/hr*4 hours/day) which is 16m^3/8-hour day or 2 m^3/hr.

Particulate Emission Factor

A particulate emission factor (PEF) of 1.32 x 10^9 was used in this HHRA (USEPA 1996). This value is a default PEF cited in EPA Soil Screening Level Guidance Document, and assumes 50% vegetation and a mean annual wind speed of 4.69 m/s (USEPA 1996).

2.3.3 Quantification of Exposure

Calculating the EPC

Exposure Point Concentrations (EPC) are used to estimate chronic daily intakes (CDIs) and dermally absorbed doses (DADs) for each medium and are representative of the types of potential exposures encountered by each receptor. Exposure can occur discretely or at a number of sampling locations depending on the type of scenario considered for a given receptor. USEPA risk assessment guidance (USEPA, 1989) recommends that an upper bound estimate of the arithmetic mean concentration be used to calculate the EPC. "Because of the uncertainty associated with estimating the true average concentration at a site, the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used for this variable. The 95 percent UCL provides reasonable confidence that the true site average will not be underestimated (USEPA 1992b)".

The EPC was calculated using the USEPA 1992 Calculating the Concentration Term Guidance and was based on its distribution. The Shapiro Wilkes test for samples less than 50 was used to determine if the data is distributed normally or lognormally. Table 2-5 presents the results of this test. Each sample set for each COPC was identified as "lognormal", therefore the appropriate method as provided in the 1992 USEPA Guidance was used to calculate the EPC based on a

lognormal distribution. However, the lognormal 95% UCL was greater than the maximum detected concentration. In cases such as this USEPA recommends using the maximum concentration as an EPC (USEPA, 1992b). Therefore in this HHRA the maximum concentration for each COPC was used as the EPC.

Calculating the CDI

The following equations were derived from USEPA Risk Assessment Guidelines Part A and B (USEPA 1989, USPEA 1995, USEPA 1991b), and were used for this HHRA.

Ingestion of Chemicals in Soil:

CDI= Cs*CF*IR*EF*ED*ET*ABS/BW*AT

CDI	Chronic daily intake (mg/kg/d)
Cs	Concentration of chemical in soil (mg/kg)
CF	Conversion Factor (10^{-6} kg/mg)
IR	Ingestion Rate soil (mg/d)
EF	Exposure Frequency (d/y)
ED	Exposure Duration (y)
ABS	bioavailability (unitless)
BW	Body weight (kg)
AT	Averaging time (d)

Dermal Contact with Chemicals in Soil:

DAD= Cs*CF*SA*AF*EF*ED*ABS/BW*AT

DAD	Dermally Absorbed Dose (mg/kg-d)
Cs	Concentration of chemical in soil (mg/kg)
CF	Conversion Factor (10^{-6} kg/mg)
SA	Skin Surface Area (cm^2/d)
AF	Adherence Factor (mg/cm^2)
EF	Exposure Frequency (d/y)
ED	Exposure Duration (years)
ET	Exposure Time (hr/d)
ABS	bioavailability (unitless)
BW	Body weight (kg)
AT	Averaging time (d)

Inhalation of Particulates:

CDI= Cs*ED*EF*ET*RR/BW*AT*PEF

CDI	Chronic daily intake (mg/kg/d)
Cs	Concentration of chemical in soil (mg/kg)
IR_h	Respiration Rate (m^3/hr)
EF	Exposure Frequency (d/y)
ED	Exposure Duration (y)
ET	Exposure Time (hrs/d)
PEF	Particulate Emission Factor (m^3/kg)
BW	Body weight (kg)
AT	Averaging time (d)

2.4 Risk Characterization

This section provides numerical estimates of human health and environmental risks posed by the presence of the COPCs at SWMU 14.

2.4.1 Quantification and Characterization of Carcinogenic Risks

Quantitative risk calculations for potentially carcinogenic COPCs estimate inferentially (versus probabilistically) the potential ICR for an individual in a specified population. This unit of risk refers to a potential cancer risk that is above the background cancer risk in unexposed individuals. For example, an ICR of 1×10^{-6} indicates that an exposed individual has an increased probability of one in one million of developing cancer subsequent to exposure, over the course of his lifetime. The following equation was used in estimating the ICR:

ICR = Cancer Slope Factor (CSF) X Chronic Daily Intake (CDI)

The CSF is expressed as $(mg/kg/day)^{-1}$ and the chronic daily intake (CDI) is expressed as mg/kg/day. The aforementioned equation was derived assuming that cancer is a non-threshold process and that the potential excess risk level is proportional to the cumulative intake over a lifetime.

For quantitative estimation of risk, it is assumed that cancer risks from various exposure routes are additive. Estimated ICR values will be compared to 1×10^{-6} to 1×10^{-4} which represents the target risk range of ICR values considered by the EPA to represent an acceptable (i.e., de minimus) risk (USEPA, 1990).

2.4.2 Quantification and Characterization of Noncarcinogenic Risks

Potential noncarcinogenic health effects associated with exposures to noncarcinogenic COPCs were not identified in IRIS or HEAST. Therefore only the carcinogenic effects associated with exposure to the COPCs identified in Section 2.0 will be addressed in this HHRA. Calculation of the CDIs, DADs, and carcinogenic risk estimates are presented in Appendix B of this HHRA and are summarized in Tables 2-6 through 2-9.

2.4.3 Results of Risk Characterization

The carcinogenic risk for future military adult residents was 2.1×10^{-6} for ingestion of surface soil, 4.2×10^{-7} for dermal contact with surface soil, and 2.3×10^{-11} for inhalation of particulates as stated in Table 2-6. A total risk across all three pathways was 2.5×10^{-6}, which falls within USEPA acceptable risk range of 1×10^{-4} and 1×10^{-6}.

The carcinogenic risk for future military child residents was 2.0×10^{-5} for ingestion of surface soil, 6.7×10^{-7} for dermal contact with surface soil, and 5.9×10^{-11} for inhalation of particulates as stated in Table 2-6. A total risk across all three pathways was 2.0×10^{-5}, which falls within USEPA acceptable risk range of 1×10^{-4} and 1×10^{-6}.

The carcinogenic risk for future construction worker was 3.3×10^{-7} for ingestion of surface soil, 7.5×10^{-9} for dermal contact with surface soil, and 2.6×10^{-11} for inhalation of particulates as stated in Table 2-7. A total risk across all three pathways was 3.3×10^{-7}, which is less than the USEPA acceptable risk range of 1×10^{-4} and 1×10^{-6}.

The carcinogenic risk for current adult trespasser was 2.4×10^{-6} for ingestion of surface soil, 4.7×10^{-7} for dermal contact with surface soil, and 2.6×10^{-11} for inhalation of particulates as stated in Table 2-8. A total risk across all three pathways was 2.8×10^{-6}, which falls within USEPA acceptable risk range of 1×10^{-4} and 1×10^{-6}.

The carcinogenic risk for current youth trespasser was 1.1×10^{-6} for ingestion of surface soil, 1.7×10^{-7} for dermal contact with surface soil, and 7.8×10^{-12} for inhalation of particulates as stated in Table 2-8. A total risk across all three pathways was 1.3×10^{-6}, which falls within USEPA acceptable risk range of 1×10^{-4} and 1×10^{-6}.

The carcinogenic risk for current/future commercial/utility workers was 8.3 x 10^{-6} for ingestion of surface soil, 1.7 x 10^{-6} for dermal contact with surface soil, and 3.7 x 10^{-10} for inhalation of particulates as stated in Table 2-9. A total risk across all pathways of exposure was 1.0 x 10^{-5}, which falls within USEPA acceptable risk range of 1 x 10^{-4} and 1 x 10^{-6}.

2.4.4 Uncertainty Analysis

Uncertainties are encountered throughout the process of performing a risk assessment. This section discusses the sources of uncertainty inherent in the following elements of the baseline human health risk assessment prepared for SWMUs 14.

- Sampling and analysis
- Selection of COPCs
- Exposure assessment
- Toxicity assessment
- Risk characterization

Uncertainties associated with this baseline RA are discussed in the following paragraphs.

Sampling and Analysis

The development of a risk assessment depends on the reliability of, and uncertainties associated with, the analytical data available to the risk assessor. These, in turn, are dependent on the operating procedures and techniques applied to the collection of environmental samples in the field and their subsequent analyses in the laboratory. To minimize the uncertainties associated with sampling and analysis at SWMU 14, USEPA approved sampling and analytical methods were employed. Data were generated following RCRA methods of analysis for organics and inorganics, and were validated in accordance with USEPA Region II procedures. Samples were taken from locations specified in the USEPA approved Work Plan along with the necessary QA/QC samples.

Analytical data are limited by the precision and accuracy of the methods of analysis which are reflected by the Relative Percent Difference (RPD) of duplicate analyses and the percent recovery of spikes, respectively. In addition, the statistical methods used to compile and analyze the data (mean concentrations, detection frequencies) are subject to the overall uncertainty in data measurement. Furthermore, chemical concentrations in environmental media fluctuate over time

and with respect to sampling location. Analytical data must be sufficient to consider the temporal and spatial characteristics of contamination at the site with respect to exposure.

Selection of COPCs

The selection of COPCs is performed in a risk assessment following the evaluation of data. Analytical data also must be comprehensive in order to address the COPCs associated with SWMU 14. Region III RBC values are based on exposure assumptions and equations that are intended to introduce conservatism in the risk assessment process by changing the COPC screening method from a relative toxicity screen as presented in RAGS, to an absolute comparison of risk. However, the use of the Region III RBC values which incorporate a set of non-site-specific assumptions in the selection of COPCs at SWMU 14, adds conservatism to the baseline HHRA.

Currently, no Station closures are planned for NSRR and future residential development of the land is not expected. The application of the residential COC values to soil and groundwater COPC selections would, therefore, tend to result in a list of COPCs that could be considered conservative for a military base. The use of conservative COPC selections in the baseline HHRA ensures the protection of public health in that the results of the baseline HHRA are incorporated into the determination of remedial alternatives and remedial action objectives in the CMS.

Exposure Assessment

In performing exposure assessments, uncertainties arise from two main sources. First, uncertainties arise in estimating the fate of a compound in the environment, including estimating release and transport in a particular environmental medium. Second, uncertainties arise in the estimation of chemical intakes resulting from contact by a receptor with a particular medium. To estimate an intake, certain assumptions must be made about exposure events, exposure durations, and the corresponding assimilation of constituents by the receptor. Exposure factors have been generated by the scientific community and have undergone review by the USEPA. The USEPA has published an Exposure Factors Handbook (USEPA, 1997a) which contains the best and latest values. Regardless of the validity of these exposure factors, they have been derived from a range of values generated by studies of limited numbers of individuals. In all instances, values used in this risk assessment, scientific judgments, and conservative assumptions agree with those of the USEPA.

Toxicological Assessment

In making quantitative estimates of the toxicity for varying dosages of compounds to human receptors, uncertainties arise from two sources. First, data on human exposure and the subsequent effects are usually insufficient, if they are at all available. Human exposure data usually lack adequate concentration estimations and suffer from inherent temporal variability. Therefore, animal studies are often used, and new uncertainties arise from the process of extrapolating animal results to humans. Second, to obtain observable effects with a manageable number of experimental subjects, high doses of a compound are often used. In this situation, a high dose means that high exposures are used in the experiment with respect to most environmental exposures. Therefore, when applying the results of the animal experiment to the human condition, the effects at the high doses must be extrapolated to approximate effects at lower doses. In extrapolating effects from high doses in animals to low doses in humans, scientific judgment and conservative assumptions are employed. In selecting animal studies for use in dose-response calculations, the following factors are considered:

- Studies are preferred where the animal closely mimics human toxicokinetics.
- Studies are preferred where dose intake most closely mimics the intake route and duration for humans.
- Studies are preferred which demonstrate the most sensitive response to the compound in question.

For compounds believed to cause threshold effects (i.e., noncarcinogens) safety factors are employed in the extrapolation of effects from animals to humans and from high doses to low doses. In deriving carcinogenic potency factors, the 95% UCL value is promulgated by the USEPA to prevent underestimation of potential risk.

Further conservatism in the baseline HHRA is also introduced through the use of experimentally-derived oral absorption efficiencies to account for a difference in the degree of toxicity between an administered dose and an absorbed dose. Equating the absorption efficiency of the dermal bi-phasic barrier to the absorption efficiency of the gastrointestinal lining is a very conservative approach that tends to overestimate the potential risk to human health.

In summary, the use of conservative assumptions results in quantitative indices of toxicity that are not expected to underestimate potential toxic effects, but may overestimate these effects by an order of magnitude or more.

Risk Characterization

The risk characterization bridges the gap between potential exposure and the possibility of systemic or carcinogenic human health effects, ultimately providing impetus for the remediation of the site or providing a basis for no remedial action.

Uncertainties associated with risk characterization include the assumption of chemical additivity and the inability to predict synergistic or antagonistic interactions between COPCs. These uncertainties are inherent in any inferential risk assessment. To account for this, USEPA-promulgated inputs to the quantitative risk assessment and toxicological indices are calculated to be protective of the human receptor and to err conservatively, so as to not underestimate the potential human health risks.

3.0 CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the results of the baseline HHRA and identifies environmental media and COPCs, which could potentially pose human health risks at the SWMU 14. Five surface soil samples were collected at the perimeter of the fire training pit, and were compared to Region III Residential RBC values. The following COPCs were identified.

- benzo(a)anthracene
- benzo(b)fluoranthene
- benzo(a)pyrene
- dibenz(a,h)anthracene
- indeno(1,2,3-c,d)pyrene

An exposure assessment was then conducted to determine human receptors, exposure pathways and exposure assumptions. Current land use scenarios that were evaluated include commercial/utility worker, and trespasser. Future land use scenarios evaluated include commercial/utility worker, trespasser, military residential, and construction worker. Each scenario evaluated the risk associated with ingestion of contaminants in surface soil, inhalation of particulates from surface soil, and dermal contact with surface soil.

The results of the HHRA did not indicate an unacceptable cancer risk for any of the exposure scenarios or pathways (i.e. ingestion, inhalation, dermal). Based on the results of this HHRA it is not likely that the COPCs detected in surface soils at SWMU 14 will pose a significant health risk to current or future receptors. Therefore, no further action is recommended for SWMU 14.

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TABLES

TABLE 2- 1

COMPARING THE MAXIMUM CONCENTRATIONS OF CHEMICALS DETECTED IN SURFACE SOIL TO REGION III RISK BASED CONCENTRATIONS
SWMU 14
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Constituent	Sample ID / Sample Date	14SS04 / 3/22/96	14SS05 / 3/22/96	14SS06 / 3/22/96	14SS07 / 3/22/96	14SS08 / 3/22/96	Maximum Detected Concentration	Residential RBC[a]	Will this chemical be retained as a COPC?
SVOCs									
Bis(2-ethylhexyl)phthalate		400 U	410 U	97 J	390 U	360 U	97	45,623 C	no
Diethylphthalate		400 U	410 U	54 J	390 U	360 U	54	6,257,143 N	no
Arcoclor-1260		28	17	12	19	6 J	28	319 C	no
Anthracene		400 U	410 U	390 U	110 J	360 U	110	2,346,429 N	no
Benz(a)anthracene		**400 U**	**45 J**	**300 J**	**3400**	**360 U**	**3,400**	**875 C**	**YES**
Benzo(b)flouranthene		**400 U**	**410 U**	**2800**	**7600**	**360 U**	**7,600**	**875 C**	**YES**
Benzo(k)flouranthene		400 U	410 U	640	2400	360 U	2,400	8,750 C	no
Benzo(a)pyrene		**400 U**	**45 J**	**1800**	**5000**	**360 U**	**5,000**	**87 C**	**YES**
Benzo(g,h,I)perylene[d]		66 J	91 J	1200	3600	360 U	3,600	234,643 N	no
Chrysene		400 U	50 J	690	3800	360 U	3,800	87,497 C	no
Dibenz(a,h)anthracene		**400 U**	**410 U**	**210 J**	**920**	**360 U**	**920**	**87 C**	**YES**
Flouranthene		88 J	110 J	230 J	67 J	360 U	110	312,857 N	no
Indeno(1,2,3-c,d)pyrene		**400 U**	**58 J**	**1300**	**3800**	**360 U**	**3,800**	**875 C**	**YES**
Phenanthrene[c]		400 U	410 U	39 J	58 J	360 U	58	2,346,429 N	no
Pyrene		170 J	270 J	650	100 J	360 U	650	234,643 N	no
TPH									
Diesel Range Organics		560	360	120	490	4.5 U	560	NA	no
Gasoline Range Organics		3.7	3.8	1.8	1.8	0.032	3.8	NA	no

a Region III Risk Based Concentrations October 1999. Noncancer RBCs were adjusted downward to correspond to a target HQ of 0.1 rather than 1 to ensure that chemicals with additive effects are not prematurely eliminated during screening (EPA 1999a).
b All concentrations reported as micrograms per kilogram (ppb)
c anthracene used as a surrogate value for phenanthrene
d pyrene used as a surrogate for benzo(g,h,i)perylene
N= noncarcinogenic
C=carcinogenic
U= Non-detect
J= Estimated
NA= RBCs not derived for TPHs
Bolding indicates exceedances of USEPA Region III RBCs.

TABLE 2-2

CARCINOGENIC TOXICITY VALUES
SWMU 14
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Constituents	Oral Cancer Slope Factor (CSFo) $(mg/kg\text{-}day)^{-1}$	Inhalation Cancer Slope Factor (CSFi) $(mg/kg\text{-}day)^{-1}$	Weight of Evidence	Reference
Benz(a)anthracene	0.73	NA	B2	USEPA 1999a,b
Benzo(b)flouranthene	0.73	NA	B2	USEPA 1999a,b
Benzo(a)pyrene	7.3	3.1	B2	USEPA 1999a,b
Dibenz(a,h)anthracene	7.3	NA	B2	USEPA 1999a,b
Indeno(1,2,3-cd)pyrene	0.73	NA	B2	USEPA 1999a,b

TABLE 2-3

POTENTIAL FUTURE AND CURRENT EXPOSURES TO SURFACE SOIL
SWMU 14
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

		Future			Current/Future		
		Military Residential		Construction Worker	Trespasser-Recreator		Commercial/ Utility Worker
		Adult	Child (1-6)	Adult	Adult	Youth (7-17)	Adult
Surface Soil							
	incidental ingestion	X	X	X	X	X	X
	dermal contact	X	X	X	X	X	X
	inhalation of particulates	X	X	X	X	X	X

TABLE 2-4

EXPOSURE PARAMETERS FOR HUMAN HEALTH RISK ASSESSMENT
SWMU 14
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

			Future			Current/Future		
			Military Residential		Construction Worker	Tresspasser-Recreator		Commercial/ Utility Worker
			Adult	Child	Adult	Adult	Youth	Adult
Exposure Duration[2]	ED	year	4[1]	4[1]	1[P]	30	9	22
Exposure Frequency[3]	EF	days/year	350	350	180	52[P]	52[P]	250
Exposure Time-Soil[2]	ET_s	hours/day	2	2	8	2	2	8
Averaging Time	AT	days						
carcinogenic			25,550	25,550	25,550	25,550	25,550	25,550
Body Weight[2,3]	BW	kg	70	15	70	70	45	70
Ingestion Rate-soil[2]	IR_s	mg/day	50	100	60	50	50	50
Dermal Absorption Factor[3]	ABS	unitless						
SVOCs[6]			0.01	0.01	0.01	0.01	0.01	0.01
Oral Absorption Factor			1.00	1.00	1.00	1.00	1.00	1.00
Surface Area-soil[2]	SA_s	cm^2	5,000	1,700	5,000	5,000	3,200	5,000
Adherence Factor[2,7]	AF	mg/cm^2	0.2	0.2	0.43	0.2	0.2	0.2
Inhalation Rate[2]	IR_h	m^3/hr	1.27	0.69	2	1.27	1.27	1.27
Particulate Emmission Factor[8]	PEF	m^3/kg	1.32×10^9	1.32×10^9	1.32×10^9	1.32×10^9	1.32×10^9	1.32×10^9

Notes:

[CS]Chemical Specific

[P]Professional Development

[1]Rivera 1999

[2]USEPA 1997b

[3]USEPA 1991b

[4]USEPA 1989

[5]USEPA 1995a

[6]Wester et al 1990

[7]USEPA 1992a

[8]USEPA 1996

TABLE 2-5

SHAPIRO WILKES TEST RESULTS AND IDENTIFICATION OF THE EXPOSURE POINT CONCENTRATION
SWMU 14
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	W-Value	Quantile	Normal Distribution?	Lognormal 95th UCL (mg/kg)	Maximum Concentration (mg/kg)	Is the Lognormal 95th UCL Greater than the Maximum Detected Concentration?	Exposure Point Concentration (mg/kg)
Benz(a)anthracene	0.61	0.76	No	975.39	3.40	Yes	3.40
Benzo(b)flouranthene	0.74	0.76	No	1,222,086.06	7.60	Yes	7.60
Benzo(a)pyrene	0.75	0.76	No	539,138.14	5.00	Yes	5.00
Dibenz(a,h)anthracene	0.65	0.76	No	3.16	0.92	Yes	0.92
Indeno(1,2,3-c,d)pyrene	0.74	0.76	No	11,138.32	3.80	Yes	3.80

TABLE 2-6

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs)
FOR FUTURE MILITARY ADULT AND MILITARY YOUNG CHILD RESIDENTS
SWMU 14
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	Future Military Adult Residents		Future Military Young Child Residents	
Pathway	ILCR	HI	ILCR	HI
Surface Soil				
Ingestion	2.1E-06	0.00	2.0E-05	0.00
Dermal Contact	4.2E-07	0.00	6.7E-07	0.00
Inhalation	2.3E-11	0.00	5.9E-11	0.00
Subtotal	2.5E-06	0.00	2.0E-05	0.00
Total	2.5E-06	0.0E+00	2.0E-05	0.0E+00

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 2-7

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs)
FOR FUTURE CONSTRUCTION WORKERS
SWMU 14
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Pathway	Future Construction Workers	
	ILCR	HI
Surface Soil		
Ingestion	3.3E-07	0.00
Dermal Contact	7.5E-09	0.00
Inhalation	2.6E-11	0.00
Subtotal	3.3E-07	0.00
Total	3.3E-07	0.0E+00

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 2-8

INCREMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (HIs)
CURRENT ADULT AND ADOLESCENT TRESPASSERS
SWMU 14
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	Current and Future Adult Trespassers		Current and Future Adolescent Trespassers	
Pathway	ILCR	HI	ILCR	HI
Surface Soil				
Ingestion	2.4E-06	0.00	1.1E-06	0.00
Dermal Contact	4.7E-07	0.00	1.7E-07	0.00
Inhalation	2.6E-11	0.00	7.8E-12	0.00
Subtotal	2.8E-06	0.00	1.3E-06	0.00
Total	2.8E-06	0.0E+00	1.3E-06	0.0E+00

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

TABLE 2-9

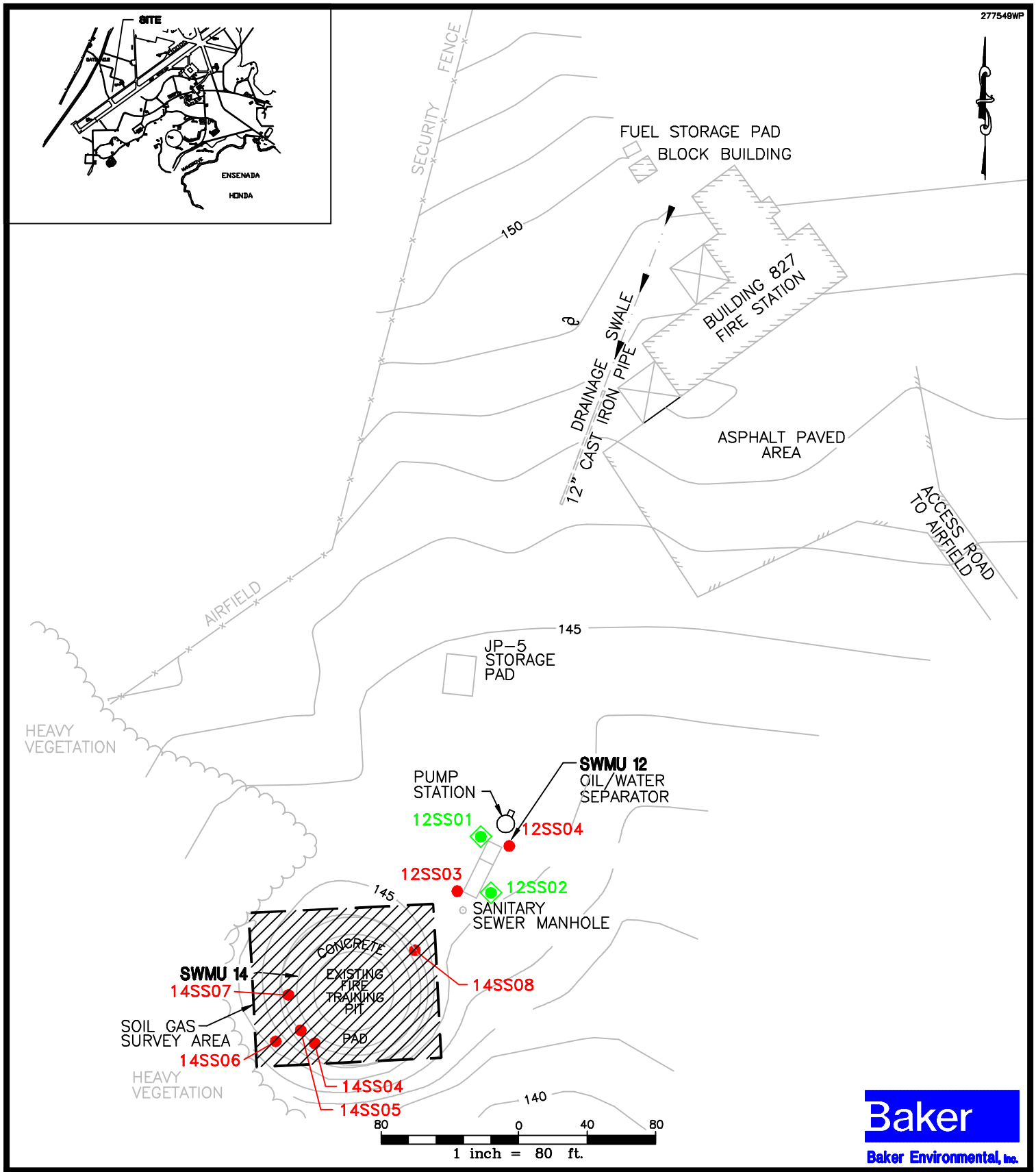
:REMENTAL LIFETIME CANCER RISKS (ILCRs) AND HAZARD INDICIES (H
FOR CURRENT COMMERCIAL/UTILITY WORKERS
SWMU 14
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Pathway	Current Commercial/Utility Workers	
	ILCR	HI
Surface Soil		
Ingestion	8.3E-06	0.00
Dermal Contact	1.7E-06	0.00
Inhalation	3.7E-10	0.00
Subtotal	1.0E-05	0.00
TotaL	1.0E-05	0.00

Notes:

Bolding indicates exceedances of USEPA acceptable target risk criteria by pathway exposures
Shading indicates exceedances of USEPA acceptable target risk criteria by subtotal and total risk value

FIGURES



LEGEND

- 145 SURFACE ELEVATION CONTOUR
- SURFACE WATER DRAINAGE DIRECTION
- SURFACE SOIL SAMPLE COLLECTED (9-95)
- SURFACE SOIL SAMPLE COLLECTED (3-22-96)
- AREA OF SOIL GAS SURVEY

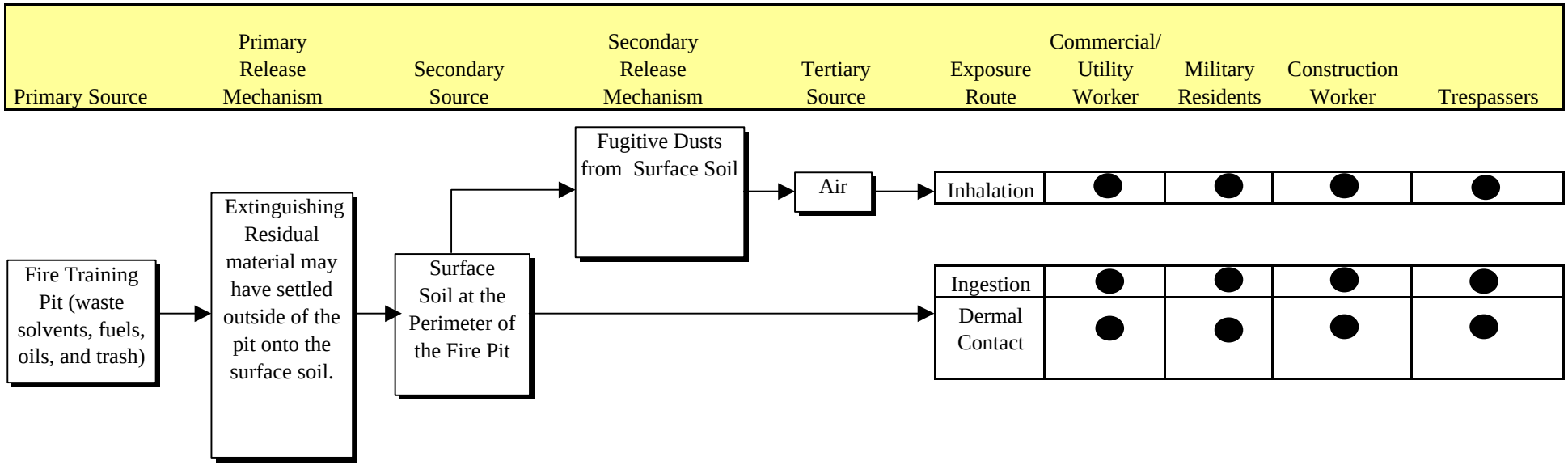
SOURCE: LANTDIV, FEB. 1992.

FIGURE 2-1
SAMPLING LOCATIONS
SWMU 14 – FIRE TRAINING PIT AREA
OPERABLE UNIT NO. 1

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

FIGURE 2-2

EXPOSURE PATHWAYS TO SURFACE SOIL
SWMU 14
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO



Legend

● Complete Exposure Pathway

○ Incomplete Exposure Pathway

APPENDIX A
RCRA FACILITY INVESTIGATION DATA (BAKER 1996)

APPENDIX A

ANALYTICAL SUMMARY OF ORGANIC COMPOUNDS IN SWMU 14 SURFACE SOIL
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

SAMPLE ID	14SS04	14SS05	14SS06	14SS07	14SS08
SAMPLE DATE	03/22/96	03/22/96	03/22/96	03/22/96	03/22/96
VOLATILES (ug/kg)					
CARBON TETRACHLORIDE	6 U	6 UJ	6 U	6 U	5 U
ACETONE	12 UJ	12 UJ	12 UJ	12 UJ	11 UJ
CHLOROFORM	6 U	6 UJ	6 U	6 U	5 U
BENZENE	6 U	6 UJ	6 U	6 U	5 U
1,1,1-TRICHLOROETHANE	6 U	6 UJ	6 U	6 U	5 U
BROMOMETHANE	12 U	12 UJ	12 U	12 U	11 U
CHLOROMETHANE	12 U	12 UJ	12 U	12 U	11 U
IODOMETHANE	12 U	12 UJ	12 U	12 U	11 U
DIBROMOMETHANE	12 U	12 UJ	12 U	12 UJ	11 UJ
CHLOROETHANE	12 U	12 UJ	12 U	12 U	11 U
VINYL CHLORIDE	12 U	12 UJ	12 U	12 U	11 U
ACETONITRILE	120 U	120 UJ	120 U	120 U	110 U
METHYLENE CHLORIDE	6 UJ	6 UJ	6 UJ	6 U	5 U
CARBON DISULFIDE	6 U	6 UJ	6 U	6 U	5 U
BROMOFORM	6 U	6 UJ	6 U	6 U	5 U
BROMODICHLOROMETHANE	6 U	6 UJ	6 U	6 U	5 U
1,1-DICHLOROETHANE	6 U	6 UJ	6 U	6 U	5 U
1,1-DICHLOROETHENE	6 U	6 UJ	6 U	6 U	5 U
TRICHLOROFLUOROMETHANE	12 UJ	12 UJ	12 UJ	12 UJ	11 UJ
DICHLORODIFLUOROMETHANE	25 U	25 UJ	23 U	24 UJ	22 UJ
PENTACHLOROETHANE	25 U	25 UJ	23 U	24 U	22 U
ISOBUTYL ALCOHOL	2500 R	2500 R	2300 R	2400 R	2200 R
1,2-DICHLOROPROPANE	6 U	6 UJ	6 U	6 U	5 U
2-BUTANONE	12 U	12 UJ	12 U	12 U	11 U
1,1,2-TRICHLOROETHANE	6 U	6 UJ	6 U	6 U	5 U
TRICHLOROETHENE	6 U	6 UJ	6 U	6 U	5 U
1,1,2,2-TETRACHLOROETHANE	6 U	6 UJ	6 U	6 U	5 U
METHYLMETHACRYLATE	25 U	25 UJ	23 U	24 U	22 U
1,2-DIBROMO-3-CHLOROPROPANE	25 UJ	25 UJ	23 UJ	24 U	22 U
1,2,3-TRICHLOROPROPANE	12 U	12 UJ	12 U	12 U	11 U
ETHYLMETHACRYLATE	25 U	25 UJ	23 U	24 U	22 U
ETHYLBENZENE	6 U	6 UJ	6 U	6 UJ	5 UJ
STYRENE	6 U	6 UJ	6 U	6 U	5 U
1,2-DIBROMOETHANE	25 U	25 UJ	23 U	24 U	22 U
ACROLEIN	620 U	630 UJ	590 U	590 U	540 U
3-CHLOROPROPENE	25 U	25 UJ	23 U	24 U	22 U
1,2-DICHLOROETHANE	6 UJ	6 UJ	6 UJ	6 U	5 U
PROPIONITRILE (ETHYL CYANIDE)	62 R	63 R	59 R	59 R	54 R
ACRYLONITRILE	120 U	120 UJ	120 U	120 U	110 U
VINYL ACETATE	12 U	12 UJ	12 U	12 U	11 U
4-METHYL-2-PENTANONE	12 U	12 UJ	12 U	12 U	11 U
TOLUENE	6 U	6 UJ	6 U	6 U	5 U
CHLOROBENZENE	6 U	6 UJ	6 U	6 U	5 U
TRANS-1,4-DICHLORO-2-BUTENE	25 U	25 UJ	23 U	24 U	22 U
DIBROMOCHLOROMETHANE	6 U	6 UJ	6 U	6 U	5 U
METHACRYLONITRILE	25 U	25 UJ	23 U	24 U	22 U
2-CHLORO-1,3-BUTADIENE	120 U	120 UJ	120 U	120 U	110 U
TETRACHLOROETHENE	6 U	6 UJ	6 U	6 U	5 U
1,2-DICHLOROETHENE (TOTAL)	6 U	6 UJ	6 U	6 U	5 U
2-HEXANONE	12 UJ	12 UJ	12 UJ	12 U	11 U
1,1,1,2-TETRACHLOROETHANE	12 U	12 UJ	12 U	12 U	11 U
XYLENE (TOTAL)	6 U	6 UJ	6 U	6 U	5 U
CIS-1,3-DICHLOROPROPENE	6 U	6 UJ	6 U	6 U	5 U
TRANS-1,3-DICHLOROPROPENE	6 U	6 UJ	6 U	6 U	5 U

APPENDIX A

ANALYTICAL SUMMARY OF ORGANIC COMPOUNDS IN SWMU 14 SURFACE SOIL
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

SAMPLE ID	14SS04	14SS05	14SS06	14SS07	14SS08
SAMPLE DATE	03/22/96	03/22/96	03/22/96	03/22/96	03/22/96
SEMIVOLATILES (ug/kg)					
BENZO(A)PYRENE	400 U	45 J	1800	5000	360 U
2,4-DINITROPHENOL	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
DIBENZO(A,H)ANTHRACENE	400 U	410 U	210 J	920	360 U
2-ACETYLAMINOFLUORENE	800 U	820 U	770 U	770 U	710 U
N-NITROSODIETHYLAMINE	400 UJ	410 U	390 U	390 U	360 U
3-METHYLCHOLANTHRENE	400 U	410 U	390 U	390 U	360 U
BENZO(A)ANTHRACENE	400 U	45 J	300 J	3400	360 U
4-NITROQUINOLINE-1-OXIDE	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
7,12-DIMETHYLBENZ(A)ANTHRACENE	800 U	820 U	770 U	770 U	710 U
2,3,4,6-TETRACHLOROPHENOL	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
4-CHLORO-3-METHYLPHENOL	800 U	820 U	770 U	770 U	710 U
N-NITROSOMORPHOLINE	800 UJ	820 UJ	770 UJ	770 UJ	710 UJ
P-DIMETHYLAMINOAZOBENZENE	800 U	820 U	770 U	770 U	710 U
PHENACETIN	400 U	410 U	390 U	390 U	360 U
ETHYL METHANESULFONATE	400 U	410 U	390 U	390 U	360 U
ANILINE	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
N-NITROSODIMETHYLAMINE	400 U	410 UJ	390 U	390 U	360 U
BENZOIC ACID	2000 U	2100 U	1900 U	1900 U	1800 U
METHYL METHANESULFONATE	400 U	410 U	390 U	390 U	360 U
HEXACHLOROETHANE	400 U	410 U	390 U	390 U	360 U
HEXACHLOROPHENE	4000 R	4100 R	3900 R	3900 R	3600 R
HEXACHLOROCYCLOPENTADIENE	400 U	410 U	390 U	390 U	360 U
ISOPHORONE	400 U	410 U	390 U	390 U	360 U
PENTACHLORONITROBENZENE	400 U	410 U	390 U	390 U	360 U
ACENAPHTHENE	400 U	410 U	390 U	390 U	360 U
DIETHYLPHTHALATE	400 U	410 U	54 J	390 U	360 U
DI-N-BUTYLPHTHALATE	400 U	410 U	390 U	390 U	360 U
PHENANTHRENE	400 U	410 U	39 J	58 J	360 U
BUTYLBENZYLPHTHALATE	400 U	410 U	390 U	390 U	360 U
N-NITROSODIPHENYLAMINE (1)	400 U	410 U	390 U	390 U	360 U
FLUORENE	400 U	410 U	390 U	390 U	360 U
CARBAZOLE	400 U	410 U	390 U	390 U	360 U
2,6-DICHLOROPHENOL	400 U	410 U	390 U	390 U	360 U
HEXACHLOROBUTADIENE	400 U	410 U	390 U	390 U	360 U
PENTACHLOROPHENOL	2000 U	2100 U	1900 U	1900 U	1800 U
2,4,6-TRICHLOROPHENOL	400 U	410 U	390 U	390 U	360 U
2-NITROANILINE	2000 U	2100 U	1900 U	1900 U	1800 U
2-NITROPHENOL	400 U	410 U	390 U	390 U	360 U
2-SEC-BUTYL-4,6-DINITROPHENOL	800 UJ	820 UJ	770 UJ	770 UJ	710 UJ
NAPHTHALENE	400 U	410 U	390 U	390 U	360 U
2-METHYLNAPHTHALENE	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
2-CHLORONAPHTHALENE	400 U	410 U	390 U	390 U	360 U
2-NAPHTHYLAMINE	1000 U	1000 U	970 U	970 U	890 U
METHAPYRILENE	1000 UJ	1000 UJ	970 UJ	970 UJ	890 UJ
3,3'-DICHLOROBENZIDINE	800 U	820 U	770 U	770 U	710 U
4-AMINOBIPHENYL	800 U	820 U	770 U	770 U	710 U
BENZIDINE	4000 UJ	4100 UJ	3900 UJ	3900 UJ	3600 UJ
SAFROLE	400 U	410 U	390 U	390 U	360 U
O-CRESOL	400 U	410 U	390 U	390 U	360 U
1,2-DICHLOROBENZENE	400 U	410 U	390 U	390 U	360 U
O-TOLUIDINE	400 R	410 R	390 R	390 R	360 R
2-CHLOROPHENOL	400 U	410 U	390 U	390 U	360 U
1,2,4,5-TETRACHLOROBENZENE	400 U	410 U	390 U	390 U	360 U
2,4,5-TRICHLOROPHENOL	2000 U	2100 U	1900 U	1900 U	1800 U

APPENDIX A

ANALYTICAL SUMMARY OF ORGANIC COMPOUNDS IN SWMU 14 SURFACE SOIL
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

SAMPLE ID	14SS04	14SS05	14SS06	14SS07	14SS08
SAMPLE DATE	03/22/96	03/22/96	03/22/96	03/22/96	03/22/96
ACETOPHENONE	400 U	410 U	390 U	390 U	360 U
NITROBENZENE	400 U	410 U	390 U	390 U	360 U
3-NITROANILINE	2000 U	2100 U	1900 U	1900 U	1800 U
1,3,5-TRINITROBENZENE	4000 U	4100 U	3900 U	3900 U	3600 U
5-NITRO-O-TOLUIDINE	800 U	820 U	770 U	770 U	710 U
1,3-DINITROBENZENE	800 U	820 U	770 U	770 U	710 U
4-NITROANILINE	2000 U	2100 U	1900 U	1900 U	1800 U
4-NITROPHENOL	2000 U	2100 U	1900 U	1900 U	1800 U
BENZYL ALCOHOL	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
N-NITROSOPIPERIDINE	400 U	410 U	390 U	390 U	360 U
4-BROMOPHENYL-PHENYLETHER	400 U	410 U	390 U	390 U	360 U
2,4-DIMETHYLPHENOL	400 U	410 U	390 U	390 U	360 U
1,4-DICHLOROBENZENE	400 U	410 U	390 U	390 U	360 U
4-CHLOROANILINE	800 U	820 U	770 U	770 U	710 U
P-PHENYLENEDIAMINE	800 UJ	820 UJ	770 UJ	770 UJ	710 UJ
2,2'-OXYBIS(1-CHLOROPROPANE)	400 U	410 U	390 U	390 U	360 U
PHENOL	400 U	410 U	390 U	390 U	360 U
2-PICOLINE	400 R	410 R	390 R	390 R	360 R
PYRIDINE	800 U	820 U	770 U	770 U	710 U
BIS(2-CHLOROETHYL)ETHER	400 U	410 U	390 U	390 U	360 U
BIS(2-CHLOROETHOXY)METHANE	400 U	410 U	390 U	390 U	360 U
BIS(2-ETHYLHEXYL)PHTHALATE	400 U	410 U	97 J	390 U	360 U
DI-N-OCTYL PHTHALATE	400 U	410 U	390 U	390 U	360 U
HEXACHLOROBENZENE	400 U	410 U	390 U	390 U	360 U
3,3'-DIMETHYLBENZIDINE	2000 U	2100 U	1900 U	1900 U	1800 U
ANTHRACENE	400 U	410 U	390 U	110 J	360 U
ISOSAFROLE	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
1,2,4-TRICHLOROBENZENE	400 U	410 U	390 U	390 U	360 U
2,4-DICHLOROPHENOL	400 U	410 U	390 U	390 U	360 U
2,4-DINITROTOLUENE	400 U	410 U	390 U	390 U	360 U
A,A-DIMETHYLPHENETHYLAMINE	2000 U	2100 U	1900 U	1900 U	1800 U
DIPHENYLAMINE	400 U	410 U	390 U	390 U	360 U
1,2-DIPHENYLHYDRAZINE	400 U	410 U	390 U	390 U	360 U
1,4-DIOXANE	800 R	820 R	770 R	770 R	710 R
PYRENE	170 J	270 J	650	100 J	360 U
1,4-NAPHTHOQUINONE	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
DIMETHYLPHTHALATE	400 U	410 U	390 U	390 U	360 U
DIBENZOFURAN	400 U	410 U	390 U	390 U	360 U
1-NAPHTHYLAMINE	800 U	820 U	770 U	770 U	710 U
ARAMITE	800 UJ	820 UJ	770 UJ	770 UJ	710 UJ
BENZO(G,H,I)PERYLENE	66 J	91 J	1200	3600	360 U
INDENO(1,2,3-CD)PYRENE	400 U	58 J	1300	3800	360 U
BENZO(B)FLUORANTHENE	400 U	410 U	2800	7600	360 U
FLUORANTHENE	88 J	110 J	230 J	67 J	360 U
BENZO(K)FLUORANTHENE	400 U	410 U	640	2400	360 U
ACENAPHTHYLENE	400 U	410 U	390 U	390 U	360 U
CHRYSENE	400 U	50 J	690	3800	360 U
CHLOROBENZILATE	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
4,6-DINITRO-2-METHYLPHENOL	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
1,3-DICHLOROBENZENE	400 U	410 U	390 U	390 U	360 U
2,6-DINITROTOLUENE	400 U	410 U	390 U	390 U	360 U
PENTACHLOROBENZENE	400 U	410 U	390 U	390 U	360 U
N-NITROSO-DI-N-PROPYLAMINE	400 U	410 U	390 U	390 U	360 U
N-NITROSO-DI-N-BUTYLAMINE	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
N-NITROSOPYRROLIDINE	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ

APPENDIX A

ANALYTICAL SUMMARY OF ORGANIC COMPOUNDS IN SWMU 14 SURFACE SOIL
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

SAMPLE ID	14SS04	14SS05	14SS06	14SS07	14SS08
SAMPLE DATE	03/22/96	03/22/96	03/22/96	03/22/96	03/22/96
HEXACHLOROPROPENE	2000 U	2100 U	1900 U	1900 U	1800 U
DIALLATE	400 U	410 U	390 U	390 U	360 U
4-CHLOROPHENYL-PHENYLETHER	400 U	410 U	390 U	390 U	360 U
N-NITROSOMETHYLETHYLAMINE	400 U	410 U	390 UJ	390 UJ	360 UJ
PRONAMIDE	400 U	410 U	390 U	390 U	360 U
META & PARA-CRESOL	400 U	410 U	390 U	390 U	360 U
PCB (ug/kg)					
AROCLOR-1260	28	17	12	19	6 NJ
AROCLOR-1254	96 U	98 U	93 U	93 U	85 U
AROCLOR-1221	48 U	49 U	46 U	46 U	42 U
AROCLOR-1232	48 U	49 U	46 U	46 U	42 U
AROCLOR-1248	48 U	49 U	46 U	46 U	42 U
AROCLOR-1016	48 U	49 U	46 U	46 U	42 U
AROCLOR-1242	48 U	49 U	46 U	46 U	42 U
TPH (mg/kg)					
DIESEL FUEL	560	360	120	490	4.5 U
GASOLINE	3.7	3.8	1.8	1.8	0.032

APPENDIX B
HHRA RISK CALCULATIONS

COMMERCIAL/UTILITY WORKERS - CURRENT SCENARIO
ACCIDENTAL INGESTION OF SURFACE SOIL -SWMU 14
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

CDI (mg/kg/d)= (Cs*IR*CF*FI*EF*ED)/(BW*AT)
ILCR = CDI*CSFo
HQ = CDI/RfDo

Parameter	Description	On-site Worker	
CDI	Chronic daily intake (mg/kg/d)	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	
CSFo	Oral cancer slope factor (1/(mg/kg/d))	CS	
HQ	Hazard quotient	CS	
RfDo	Oral reference dose (mg/kg/d)	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	
IR	Ingestion Rate (mg/d)	50	
CF	Conversion factor (kg/mg)	1.00E-06	
FI	Fraction of soil ingested from site	1	
EF	Exposure Frequency (d/yr)	250	
ED	Exposure Duration (yrs)	22	
BW	Body weight (kg)	70	
ATc	Averaging time, carcinogens (d)	25,550	
ATn	Averaging time, noncarcinogens (d)	8,030	

				Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	CSFo 1/(mg/kg/d)	RfDo (mg/kg/d)	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	7.30E-01	NA	5.2E-07	3.8E-07	4.6%	1.7E-06	--	--
Benzo(b)fluoranthene	7.6	7.30E-01	NA	1.2E-06	8.5E-07	10.3%	3.7E-06	--	--
Benzo(a)pyrene	5	7.30E+00	NA	7.7E-07	5.6E-06	67.6%	2.4E-06	--	--
Dibenz(a,h)anthracene	0.92	7.30E+00	NA	1.4E-07	1.0E-06	12.4%	4.5E-07	--	--
Indeno(1,2,3 c,d)pyrene	3.8	7.30E-01	NA	5.8E-07	4.3E-07	5.1%	1.9E-06	--	--
				Total ILCR:	8.3E-06	100.0%	HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

COMMERCIAL/UTILITY WORKERS - CURRENT SCENARIO
DERMAL CONTACT WITH SURFACE SOIL - SWMU 14
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

DAD (mg/kg/d)= (Cs*CF*AF*ABS*A*EF*ED)/(BW*AT)
ILCR = CDI*CSFd
HQ = CDI/RfDd

Parameter	Description	On-site Worker	
DAD	Dermally absorbed dose (mg/kg/d)	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	
CSFo	Oral cancer slope factor (1/(mg/kg/d))	CS	
HQ	Hazard quotient	CS	
RfDo	Oral reference dose (mg/kg/d)	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	
CF	Conversion factor (kg/mg)	1.00E-06	
AF	Soil to skin adherence factor (mg/cm2-event)	0.2	
ABS	Absorption fraction	CS	
A	Skin surface area available for contact (cm2)	5,000	
EF	Exposure Frequency (d/yr)	250	
ED	Exposure Duration (yrs)	22	
BW	Body weight (kg)	70	
ATc	Averaging time, carcinogens (d)	25,550	
ATn	Averaging time, noncarcinogens (d)	8,030	

					Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	ABS	CSFd 1/(mg/kg/d)	RfDd (mg/kg/d)	DAD (mg/kg/d)	ILCR	% Contrib. Total ILCR	DAD (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	0.01	7.30E-01	NA	1.0E-07	7.6E-08	4.6%	3.3E-07	--	--
Benzo(b)fluoranthene	7.6	0.01	7.30E-01	NA	2.3E-07	1.7E-07	10.3%	7.4E-07	--	--
Benzo(a)pyrene	5	0.01	7.30E+00	NA	1.5E-07	1.1E-06	67.6%	4.9E-07	--	--
Dibenz(a,h)anthracene	0.92	0.01	7.30E+00	NA	2.8E-08	2.1E-07	12.4%	9.0E-08	--	--
Indeno(1,2,3 c,d)pyrene	3.8	0.01	7.30E-01	NA	1.2E-07	8.5E-08	5.1%	3.7E-07	--	--
					Total ILCR:	1.7E-06	100.0%	HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

COMMERCIAL/UTILITY WORKERS - CURRENT SCENARIO
INHALATION OF FUGITIVE DUSTS EMANATING FROM SURFACE SOIL - SWMU 14
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

CDI (mg/kg/d)= (Ca*RR*ET*EF*ED)/(BW*AT)
Where: Ca = Cs * (1/PEF)

ILCR = CDI*CSFi
HQ = CDI/RfDi

Parameter	Description	On-site Worker	
CDI	Chronic daily intake (mg/kg/d)	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	
CSFi	Inhalation cancer slope factor (1/(mg/kg/d))	CS	
HQ	Hazard quotient	CS	
RfDi	Inhalation reference dose (mg/kg/d)	CS	
Ca	Concentration of chemical in air as fugitive dusts (mg/m3)	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	
PEF	Particulate emission factor (m3/kg)	1.32E+09	
RR	Respiration rate (m3/hr)	1.27	
ET	Exposure time (hrs/d)	8	
EF	Exposure Frequency (d/yr)	250	
ED	Exposure Duration (yrs)	22	
BW	Body weight (kg)	70	
ATc	Averaging time, carcinogens (d)	25550	
ATn	Averaging time, noncarcinogens (d)	8030	

					Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	Ca (mg/m3)	CSFi 1/(mg/kg/d)	RfDi (mg/kg/d)	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	2.58E-09	NA	NA	8.0E-11	--	--	2.6E-10	--	--
Benzo(b)fluoranthene	7.6	5.76E-09	NA	NA	1.8E-10	--	--	5.7E-10	--	--
Benzo(a)pyrene	5	3.79E-09	3.1	NA	1.2E-10	3.7E-10	100.0%	3.8E-10	--	--
Dibenz(a,h)anthracene	0.92	6.97E-10	NA	NA	2.2E-11	--	--	6.9E-11	--	--
Indeno(1,2,3 c,d)pyrene	3.8	2.88E-09	NA	NA	9.0E-11	--	--	2.9E-10	--	--
					Total ILCR:	3.7E-10	100.0%	HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

MILITARY ADULT AND YOUNG CHILD RESIDENTS (AGES 1 TO 6 YEARS) - FUTURE SCENARIO
ACCIDENTAL INGESTION OF SURFACE SOIL - SWMU 14
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS

CDI (mg/kg/d)= (Cs*IR*CF*ABS*EF*ED)/(BW*AT)
ILCR = CDI*CSFo
HQ = CDI/RfDo

Parameter	Description	Adult	Young Child	
CDI	Chronic daily intake (mg/kg/d)	CS	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	CS	
CSFo	Oral cancer slope factor (1/(mg/kg/d))	CS	CS	
HQ	Hazard quotient	CS	CS	
RfDo	Oral reference dose (mg/kg/d)	CS	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	CS	
IR	Ingestion Rate (mg/d)	50	100	
CF	Conversion factor (kg/mg)	0.000001	0.000001	
ABS	Amount available for Absorption	1	1	
EF	Exposure Frequency (d/yr)	350	350	
ED	Exposure Duration (yrs)	4	4	
BW	Body weight (kg)	70	15	
ATc	Averaging time, carcinogens (d)	25550	25550	
ATn	Averaging time, noncarcinogens (d)	1460	1460	

				Adult						Young Child					
				Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	CSFo 1/(mg/kg/d)	RfDo (mg/kg/d)	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.40	7.30E-01	NA	1.3E-07	9.7E-08	4.6%	2.3E-06	--	--	1.2E-06	9.1E-07	4.6%	2.2E-05	--	--
Benzo(b)fluoranthene	7.60	7.30E-01	NA	3.0E-07	2.2E-07	10.3%	5.2E-06	--	--	2.8E-06	2.0E-06	10.3%	4.9E-05	--	--
Benzo(a)pyrene	5.00	7.30E+00	NA	2.0E-07	1.4E-06	67.6%	3.4E-06	--	--	1.8E-06	1.3E-05	67.6%	3.2E-05	--	--
Dibenz(a,h)anthracene	0.92	7.30E+00	NA	3.6E-08	2.6E-07	12.4%	6.3E-07	--	--	3.4E-07	2.5E-06	12.4%	5.9E-06	--	--
Indeno(1,2,3 c,d)pyrene	3.80	7.30E-01	NA	1.5E-07	1.1E-07	5.1%	2.6E-06	--	--	1.4E-06	1.0E-06	5.1%	2.4E-05	--	--
				Total ILCR:	2.1E-06	100.0%	HI:	0.0E+00	0.0%	Total ILCR:	2.0E-05	100.0%	HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

MILITARY ADULT AND YOUNG CHILD RESIDENTS (AGES 1 TO 6 YEARS) - FUTURE SCENARIO
DERMAL CONTACT WITH SURFACE SOIL - SWMU 14
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS

DAD (mg/kg/d)= (Cs*CF*AF*ABS*A*EF*ED)/(BW*AT)
ILCR = CDI*CSFd
HQ = CDI/RfDd

Parameter	Description	Adult	Young Child	
DAD	Dermally absorbed dose (mg/kg/d)	CS	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	CS	
CSFo	Oral cancer slope factor (1/(mg/kg/d))	CS	CS	
HQ	Hazard quotient	CS	CS	
RfDo	Oral reference dose (mg/kg/d)	CS	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	CS	
CF	Conversion factor (kg/mg)	1.00E-06	1.00E-06	
AF	Soil to skin adherence factor (mg/cm2-event)	0.2	0.2	
ABS	Absorption fraction	CS	CS	
A	Skin surface area available for contact (cm2)	5,000	1,700	
EF	Exposure Frequency (d/yr)	350	350	
ED	Exposure Duration (yrs)	4	4	
BW	Body weight (kg)	70	15	
ATc	Averaging time, carcinogens (d)	25550	25,550	
ATn	Averaging time, noncarcinogens (d)	1460	1,460	

					Adult						Young Child					
					Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	ABS	CSFd 1/(mg/kg/d)	RfDd (mg/kg/d)	DAD (mg/kg/d)	ILCR	% Contrib. Total ILCR	DAD (mg/kg/d)	HQ	% Contrib. HI	DAD (mg/kg/d)	ILCR	% Contrib. Total ILCR	DAD (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	0.01	7.30E-01	NA	2.7E-08	1.9E-08	4.6%	4.7E-07	--	--	4.2E-08	3.1E-08	4.6%	7.4E-07	--	--
Benzo(b)fluoranthene	7.6	0.01	7.30E-01	NA	5.9E-08	4.3E-08	10.3%	1.0E-06	--	--	9.4E-08	6.9E-08	10.3%	1.7E-06	--	--
Benzo(a)pyrene	5	0.01	7.30E+00	NA	3.9E-08	2.9E-07	67.6%	6.8E-07	--	--	6.2E-08	4.5E-07	67.6%	1.1E-06	--	--
Dibenz(a,h)anthracene	0.92	0.01	7.30E+00	NA	7.2E-09	5.3E-08	12.4%	1.3E-07	--	--	1.1E-08	8.3E-08	12.4%	2.0E-07	--	--
Indeno(1,2,3 c,d)pyrene	3.8	0.01	7.30E-01	NA	3.0E-08	2.2E-08	5.1%	5.2E-07	--	--	4.7E-08	3.4E-08	5.1%	8.3E-07	--	--
					Total ILCR:	4.2E-07	100.0%	HI:	0.0E+00	0.0%	Total ILCR:	6.7E-07	100.0%	HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

MILITARY ADULT AND YOUNG CHILD RESIDENTS (AGES 1 TO 6 YEARS) - FUTURE SCENARIO
INHALATION OF FUGITIVE DUSTS EMANATING FROM SURFACE SOIL - SWMU 14
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS

CDI (mg/kg/d)= (Ca*RR*ET*EF*ED)/(BW*AT)
Where: Ca = Cs * (1/PEF)

ILCR = CDI*CSFi
HQ = CDI/RfDi

Parameter	Description	Adult	Adolescent	
CDI	Chronic daily intake (mg/kg/d)	CS	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	CS	
CSFi	Inhalation cancer slope factor (1/(mg/kg/d))	CS	CS	
HQ	Hazard quotient	CS	CS	
RfDi	Inhalation reference dose (mg/kg/d)	CS	CS	
Ca	Concentration of chemical in air as fugitive dusts (mg/m3)	CS	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	CS	
PEF	Particulate emission factor (m3/kg)	1.32E+09	1.32E+09	USEPA 1996 assumes 50% vegetation
RR	Respiration rate (m3/hr)	1.27	0.69	
ET	Exposure time (hrs/d)	2	2	
EF	Exposure Frequency (d/yr)	350	350	
ED	Exposure Duration (yrs)	4	4	
BW	Body weight (kg)	70	15	
ATc	Averaging time, carcinogens (d)	25,550	25,550	
ATn	Averaging time, noncarcinogens (d)	1,460	1,460	

					Adult						Young Child					
					Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	Ca (mg/m3)	CSFi 1/(mg/kg/d)	RfDi (mg/kg/d)	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	2.576E-09	NA	NA	5.1E-12	--	--	9.0E-11	--	--	1.3E-11	--	--	2.3E-10	--	--
Benzo(b)fluoranthene	7.6	5.758E-09	NA	NA	1.1E-11	--	--	2.0E-10	--	--	2.9E-11	--	--	5.1E-10	--	--
Benzo(a)pyrene	5	3.788E-09	3.1	NA	7.5E-12	2.3E-11	100.0%	1.3E-10	--	--	1.9E-11	5.9E-11	100.0%	3.3E-10	--	--
Dibenz(a,h)anthracene	0.92	6.97E-10	NA	NA	1.4E-12	--	--	2.4E-11	--	--	3.5E-12	--	--	6.1E-11	--	--
Indeno(1,2,3 c,d)pyrene	3.8	2.879E-09	NA	NA	5.7E-12	--	--	1.0E-10	--	--	1.5E-11	--	--	2.5E-10	--	--
					Total ILCR:	2.3E-11	100.0%	HI:	0.0E+00	0.0%	Total ILCR:	5.9E-11	100.0%	HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

CONSTRUCTION WORKERS - FUTURE SCENARIO
ACCIDENTAL INGESTION OF SURFACE SOIL
REASONABLE MAXIMUM EXPOSURE- SWMU 14
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS

CDI (mg/kg/d)= (Cs*IR*CF*ABS*EF*ED)/(BW*AT)
ILCR = CDI*CSFo
HQ = CDI/RfDo

Parameter	Description	Adult	
CDI	Chronic daily intake (mg/kg/d)	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	
CSFo	Oral cancer slope factor (1/(mg/kg/d))	CS	
HQ	Hazard quotient	CS	
RfDo	Oral reference dose (mg/kg/d)	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	
IR	Ingestion Rate (mg/d)	60	
CF	Conversion factor (kg/mg)	1.00E-06	
ABS	Amount available for Absorption	1	
EF	Exposure Frequency (d/yr)	180	
ED	Exposure Duration (yrs)	1	
BW	Body weight (kg)	70	
ATc	Averaging time, carcinogens (d)	25550	
ATn	Averaging time, noncarcinogens (d)	365	

				Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	CSFo 1/(mg/kg/d)	RfDo (mg/kg/d)	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	7.30E-01	NA	2.1E-08	1.5E-08	4.6%	1.4E-06	--	--
Benzo(b)fluoranthene	7.6	7.30E-01	NA	4.6E-08	3.4E-08	10.3%	3.2E-06	--	--
Benzo(a)pyrene	5	7.30E+00	NA	3.0E-08	2.2E-07	67.6%	2.1E-06	--	--
Dibenz(a,h)anthracene	0.92	7.30E+00	NA	5.6E-09	4.1E-08	12.4%	3.9E-07	--	--
Indeno(1,2,3 c,d)pyrene	3.8	7.30E-01	NA	2.3E-08	1.7E-08	5.1%	1.6E-06	--	--
				Total ILCR:	3.3E-07	100.0%	Total HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

CONSTRUCTION WORKERS - FUTURE SCENARIO
DERMAL CONTACT WITH SURFACE SOIL
REASONABLE MAXIMUM EXPOSURE -SWMU 14
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS

DAD (mg/kg/d)= (Cs*CF*AF*ABS*SA*EF*ED)/(BW*AT)
ILCR = CDI*CSFd
HQ = CDI/RfDd

Parameter	Description	Adult	
DAD	Dermally absorbed dose (mg/kg/d)	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	
CSFo	Oral cancer slope factor (1/(mg/kg/d))	CS	
HQ	Hazard quotient	CS	
RfDo	Oral reference dose (mg/kg/d)	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	
CF	Conversion factor (kg/mg)	1.00E-06	
AF	Soil to skin adherence factor (mg/cm2-event)	0.43	
ABS	Absorption fraction	CS	
SA	Skin surface area available for contact (cm2)	5,000	
EF	Exposure Frequency (d/yr)	250	
ED	Exposure Duration (yrs)	1	
BW	Body weight (kg)	70	
ATc	Averaging time, carcinogens (d)	25550	
ATn	Averaging time, noncarcinogens (d)	365	

					Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	ABS	CSFd 1/(mg/kg/d)	RfDd (mg/kg/d)	DAD (mg/kg/d)	ILCR	% Contrib. Total ILCR	DAD (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	0.01	7.30E-01	NA	1.0E-08	7.5E-09	100.0%	7.2E-07	--	--
Benzo(b)fluoranthene	7.6	0.01	7.30E-01	NA	2.3E-08	1.7E-08	223.5%	1.6E-06	--	--
Benzo(a)pyrene	5	0.01	7.30E+00	NA	1.5E-08	1.1E-07	1470.6%	1.1E-06	--	--
Dibenz(a,h)anthracene	0.92	0.01	7.30E+00	NA	2.8E-09	2.0E-08	270.6%	1.9E-07	--	--
Indeno(1,2,3 c,d)pyrene	3.8	0.01	7.30E-01	NA	1.1E-08	8.3E-09	111.8%	8.0E-07	--	--
					Total ILCR:	7.5E-09	100.0%	HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

CONSTRUCTION WORKERS - FUTURE SCENARIO
INHALATION OF FUGITIVE DUSTS EMANATING FROM SURFACE SOIL
REASONABLE MAXIMUM EXPOSURE- SWMU
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS

CDI (mg/kg/d)= (Ca*RR*ET*EF*ED)/(BW*AT)
Where: Ca = Cs * (1/PEF)

ILCR = CDI*CSFi
HQ = CDI/RfDi

Parameter	Description	Adult	
CDI	Chronic daily intake (mg/kg/d)	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	
CSFi	Inhalation cancer slope factor (1/(mg/kg/d))	CS	
HQ	Hazard quotient	CS	
RfDi	Inhalation reference dose (mg/kg/d)	CS	
Ca	Concentration of chemical in air as fugitive dusts (mg/m3)	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	
PEF	Particulate emission factor (m3/kg)	1.32E+09	
RR	Respiration rate (m3/hr)	2.00	
ET	Exposure time (hrs/d)	8	
EF	Exposure Frequency (d/yr)	250	
ED	Exposure Duration (yrs)	1	
BW	Body weight (kg)	70	
ATc	Averaging time, carcinogens (d)	25,550	
ATn	Averaging time, noncarcinogens (d)	365	

					Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	Ca (mg/m3)	CSFi 1/(mg/kg/d)	RfDi (mg/kg/d)	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	2.576E-09	NA	NA	5.8E-12	--	--	4.0E-10	--	--
Benzo(b)fluoranthene	7.6	5.758E-09	NA	NA	1.3E-11	--	--	9.0E-10	--	--
Benzo(a)pyrene	5	3.788E-09	3.1	NA	8.5E-12	2.6E-11	100.0%	5.9E-10	--	--
Dibenz(a,h)anthracene	0.92	6.97E-10	NA	NA	1.6E-12	--	--	1.1E-10	--	--
Indeno(1,2,3 c,d)pyrene	3.8	2.879E-09	NA	NA	6.4E-12	--	--	4.5E-10	--	--
					Total ILCR:	2.6E-11	100.0%	HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

TRESPASSERS - CURRENT AND FUTURE SCENARIOS
ACCIDENTAL INGESTION OF SURFACE SOIL - SWMU 14
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS

CDI (mg/kg/d)= (Cs*IR*CF*FI*EF*ED)/(BW*AT)
ILCR = CDI*CSFo
HQ = CDI/RfDo

Parameter	Description	Adult	Adolescent	
CDI	Chronic daily intake (mg/kg/d)	CS	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	CS	
CSFo	Oral cancer slope factor (1/(mg/kg/d))	CS	CS	
HQ	Hazard quotient	CS	CS	
RfDo	Oral reference dose (mg/kg/d)	CS	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	CS	
IR	Ingestion Rate (mg/d)	50	50	
CF	Conversion factor (kg/mg)	1.00E-06	0.000001	
FI	Fraction of soil ingested from site	1	1	
EF	Exposure Frequency (d/yr)	52	52	
ED	Exposure Duration (yrs)	30	9	
BW	Body weight (kg)	70	45	
ATc	Averaging time, carcinogens (d)	25550	25550	
ATn	Averaging time, noncarcinogens (d)	10950	3285	

				Adult						Adolescent					
				Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	CSFo 1/(mg/kg/d)	RfDo (mg/kg/d)	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	7.30E-01	NA	1.5E-07	1.1E-07	4.6%	3.5E-07	--	--	6.9E-08	5.1E-08	4.6%	5.4E-07	--	--
Benzo(b)fluoranthene	7.6	7.30E-01	NA	3.3E-07	2.4E-07	10.3%	7.7E-07	--	--	1.5E-07	1.1E-07	10.3%	1.2E-06	--	--
Benzo(a)pyrene	5	7.30E+00	NA	2.2E-07	1.6E-06	67.6%	5.1E-07	--	--	1.0E-07	7.4E-07	67.6%	7.9E-07	--	--
Dibenz(a,h)anthracene	0.92	7.30E+00	NA	4.0E-08	2.9E-07	12.4%	9.4E-08	--	--	1.9E-08	1.4E-07	12.4%	1.5E-07	--	--
Indeno(1,2,3-cd)pyrene	3.8	7.30E-01	NA	1.7E-07	1.2E-07	5.1%	3.9E-07	--	--	7.7E-08	5.6E-08	5.1%	6.0E-07	--	--
				Total ILCR:	2.4E-06	100.0%	Total HI:	0.0E+00	0.0%	Total ILCR:	1.1E-06	100.0%	Total HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

TRESPASSERS - CURRENT AND FUTURE SCENARIOS
DERMAL CONTACT WITH SURFACE SOIL - SWMU 14
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS

DAD (mg/kg/d)= (Cs*CF*AF*ABS*SA*EF*ED)/(BW*AT)
ILCR = CDI*CSFd
HQ = CDI/RfDd

Parameter	Description	Adult	Adolescent	
DAD	Dermally absorbed dose (mg/kg/d)	CS	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	CS	
CSFo	Oral cancer slope factor (1/(mg/kg/d))	CS	CS	
HQ	Hazard quotient	CS	CS	
RfDo	Oral reference dose (mg/kg/d)	CS	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	CS	
CF	Conversion factor (kg/mg)	1.00E-06	1.00E-06	
AF	Soil to skin adherence factor (mg/cm2-event)	0.2	0.2	
ABS	Absorption fraction	CS	CS	
SA	Skin surface area available for contact (cm2)	5,000	3,200	
EF	Exposure Frequency (d/yr)	52	52	
ED	Exposure Duration (yrs)	30	9	
BW	Body weight (kg)	70	37	
ATc	Averaging time, carcinogens (d)	25,550	25550	
ATn	Averaging time, noncarcinogens (d)	10,950	3285	

					Adult						Adolescent					
					Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	ABS	CSFd 1/(mg/kg/d)	RfDd (mg/kg/d)	DAD (mg/kg/d)	ILCR	% Contrib. Total ILCR	DAD (mg/kg/d)	HQ	% Contrib. HI	DAD (mg/kg/d)	ILCR	% Contrib. Total ILCR	DAD (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	0.01	7.30E-01	NA	3.0E-08	2.2E-08	4.6%	6.9E-08	--	--	1.1E-08	7.9E-09	4.6%	8.4E-08	--	--
Benzo(b)fluoranthene	7.6	0.01	7.30E-01	NA	6.6E-08	4.8E-08	10.3%	1.5E-07	--	--	2.4E-08	1.8E-08	10.3%	1.9E-07	--	--
Benzo(a)pyrene	5	0.01	7.30E+00	NA	4.4E-08	3.2E-07	67.6%	1.0E-07	--	--	1.6E-08	1.2E-07	67.6%	1.2E-07	--	--
Dibenz(a,h)anthracene	0.92	0.01	7.30E+00	NA	8.0E-09	5.9E-08	12.4%	1.9E-08	--	--	2.9E-09	2.1E-08	12.4%	2.3E-08	--	--
Indeno(1,2,3-cd)pyrene	3.8	0.01	7.30E-01	NA	3.3E-08	2.4E-08	5.1%	7.7E-08	--	--	1.2E-08	8.8E-09	5.1%	9.4E-08	--	--
					Total ILCR:	4.7E-07	100.0%	HI:	0.0E+00	0.0%	Total ILCR:	1.7E-07	100.0%	HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.

TRESPASSERS - CURRENT SCENARIO
INHALATION OF FUGITIVE DUSTS EMANATING FROM SURFACE SOIL - SWMU 14
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS

CDI (mg/kg/d)= (Ca*RR*ET*EF*ED)/(BW*AT)
Where: Ca = Cs * (1/PEF)

ILCR = CDI*CSFi
HQ = CDI/RfDi

Parameter	Description	Adult	Adolescent	
CDI	Chronic daily intake (mg/kg/d)	CS	CS	(Chemical Specific)
ILCR	Incremental lifetime cancer risk	CS	CS	
CSFi	Inhalation cancer slope factor (1/(mg/kg/d))	CS	CS	
HQ	Hazard quotient	CS	CS	
RfDi	Inhalation reference dose (mg/kg/d)	CS	CS	
Ca	Concentration of chemical in air as fugitive dusts (mg/m3)	CS	CS	
Cs	Concentration of chemical in soil (mg/kg)	CS	CS	
PEF	Particulate emission factor (m3/kg)	1.32E+09	1.32E+09	
RR	Respiration rate (m3/hr)	1.27	1.27	
ET	Exposure time (hrs/d)	2	2	
EF	Exposure Frequency (d/yr)	52	52	
ED	Exposure Duration (yrs)	30	9	
BW	Body weight (kg)	70	70	
ATc	Averaging time, carcinogens (d)	25550	25550	
ATn	Averaging time, noncarcinogens (d)	10950	3285	

					Adult						Adolescent					
					Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	Cs (mg/kg)	Ca (mg/m3)	CSFi 1/(mg/kg/d)	RfDi (mg/kg/d)	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI	CDI (mg/kg/d)	ILCR	% Contrib. Total ILCR	CDI (mg/kg/d)	HQ	% Contrib. HI
Benzo(a)anthracene	3.4	2.58E-09	NA	NA	5.7E-12	--	--	1.3E-11	--	--	1.7E-12	--	--	1.3E-11	--	--
Benzo(b)fluoranthene	7.6	5.76E-09	NA	NA	1.3E-11	--	--	3.0E-11	--	--	3.8E-12	--	--	3.0E-11	--	--
Benzo(a)pyrene	5	3.79E-09	3.1	NA	8.4E-12	2.6E-11	100.0%	2.0E-11	--	--	2.5E-12	7.8E-12	100.0%	2.0E-11	--	--
Dibenz(a,h)anthracene	0.92	6.97E-10	NA	NA	1.5E-12	--	--	3.6E-12	--	--	4.6E-13	--	--	3.6E-12	--	--
Indeno(1,2,3-cd)pyrene	3.8	2.88E-09	NA	NA	6.4E-12	--	--	1.5E-11	--	--	1.9E-12	--	--	1.5E-11	--	--
					Total ILCR:	2.6E-11	100.0%	HI:	0.0E+00	0.0%	Total ILCR:	7.8E-12	100.0%	HI:	0.0E+00	0.0%

NOTES:
NA - Toxicity criterion not available.
-- Not applicable.