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DRAFT PHASE II INVESTIGATION AND CORRECTIVE MEASURES STUDY REPORT FOR SOLID WASTE MANAGEMENT UNIT 74 FUEL PIPELINES AND HYDRANT PITS FUELING PIERS AREA NAVAL ACTIVITY PUERTO RICO (DRAFT ACTING AS FINAL)
8/16/2011
BAKER

DRAFT
PHASE II INVESTIGATION AND CORRECTIVE MEASURES STUDY REPORT SWMU 74 – FUEL PIPELINES AND HYDRANT PITS FUELING PIERS AREA

For NAVAL ACTIVITY PUERTO RICO
EPA I.D. No. PR2170027203
CEIBA, PUERTO RICO

Prepared for:

Department of the Navy
NAVFAC SOUTHEAST
North Charleston, South Carolina

Prepared by:

Baker

Michael Baker Jr., Inc.
Moon Township, PA

Contract No. N62470-10-D-3000
DO JM01

August 16, 2011

IQC for A/E Services for Multi-Media Environmental Compliance Engineering Support

DRAFT

PHASE II INVESTIGATION AND CORRECTIVE MEASURES STUDY REPORT SWMU 74 – FUEL PIPELINES AND HYDRANT PITS FUELING PIERS AREA

NAVAL ACTIVITY PUERTO RICO
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AUGUST 16, 2011

Prepared for:

DEPARTMENT OF THE NAVY
NAVFAC SOUTHEAST
North Charleston, SC

Under:

Contract No. N62470-10-D-3000
DELIVERY ORDER JM01

Prepared by:

MICHAEL BAKER JR., INC.
Moon Township, Pennsylvania

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS
(continued)

Page

TABLE OF CONTENTS
(continued)

Page

TABLES

TABLE OF CONTENTS
(continued)

TABLES

TABLE OF CONTENTS
(continued)

TABLES

FIGURES

TABLE OF CONTENTS
(continued)

APPENDICES

ACRONYMS AND ABBREVIATIONS

ABS	Absorption
ADAFs	Age-Dependent Adjustment Factors
AF	Adherence Factor
AOC	Area of Concern
ATs	Averaging Times
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	Area Use Factor
AUF_j	Area Use Factor for Receptor j
BAFs	Bioaccumulation Factors
Baker	Michael Baker Jr., Inc.
BERA	Baseline Ecological Risk Assessment
bgs	Below Ground Surface
BRAC	Base Realignment and Closure
BW_j	Body Weight for Receptor j
BW_r	Body Weight of Receptor Species
BW_t	Body Weight of Test Species
CAC	Corrective Action Complete
CADD	Computer Aided Design and Drafting
Cal EPA	California Environmental Protection Agency
CAOs	Corrective Action Objectives
CCME	Canadian Council of Ministers of the Environment
CDIs	Chronic Daily Intakes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERFA	Community Environmental Response Facilitation Act
CFR	Code of Federal Regulations
cm^2	Square Centimeters
CMS	Corrective Measures Study
CNO	Chief of Naval Operations
COCs	Chemicals of Concern
COPC	Chemical of Potential Concern
CRQLs	Contract Required Quantitation Limits
CSFs	Cancer Slope Factors
DADs	Dermally Absorbed Doses
DDT	Dichlorodiphenyltrichloroethane
DFM	Diesel Fuel Marine
DI_{xj}	Dietary Intake of Chemical x by Receptor j
DO	Delivery Order
DoN	Department of the Navy
DPT	Direct Push Technology
DRO	Diesel-Range Organics
E2SS3	Estuarine, Intertidal, Scrub-Shrub, Broad-Leaved Evergreen
EC	Exposure Concentration
ECOSAR	Ecological Structure Activity Relationships
ECO-SSL	Ecological Soil Screening Level
ECP	Environmental Condition of Property

ACRONYMS AND ABBREVIATIONS
(continued)

ED	Exposure Duration
EF	Exposure Frequency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESL	Ecological Screening Level
ET	Exposure Time
F	Fahrenheit
FC_{xi}	Concentration of Chemical x in Food Item i
FID	Flame Ionization Detector
FIR_j	Food Ingestion Rate for Receptor j
f_{oc}	Fraction of Organic Carbon
GIS	Geographic Information System
GPS	Global Positioning System
GRO	Gasoline-Range Organics
HEAST	Health Effects Assessment Summary Table
HHRA	Human Health Risk Assessment
HI	Hazard Index
HMW	High Molecular Weight
HQ	Hazard Quotient
IDW	Investigation Derived Waste
ILCR	Incremental Lifetime Cancer Risk
IR	Ingestion Rate
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
J	Estimated (data validation code)
K_d	Adsorption Coefficient
kg	Kilogram
kg/day	Kilogram per Day
K_{oc}	Organic Carbon Partition Coefficient
K_{ow}	Octanol-Water Partition Coefficient
K_{ww}	Biota to Soil Water Partitioning Coefficient
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
LC_{50}	Median Lethal Concentration
LD_{50}	Median Lethal Dose
LLPAHs	Low-Level Polynuclear Aromatic Hydrocarbons
LMW	Low Molecular Weight
LOAEC	Lowest Observed Adverse Effect Concentration
LOAELs	Lowest Observed Adverse Effects Levels
LOD	Limit of Detection
MATC	Maximum Acceptable Toxicant Concentration
MDL	Method Detection Limit

ACRONYMS AND ABBREVIATIONS
(continued)

mg	Milligram
mg/cm^2	Milligrams per Square Centimeter
MGD	Million Gallons per Day
mg/day	Milligrams per Day
mg/kg	Milligrams per Kilogram
mg/kg-BW/day	Milligram per Kilogram-Body Weight per Day
mg/L	Milligrams per Liter
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Liter
$\mu g/m^3$	Micrograms per Cubic Meter
MHSPE	Ministry of Housing, Spatial Planning and Environment
MMOA	Mutagenic Mode of Action
MRL	Method Reporting Limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAD	North American Datum
NAPR	Naval Activity Puerto Rico
NAVFAC	Naval Facilities Engineering Command
NAWQC	National Ambient Water Quality Criteria
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NFESC	Naval Facility Engineering Service Center
NOAEC	No Observed Adverse Effect Concentration
NOAELs	No Observed Adverse Effects Levels
$NOAEL_r$	No Observed Adverse Effect Level for the receptor species
$NOAEL_t$	No Observed Adverse Effect Level for the test species
NSRR	Naval Station Roosevelt Roads
ORP	Oxidation/Reduction Potential
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PDF_i	Proportion of Diet Composed of Food Item i
PDS	Proportion of Diet Composed of Soil/Sediment
PEF	Particulate Emission Factor
PID	Photoionization Detector
PMO	Program Management Office
POL	Petroleum, Oils, and Lubricant
ppm	Parts per Million
PPRTVs	Provisional Peer Reviewed Toxicity Values
ppt	Parts Per Thousand
PRDNR	Puerto Rico Department of Natural Resources
PREQB	Puerto Rico Environmental Quality Board
QC	Quality Control
QA/QC	Quality Assurance/Quality Control

ACRONYMS AND ABBREVIATIONS
(continued)

R	Rejected Data; Data is Not Usable (data validation code)
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RfCs	Reference Concentrations
RfDs	Reference Doses
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
SARs	Structure Activity Relationships
SC_x	Concentration of Chemical x in Soil/Sediment
SDG	Sample Delivery Group
SE	Southeast
SERA	Screening Level Ecological Risk Assessment
SOP	Standard Operating Procedure
STSC	Superfund Health Risk Technical Support Center
SVOCs	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
TRV	Toxicity Reference Values
U	Not Detected (data validation code)
UCL	Upper Confidence Limit
UJ	Not Detected, Estimated (data validation code)
ULM	Upper Limit of the Mean
UNEP	United Nations Environmental Program
USACE	U.S. Army Corp of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VDEQ	Virginia Department of Environmental Quality
VOCs	Volatile Organic Compounds
WQPs	Water Quality Parameters

1.0 INTRODUCTION

This report presents the results of the Phase II Corrective Measures Study (CMS) Investigation and evaluation for the Fueling Piers Area of Solid Waste Management Unit (SWMU) 74 – Fuel Pipelines and Hydrant Pits at Naval Activity Puerto Rico (NAPR), Ceiba, Puerto Rico. The report has been prepared by Michael Baker Jr., Inc. (Baker) for the Navy Base Realignment and Closure (BRAC) Program Management Office (PMO), Southeast (SE) Office under contract with the Naval Facilities Engineering Command (NAVFAC), SE (Contract Number N62470-10-D-3000, Delivery Order [DO] JM0103).

On January 29, 2007, the U.S. Environmental Protection Agency (USEPA) issued a Resource Conservation and Recovery Act (RCRA) §7003 Administrative Order on Consent (USEPA, 2007), which identified documented releases of solid and/or hazardous waste and hazardous constituents at SWMU 74 (formerly referred to as Environmental Condition of Property [ECP] Site 20). The Administrative Order required an acceptable work plan and a CMS to complete characterization of the SWMU and determine the final remedy. The Final Corrective Measures Study Work Plan – SWMU 74 (Baker, 2007) was approved by the USEPA on April 10, 2008. The Work Plan was revised in March 2011 to include Addendum A – Phase II of the CMS Investigation Work Plan (Baker, 2011) and subsequently approved by the USEPA on March 24, 2011.

The CMS Investigation for SWMU 74 was conducted in two phases. Phase I was conducted from April through June 2008 in accordance with the USEPA-approved Work Plan (Baker, 2007). The investigation included sampling along the pipelines and near valve pits to identify areas of potential petroleum-impacted soil and/or groundwater. A complete description of the investigation activities and results was previously presented in the report titled Revised Final Phase I of the Corrective Measures Study Investigation, SWMU 74 – Fuel Pipelines and Hydrant Pits (Baker, 2010); a summary of the Phase I results is presented in Section 2.3.2 of this report.

SWMU 74 transverses across a large area of the central and eastern portions of NAPR. Due to its large size and broad geographical coverage, the SWMU was divided into the following five geographical areas during preparation of the Phase I report, including the Fueling Piers Area which is the subject of this report:

- Airfield Area
- SWMU 9 Area A/B
- JP-5 Hill and Diesel Fuel Marine (DFM) Area
- SWMU 9 Area C
- Fueling Piers Area

This geographical division will be carried forward through the CMS process. The CMS for the remaining four areas of SWMU 74 will be provided under separate cover.

The Phase II CMS Investigation for the Fueling Piers Area was conducted from April 18 through April 29, 2011 in accordance with the USEPA-approved addendum to the Work Plan (Baker, 2011). The primary objective of Phase II was to delineate the extent of potential petroleum-related impacts identified during the first phase.

1.1 Purpose of Report

The overall purpose of this report is to meet the requirement for conducting a CMS for the Fueling Piers Area of SWMU 74 as specified in the §7003 Administrative Order. This report has been prepared to complete the characterization process and serves as the basis for selection of a corrective measure to protect human health and environment. The report presents the environmental data collected, evaluates potential ecological and human health risks, develops chemicals of concern (COCs) and corrective action objectives (CAOs) as applicable, and recommends a preferred corrective measure.

Based on results from the Phase I/Phase II CMS Investigations, it was determined that a streamlined CMS was appropriate for the Fueling Piers Area. A highly focused or streamlined CMS is appropriate for SWMUs that have "straightforward remedial solutions" where standard engineering practices can be applied that have proved effective in similar situations (USEPA, 1994). The corrective measure selected and documented in this CMS provides the most appropriate remedy to mitigate the identified risks.

1.2 Objectives

The specific objectives of the Phase II CMS for the Fueling Piers Area were as follows:

- Complete the characterization and delineation of petroleum-related impacts
- Identify specific COCs and their extent
- Identify realistic ecological and human health exposure pathways that may be present
- Develop ecological and human health CAOs for each media/COC
- Evaluate potential corrective measures in the form of a streamlined CMS that could be implemented to meet the CAOs
- Recommend a preferred corrective measure
- Develop the technical approach to implementing the recommended corrective measure

1.3 Report Organization

This CMS report is organized into 11 sections. Section 1.0 provides an introduction and presents the purpose of the report and objectives of the CMS. A brief summary of pertinent background information for NAPR and SWMU 74 is provided in Section 2.0. Section 3.0 discusses the climatology, topography, and regional geology, hydrology, and hydrogeology for NAPR. Section 4.0 provides a description of the Phase II CMS Investigation activities including soil and groundwater sampling, quality assurance/quality control (QA/QC) sampling, and other investigation considerations. Section 5.0 discusses the physical results from the CMS Investigation including current conditions and area geology/hydrogeology. Section 6.0 discusses the analytical results of the samples collected during the Phase II CMS Investigation and presents a summary of the data validation/usability assessment. Section 7.0 provides an evaluation of ecological risks. Similarly, Section 8.0 provides an evaluation of human health risks and develops CAOs based on protection of potential human receptors. A summary of the COCs and CAOs developed for protection of ecological and/or human receptors is provided in Section 9.0. Justification for the recommended corrective measure is provided in Section 10.0, and the technical approach to implementing the corrective measure is provided in Section 11.0. Tables and figures are presented directly behind the text for clarity purposes. Supporting information and documentation are presented in the appendices.

1.4 References

Baker. 2011. Addendum A (Phase II of the CMS Investigation Work Plan), Final Corrective Measures Study Work Plan – SWMU 74, Naval Activity Puerto Rico, Ceiba, Puerto Rico. March 4, 2011.

Baker. 2010. Revised Final Phase I of the Corrective Measures Study Investigation, SWMU 74 – Fuel Pipelines and Hydrant Pits, Naval Activity Puerto Rico, Ceiba, Puerto Rico. July 9, 2010.

Baker. 2007. Final Corrective Measures Study Work Plan – SWMU 74, Naval Activity Puerto Rico, Ceiba, Puerto Rico. December 6, 2007.

USEPA. 2007. RCRA §7003 Administrative Order on Consent. In the Matter of: United States The Department of the Navy, Naval Activity Puerto Rico formerly Naval Station Roosevelt Roads, Puerto Rico. Environmental Protection Agency, EPA Docket No. RCRA-02-2007-7301. January 29, 2007.

USEPA. 1994. RCRA Corrective Action Plan. Office of Solid Waste and Emergency Response. OSWER Directive 9902.3-2A. May 1994.

2.0 BACKGROUND

This section discusses the description and history of NAPR and SWMU 74. In addition, this section presents a summary of results from previous investigations conducted at the SWMU.

2.1 NAPR Description and History

NAPR occupies over 8,800 acres on the northern side of the east coast of Puerto Rico along Vieques Passage. Vieques Island lies to the east approximately 10 miles off the harbor entrance (see Figure 2-1). NAPR also occupies the immediately adjacent islands of Piñeros and Cabeza de Perro (see Figure 2-2). The northern entrance to NAPR is approximately 35 miles east along the coast road (Route 3) from San Juan. The property consists of 3,938 acres of upland (developable) property and 4,955 acres of environmentally sensitive areas including wetlands, mangroves, and wildlife habitat. The closest large town is Fajardo (population approximately 37,000), which is about 5 miles north of NAPR off Route 3. Ceiba (population approximately 17,000) adjoins the western boundary of NAPR (see Figure 2-1).

The facility was commissioned in 1943 as a Naval Operations Base and re-designated as a Naval Station in 1957. Naval Station Roosevelt Roads (NSRR) operated from 1957 until March 31, 2004. NSRR was one of the largest naval facilities in the world with more than 100 miles of paved roads, approximately 1,300 buildings, a large-scale airfield (Offsite Field), a deep water port, and over 30 tenant commands. NSRR played a major role in providing communication support to the Atlantic and Caribbean areas and also served as a major training site for fleet exercises.

Section 8132 of Fiscal Year 2004 Defense Appropriations Act, signed into law on September 30, 2003, directed that NSRR be disestablished within six months and the real estate disposal/transfer be carried out in accordance with procedures contained in the BRAC Act of 1990. This legislation required that the base closure be conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Community Environmental Response Facilitation Act (CERFA). NSRR has undergone operational closure as of March 31, 2004 and has been designated as NAPR. The mission of NAPR is to protect the physical assets remaining, comply with environmental regulations, and sustain the value of the property until its final disposal/transfer. NAPR will continue until the property disposal/transfer is completed.

In anticipation of operational closure of NSRR, the Naval Facilities Engineering Command, Atlantic Division (LANTDIV) prepared Phase I/Phase II ECP reports to document the environmental condition of NSRR. The Draft Phase I Environmental Condition of Property Report (LANTDIV, 2004) identified new sites at NAPR based on results from a review of records, an analysis of historical aerial photographs, physical site inspections, and interviews with persons familiar with past and current operations and activities. The new ECP sites had not been previously identified or investigated under existing environmental program areas. As a result, a Phase II ECP Investigation was conducted in 2004 and included environmental sampling to determine if a release/disposal actually occurred at any of the sites and, if so, whether any potential risks to human health were present. The Final Phase I/Phase II Environmental Condition of Property Report (NAVFAC Atlantic, 2005) recommends that additional sampling be undertaken at ECP Site 20 (SWMU 74) as part of the RCRA Corrective Action Program.

On January 29, 2007, the USEPA issued a RCRA §7003 Administrative Order on Consent (USEPA, 2007), which identified documented releases of solid and/or hazardous waste and hazardous constituents at SWMU 74 (formerly referred to as ECP Site 20). The Administrative Order required an acceptable work plan and a CMS to complete characterization of the SWMU and determine the final remedy.

2.2 SWMU 74 Description and History

SWMU 74 consists of fuel pipelines, valve pits, and hydrants and transverses across a large area of the central and eastern portions of NAPR (see Figure 2-2). It is estimated that approximately 60,000 feet of pipelines are present within the SWMU boundary based on information provided in the fuel pipeline and tank cleaning project completion report (AGVIQ-CH2M Hill, 2005).

SWMU 74 endpoints are the deep water piers located at the Ensenada Honda and the airfield hydrant system (see Figure 2-3). There are three piers located at the Ensenada Honda of which two were used for ship refueling and are equipped with fuel lines out over the water. The airfield endpoint includes a line of four aircraft refueling hydrants fed by a day tank storage area equipped with pumps, valves, and a filtration system. Typically, DFM was piped to the piers to fuel ships, and JP-5 was piped to the airfield to fuel planes. JP-5 was also used in some military ships because it was considered safer during combat due to the reduced flashpoint. JP-5 and DFM were stored in large, steel, above ground storage tanks or concrete, cut and cover, below ground (bunkered) tanks located at up to six different areas of NAPR. However, SWMU 74 is limited to the piping network and associated valve pits between these storage areas and not the storage areas themselves (USEPA, 2007). In addition, SWMU 74 does not include sediments in the Ensenada Honda as these have been designated as Area of Concern (AOC) D.

As previously discussed, SWMU 74 was divided into the following five geographical areas including the Fueling Piers Area, which is the subject of this report:

- Airfield Area
- SWMU 9 Area A/B
- JP-5 Hill and DFM Area
- SWMU 9 Area C
- Fueling Piers Area

The boundaries for these five areas are presented on Figure 2-4.

The Fueling Piers Area of SWMU 74 consists of the underground pipeline along Forrestal Drive and the spurs that lead to the Deep Water Fueling Pier (Pier No. 1) and the Berthing Pier (Pier No. 3). One valve pit (VP-56) is present within the Fueling Piers Area near the intersection of Forrestal Drive and Palau Street. No tanks are located within the area. However, the Tow Way Fuel Farm (SWMU 7/8) is located immediately north of VP-56.

2.3 Previous Investigations

SWMU 74 includes the previously designated ECP Site 20. The ECP site consisted of specific portions of the JP-5 and DFM fuel pipelines and the aircraft refueling hydrants. In 1995, NAVFAC, Atlantic Division evaluated the integrity of specific portions of the base petroleum, oils, and lubricant (POL) system. This evaluation identified leaks at two locations along the JP-5 pipeline and at selected valve pits. Petroleum-related impacts to soil were also identified at various locations throughout the tested portion of the JP-5 and DFM pipelines. In addition, interviews indicated that numerous small spills and leaks of fuel have occurred at the aircraft hydrant refueling area since it went into operation in the early 1960s.

Subsequent environmental sampling investigations conducted at SWMU 74 have included the Phase II ECP Investigation and Phase I CMS Investigation. A summary of the investigation activities and results is provided below.

2.3.1 Phase II ECP Investigation

The Phase II ECP Investigation (NAVFAC Atlantic, 2005) was conducted in 2004 and included environmental sampling near suspected leaky valves and pipeline runs. Seven soil borings (20E-SB01 through 20E-SB07 as shown on Figure 2-5) were advanced using a Geoprobe® rig and direct push technology (DPT) methods. Subsurface soil samples were collected from each boring down to the groundwater interface and field-screened for total volatile organic vapors using a flame ionization detector (FID).

Evidence of petroleum-impacted soil was observed at two of the boring locations (20E-SB05 and 20E-SB06). Petroleum odor, staining, and elevated FID measurements were identified at boring 20E-SB05 within the residual clay and bedrock from a depth of approximately 8 to 20 feet below ground surface (bgs). A slight petroleum odor and FID measurement were identified at boring 20E-SB06 from a depth of approximately 10 to 11.9 feet bgs. As a result, temporary monitoring wells were installed at these two locations.

Eight soil samples (including one field duplicate sample) and two groundwater samples were submitted to a qualified laboratory and analyzed for Appendix IX volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals (dissolved fraction for groundwater), and total petroleum hydrocarbons (TPH) gasoline-range organics (GRO) and diesel-range organics (DRO).

Based on the detections of petroleum-related constituents and exceedances of the screening values for benzene, ethylbenzene, xylenes, and lead, it was concluded that groundwater near location 20E-SB05 (DFM Area of SWMU 74) had been impacted by past activities at the site. However, soil at this location did not appear to be significantly impacted above the screening values. Nevertheless, because of the historical releases and findings of the investigation, the ECP recommended further investigation under the RCRA Corrective Action Program, which was the basis for incorporating SWMU 74 into the §7003 Administrative Order and ultimately for conducting this CMS.

2.3.2 Phase I CMS Investigation

The Phase I CMS Investigation was conducted from April through June 2008 in accordance with the USEPA-approved Final Corrective Measures Study Work Plan – SWMU 74 (Baker, 2007). The investigation included sampling along the pipelines and near valve pits to identify areas of potential petroleum-impacted soil and/or groundwater. A complete description of the investigation activities and results was previously presented in the report titled Revised Final Phase I of the Corrective Measure Study Investigation, SWMU 74 – Fuel Pipelines and Hydrant Pits (Baker, 2010).

Specifically, the investigation for the Fueling Piers Area of SWMU 74 included surface and/or subsurface soil sampling at 42 borings, installation of three new monitoring wells (74SB236, 74SB246, and 74SB256), and groundwater sampling at the three new wells and three existing wells (MW02, UGW12, and GW04). The boring and well locations are shown on Figure 2-6. The samples were submitted to a qualified laboratory and analyzed for Appendix IX VOCs, low-level polynuclear aromatic hydrocarbons (LLPAHs), metals (total and dissolved fraction for groundwater), and/or TPH GRO and DRO.

Total TPH was selected as an indicator of a release from the pipeline and/or valve pits in accordance with the Work Plan. Specifically, areas of potential petroleum-impacted soil and groundwater were identified using a screening value equal to 25 percent of the current Puerto Rico Environmental Quality Board (PREQB) screening criterion for total TPH of 100 milligrams per kilogram (mg/kg) for soil and 50 milligrams per liter (mg/L) for groundwater (i.e., 25 mg/kg for soil and 12.5 mg/L for groundwater). In addition, the relationships between polynuclear aromatic hydrocarbons (PAHs), metals, and TPH were evaluated to determine a potential trigger level for TPH, above which the presence of one or more PAH constituents or metals would be likely. The overall result of this evaluation suggested that the detection of PAHs and metals in the soil and groundwater samples was not necessarily the result of a release from SWMU 74. Consequently, detections of these constituents in excess of background, ecological, and/or human health screening values were considered on a case-by-case basis and did not automatically trigger identification of an area for additional investigation under the Phase II CMS.

Petroleum-impacted surface soil was identified at two of the boring locations (74SB221 and 74SB231) based on total TPH concentrations of 100 J and 69 mg/kg, respectively. In addition, petroleum-impacted subsurface soil was identified at 15 of the boring locations (74SB215, 74SB216, 74SB218, 74SB221 through 74SB224, 74SB256, 74SB258, 74SB260, 74SB261, 74SB263 through 74SB265, and 74SB267) based on total TPH values ranging from 25.018 J to 2,929 mg/kg.

Except for location 74SB231, these borings are located proximate to the Tow Way Fuel Farm (SWMU 7/8). The TPH detections (as well as LLPAH detections) are further verification of the historical petroleum-related impacts from the fuel farm. Consequently, these locations were not moved into the Phase II CMS Investigation because they are being addressed under SWMU 7/8.

Total TPH in groundwater did not exceed the established screening value in any of the six wells sampled. However, benzo[a]anthracene (0.036 J micrograms per liter [μg/L]) was detected at a low, estimated concentration in the groundwater sample collected from well 74SB246. The concentration exceeded the USEPA Regional Screening Level (RSL) for tap water.

2.4 References

AGVIQ-CH2M Hill. 2005. Project Completion Report for Mothball DESC and Cut and Cover Tanks, Naval Activity Puerto Rico, Ceiba, Puerto Rico. October 2005.

Baker. 2010. Revised Final Phase I of the Corrective Measures Study Investigation, SWMU 74 – Fuel Pipelines and Hydrant Pits, Naval Activity Puerto Rico, Ceiba, Puerto Rico. July 9, 2010.

Baker. 2007. Final Corrective Measures Study Work Plan – SWMU 74, Naval Activity Puerto Rico, Ceiba, Puerto Rico. December 6, 2007.

LANTDIV. 2004. Draft Phase I Environmental Condition of Property Report, U.S. Naval Station Roosevelt Roads, Ceiba, Puerto Rico. March 31, 2004.

NAVFAC Atlantic. 2005. Final Phase I/II Environmental Condition of Property Report, Former U.S. Naval Station Roosevelt Roads, Ceiba, Puerto Rico. July 15, 2005.

USEPA. 2007. RCRA §7003 Administrative Order on Consent. In the Matter of: United States The Department of the Navy, Naval Activity Puerto Rico formerly Naval Station Roosevelt Roads, Puerto Rico. Environmental Protection Agency, EPA Docket No. RCRA-02-2007-7301. January 29, 2007.

3.0 PHYSICAL CHARACTERISTICS OF STUDY AREA

The physical setting of NAPR was documented in the Initial Assessment Study of Naval Station Roosevelt Roads (Naval Energy and Environmental Support Activity [NEESA], 1984). Pertinent information is summarized in the following sections.

3.1 Climatology

The climate associated with NAPR is characterized as warm and humid with frequent showers occurring throughout the year. A major factor affecting the weather is the pattern of trade winds associated with the Bermuda High, the center of which is in the vicinity of 30^{o} North, 30^{o} West. The prevailing wind direction reflects the easterly trade winds. The area receives a surface flow varying between the northeast to the southeast about 75 percent of the year, and as much as 95 percent of the time in July when the easterly winds are strongest. The differential heating of the land and sea during the day tends to give a more northerly component to the flow on the northern side of the island and a more southerly component on the southern side. During the night, a land breeze causes a prevailing southeasterly flow in the north and a prevailing northeasterly flow over the southern coast. The mean annual wind velocity is 5.5 knots with a minimum in November and a maximum in August. Gales associated with westward moving disturbances in the trade winds or hurricanes passing either north or south of the area have the highest probability of occurrence from June through October.

Uniform temperatures prevail with small diurnal ranges as a result of insular exposure and the relatively small land areas. The warmest months are August and September, while the coolest are January and February. Mean annual maximum temperatures range from 82.0° Fahrenheit (F) in January to 88.2° F in August. The mean annual minimum temperatures vary from 64.0° F in January to 73.2° F in June. The highest maximum temperature recorded was 95.0° F, while the lowest minimum was 59.0° F. Rain usually occurs at least nine days in every month with an average of 60 inches per year, although a dry winter season occurs from December through April. About 22 thunderstorm-days occur per year with maximum frequencies of three days per month from May through October.

In late summer, the mean sky cover begins a steady decrease from a monthly maximum average of 6.5-tenths coverage in September to a minimum monthly average of 4.4-tenths coverage in February. From March through August, the monthly average cloud cover increases steadily from 4.5- to 6.0-tenths coverage. Over the open sea, a maximum of clouds (usually broken stratocumulus) occurs during early morning. The skies generally clear or become scattered with cumulus clouds by afternoon. Completely clear or overcast skies are rare during daylight hours, while clear skies frequently occur at night.

An average of two tropical storms per year occurs in the study area, one of which usually reaches hurricane intensity. The hurricane season is from mid-June through mid-September, and maximum winds exceed 95 knots during severe hurricanes.

3.2 Topography

The regional area of NAPR consists of an interrupted, narrow coastal plain with small valleys extending from the Sierra de Luquillo range, which has been severely eroded by streams into valleys several hundreds of feet deep. Slopes up to 60^{o} are common.

In the immediate area of NAPR, elevations range from sea level to approximately 295 feet above sea level. Immediately north of the NAPR boundary, the hills rise abruptly to heights of 800 to 1,050 feet above sea level. The tallest peak is located within 2 kilometers of the NAPR boundary. There is a series of three hilly areas on NAPR, two of which separate the southern airfield area from the port/industrial, housing, and personnel support areas. The third set of hills is in the Fort Bundy area. These ridgelines not only separate sections of NAPR, but also dictate the degree of allowable development. Relief is low along the shoreline, and lagoons and mangrove swamps are common.

3.3 Geology, Hydrology, and Hydrogeology

The following sections present general descriptions of the geologic, hydrologic, and hydrogeologic conditions across NAPR. Specific geologic and hydrogeologic information collected during the Phase I/Phase II CMS Investigations at the Fueling Piers Area of SWMU 74 is provided in Section 5.2.

3.3.1 Soils

The soil associations present at NAPR predominantly consist of the Swamps-Marshes Association and the Mabi-Rio-Arriba-Cayagua Association, which are typical of humid areas, and the Descalabrado-Guayama Association, which is typical of dry areas. In addition, isolated areas of the Caguabo-Mucara-Naranjito Association, the Coloso-Toa-Bajura Association, and the Jacana Amelia-Fraternidad Association are present at NAPR. The Swamps-Marshes Association and Mabi-Rio-Arriba-Cayagua Association cover over one half of NAPR's surface area and are equally distributed. The Descalabrado-Guayama Association and Caguabo-Mucara-Naranjito Association primarily cover the remaining area.

The Swamps-Marshes Association consists of deep, very poorly drained soils. This association is present in level or nearly level areas that are slightly above sea level but are wet, and when the tide is high, are covered or affected by saltwater or brackish water. The soils are sandy or clayey and contain organic materials from decaying mangrove trees. Coral, shells, and marl at varying depths underlie these soils. The high concentration of salt inhibits the growth of vegetation except mangrove trees and, in small-scattered patches, other salt-tolerant plants.

The Mabi-Rio-Arriba-Cayagua Association consists generally of deep, somewhat poorly drained and moderately well drained, nearly level to moderately steep soils present on foot and side slopes, terraces, and alluvial fans. Soils of this association are basically clayey.

The Descalabrado-Guayama Association generally consists of shallow, well drained, strongly sloping to very steep soils on volcanic uplands. Soils of this association are present primarily in the hilly areas located directly inland and adjacent to soils of the Swamps-Marshes Association.

The Caguabo-Mucara-Naranjito Association consists generally of shallow and moderately deep, well drained, sloping to very steep soils on volcanic uplands. This association consists of soils that formed in residual material weathered from volcanic rocks. The association is represented at NAPR by soils of the Sabana series, which are present on the side slopes and hilly terrain west of Langley Drive in the Fort Bundy area. These soils are suited for pasture and woodland. Steep slopes, susceptibility to erosion, and depth to bedrock are the main limitations for farming and for recreation and urban areas.

The Coloso-Toa-Bajura Association consists of deep, moderately well drained to poorly drained, nearly level soils present on floodplains. This soil association extends along the western boundary of NAPR and around the airfield. The soils of this association formed in fine-textured and moderately fine-textured sediment of mixed origin on floodplains. The Coloso soils are deep and somewhat poorly drained; the Toa soils are deep and moderately well drained; and the Bajura soils and Maunabo soils are deep and poorly drained. The Reilly soils, also part of this association, are shallow sands and gravels and are excessively drained. These soils lie adjacent to streams. The minor soils include Talante, Vivi, Fortuna, Vega Alta, and Vega Baja. The Talante, Vivi, Fortuna, and Vega Baja soils are present on floodplains, while the Vega Alta soils occupy slightly higher positions on terraces.

The Jacana-Amelia-Fraternidad Association consists generally of moderately deep and deep, well drained and moderately well drained, nearly level to strongly sloping soils on terraces, alluvial fans, and foot slopes. This association is represented at NAPR by soils of the Jacana series, which consist of moderately deep, well-drained soils present on the foot slopes and low rolling hills along Langley Drive and just east of the airfield. These soils formed in fine-textured sediment and residuum derived from basic volcanic rocks.

3.3.2 Regional Geology

The underlying geology of NAPR is predominantly volcanic (composed of lava and tuff) and sedimentary (rocks derived from discontinuous beds of limestone). These rocks all range in age from the early Cretaceous to middle Eocene periods. The volcanic rocks and interbedded limestone have been complexly faulted, folded, metamorphosed, and variously intruded by dioritic rocks. This complex geological structuring occurred sometime after deposition of the limestone during the middle Tertiary period when Puerto Rico was separated from the other major Antillean Islands by block faulting and was arched, uplifted, and tilted to the northeast. Culebra, Vieques, and the Virgin Islands are part of the Puerto Rican block. These islands are separated from the main island simply because of the drowning that resulted from the tilting. In addition to the predominant volcanic and sedimentary rock, unconsolidated alluvial and older deposits from the Quaternary period underlie the northwestern and western sectors of the base.

The primary geologic formations on and near NAPR are various beach deposits, alluvium, quartz diorite and granodiorite, quartz keratophyre, the Daguao Formation, and the Figuera Lava. The Peña Pobre fault zone traverses NAPR.

3.3.3 Regional Hydrology

The surface waters that flow across the northeastern plain of Puerto Rico, where NAPR is located, originate on the eastern slopes of the Sierra De Luquillo Mountains. Surface runoff is channeled into various rivers and streams that eventually flow into the Caribbean Sea. The Rio Daguao River and Quebrada Seca Stream (a tributary to Rio Daguao River) collect surface waters from the hills immediately north of NAPR, and during periods of heavy rain, flooding on NAPR occurs. The Daguao-Quebrada Seca watershed comprises an area of approximately 7.6 square miles (4,900 acres), and the river falls some 700 feet from its source to sea level. Increased development in the town of Ceiba, especially in areas adjacent to NAPR's northern boundary, has significantly increased the surface runoff reaching NAPR, which results in ponding and erosion in the Boxer Drive area. Boxer Drive, for a major portion of its length, is subject to surface water flooding, as are Hangar 200, Hangar 379, and adjacent apron areas. This condition has been alleviated by construction of a new highway (Route 3) immediately outside the fence, realignment of Boxer Drive, and installation of storm water management features associated with both roadways.

In the low-lying shore areas, seawater flooding results from storms, wind, and abnormally high tides. The tidal ranges in the NAPR area are rather small with a maximum spring range of less than 3 feet. The tides are semidiurnal and have a usual range of about 1 foot in the main harbor of NAPR.

The quality of surface waters is variable, which is a reflection of the drainage area through which the water flows. Generally, surface waters have high turbidities and bio-organics (naturally occurring organics, such as decay products of vegetable and animal matter) due to the periodic heavy rains that can easily erode soils from steep slopes, exposed areas, and disturbed streambeds.

Water from alluvial aquifers along the coast of NAPR is of a calcium bicarbonate type and has high concentrations of iron and manganese. The source of these minerals is unknown, but they may be derived from buried swamp or lagoon deposits. A seawater-freshwater interface is present in the aquifers throughout the coastal areas of Puerto Rico usually within a short distance inland of the coastline.

The NAPR potable water treatment plant receives raw water from the Rio Blanco through a 27-inch, reinforced concrete pipe that replaced the old, open channel. The intake is located at the foot of the El Yunque rain forest. This buried raw water line traverses a distance of 14 miles from the intake to the NAPR boundary. A raw water reservoir is located at the water treatment plant and has a 45 million gallon capacity. In addition, there are two fire protection storage reservoirs with a total capacity of 520,000 gallons.

NAPR has been served for over 30 years by the present treatment facility. The plant (Building 88) has a capacity of 4.0 million gallons per day (MGD). Water flows by gravity into a 45 million-gallon, raw water storage basin from which the plant draws its supply at a rate of 1.3 MGD on average. Treatment consists of pre-chlorination, coagulation sedimentation, filtration, and post-chlorination.

3.3.4 Regional Hydrogeology

Little information exists concerning the hydrogeology of NAPR. The only known potential sources of groundwater lie in lenticular beds of clay, sand and gravel, and rock fragments, which occur at a depth of less than 30 meters. No wells have been developed on base from these layers. Some wells had been developed up gradient of NAPR in Ceiba, some three kilometers from base headquarters, but were abandoned due to high levels of salinity.

The hydrogeology can be better understood in context of the NAPR regional geology. For the sake of simplicity, the NAPR regional geology can be divided into the following three regions:

- Upland areas
- Near-shore flat land areas
- Inland flat land areas

The upland areas of NAPR include the hills encompassing the Tow Way Fuel Farm and hospital areas and the hills encompassing the area behind the exchange, the former Atlantic Fleet Weapons Training Facility Command, and the Fort Bundy area. These upland areas are underlain by bedrock (predominately Gabbro) and exhibit varying degrees of weathering. Typically, the bedrock is overlain by a relatively thin residual soil (i.e., residuum) that originated from weathered-in-place bedrock. This residuum generally consists of sand, silt, and clay.

The near-shore flat land areas include mangrove swamps and the shores of the Ensenada Honda and Puerca Bay. The near-shore areas are typically underlain by marine sand layers with coral and shell fragments, silt and clay layers, and occasional peat layers. In some near-shore areas, particularly by the harbor and Camp Moscrip in the southeastern portion of NAPR, fill material overlays the marine layers. The fill consists of rock fragments, debris (e.g., brick), sand, silt, and clay.

The inland flat land areas generally encompass the airfield and golf course areas and are typically underlain by relatively thick residuum. In general, the residuum consists predominately of clay. Fill material overlays the residuum in some areas, particularly the airfield, and generally consists of sand and gravel with lesser amounts of silt and clay.

3.4 References

NEESA. 1984. Initial Assessment Study of Naval Station Roosevelt Roads, Puerto Rico. NEESA 13-051.

4.0 PHASE II CMS INVESTIGATION ACTIVITIES

The Phase II CMS Investigation for the Fueling Piers Area of SWMU 74 was conducted from April 18 through 29, 2011 and included the following:

- Surface soil sampling at 13 borings
- Subsurface soil sampling at six borings
- Groundwater sampling at one existing monitoring well

Other activities were also conducted in support of the investigation and included decontamination and investigation derived waste (IDW) management, utility clearance, surveying, QA/QC sampling, laboratory analyses, and data validation. The investigation was conducted in accordance with the USEPA-approved addendum (Phase II of the CMS Investigation Work Plan) to the Final Corrective Measures Study Work Plan – SWMU 74 (Baker, 2011).

A summary matrix showing the primary environmental, field duplicate, and matrix spike/matrix spike duplicate (MS/MSD) samples collected and the associated analyses is presented on Table 4-1. Other QA/QC samples (e.g., trip blanks, field blanks, equipment rinsate blanks) collected and the associated analyses are presented on Table 4-2. The analytical parameter lists and contract required quantitation limits (CRQLs) are presented on Table 4-3. Site photographs, field logbook notes, daily meter calibration records, test boring records, groundwater sampling forms, and chain-of-custody forms are included in Appendix A. The laboratory analytical results are included in Appendix B, and the data validation report summaries are included in Appendix C.

The following sections present an overview of the investigation procedures and rationale behind specific sampling locations. The sample and monitoring well locations are shown on Figures 4-1 and 4-2.

4.1 Surface and Subsurface Soil Sampling

Petroleum-impacted surface soil was identified at boring 74SB231 (Phase I CMS Investigation) based on a total TPH concentration of 69 mg/kg. Therefore, on April 18, 2011, six shallow borings (74SB748 through 74SB753 as shown on Figure 4-2) were advanced to a depth of 4 feet bgs in the vicinity of this location to further characterize and delineate the extent of TPH. The boring specifications are summarized on Table 4-4.

The borings were advanced by GeoEnviroTech, Inc. of Guaynabo, Puerto Rico using a 6610DT Geoprobe® and DPT methods. A 4-foot soil core was collected from each boring using new, disposable acetate liners and a Macro-Core® sampler. Upon retrieval of the sampler, the acetate liner was removed and sliced with a cutting tool to expose the soil core. Each soil core was then field-screened at 0.5-foot intervals for total volatile organic vapors using a photoionization detector (PID) equipped with an 11.7 eV probe and calibrated to isobutylene. The highest PID reading for each interval was recorded in the field logbook and on test boring records (Appendix A).

No PID measurements or obvious visual/olfactory impacts were identified in the borings except for boring 74SB748. Petroleum odors, staining, and a PID measurement of 10.5 parts per million (ppm) were identified in boring 74SB748 within the silty, sand and gravel fill material from a depth of approximately 0.2 to 0.5 feet bgs. As a result, on April 19, 2011, two additional borings (74SB754 and 74SB755 as shown on Figure 4-2) were advanced to a depth of approximately 1 foot bgs using decontaminated, stainless steel bucket augers.

One surface soil sample (generally 0 to 1 foot bgs) and one subsurface soil sample (generally 1 to 3 feet bgs) were collected from each of the six DPT borings and submitted to the laboratory for analyses of Appendix IX VOCs, LLPAHs, metals, and TPH GRO and DRO. In addition, one surface soil sample (0 to 1 foot bgs) was collected from each of the two bucket auger borings for laboratory analyses. Subsurface soil samples were not collected from the bucket auger borings because the petroleum-related impacts identified in the initial DPT borings, as well as boring 74SB231 (Phase I CMS Investigation), were limited to surface soil. Soil for VOC and TPH GRO analyses was collected using TerraCore® sampling devices and preserved in accordance with USEPA Method 5035. Soil for all other analyses (e.g., LLPAHs, metals, TPH DRO) was then thoroughly homogenized in a disposable pan using a stainless steel spoon to ensure that the sample was as representative of the sample interval as possible. The homogenized sample was placed into appropriate, laboratory-supplied containers.

The soil samples were also analyzed in the field for TPH using PetroFlag™ chemical test kits. The PetroFlag™ test kits use patented chemistry and a turbidimeter to measure the concentration of a broad range of hydrocarbons in a sample after soil extraction. However, upon evaluation, it was determined that the PetroFlag™ data did not correlate well with the PID measurements and visual/olfactory observations. Therefore, the laboratory was requested to analyze the soil samples for TPH GRO and DRO on an expedited turnaround time.

Preliminary evaluation of the resulting TPH data from the initial eight borings indicated that the extent of TPH in surface soil had not been fully delineated in the vicinity of borings 74SB748, 74SB749, 74SB753, and 74SB755. Therefore, on April 29, 2011, five additional borings (74SB756 through 74SB760 as shown on Figure 4-2) were advanced to a depth of approximately 1 foot bgs using decontaminated, stainless steel bucket augers. One surface soil sample (0 to 1 foot bgs) was collected from each boring and handled/analyzed as previously described.

Soil descriptions, including estimates of grain size, moisture content, discoloration, odor, PID measurements, and other visual observations, were recorded in the field logbook and/or on test boring records (Appendix A). Subsequent to sampling, the minimal volume of remaining soil from the DPT borings was placed back into each respective boring, and the boreholes were backfilled with bentonite grout. The bucket auger borings were backfilled with their excess soil cuttings.

4.2 Groundwater Sampling

Benzo[a]anthracene (0.036 J µg/L) was detected at a low, estimated concentration in the groundwater sample collected from monitoring well 74SB246 in May 2008 (Phase I CMS Investigation). The concentration exceeded the USEPA RSL for tap water. As a result, this well was re-sampled on April 19, 2011 and analyzed for LLPAHs to confirm the detection.

Prior to sampling, the water level was measured in the well. In addition, an interface probe was used to carefully determine the presence of any potential non-aqueous phase liquid accumulation in the well. No free-phase product was detected in the well.

The well was sampled using a decontaminated, stainless steel bladder pump and low flow purging/sampling methods (USEPA, 1998) to minimize sampling-induced turbidity problems and provide a sample representative of ambient groundwater quality. Water quality parameters (WQPs), including pH, oxidation/reduction potential (ORP), specific conductance, dissolved oxygen, temperature, and turbidity, were measured frequently during purging and recorded on a groundwater sampling form (Appendix A). The field testing was conducted within a flow-through cell that limited exposure of the groundwater to the atmosphere while the field measurements were recorded. Purging was considered complete when three successive WQP readings stabilized within 0.1 Standard Units for pH, 10 millivolts for ORP, 3 percent for specific conductance, and 10 percent for dissolved oxygen and turbidity. Temperature readings were recorded but not used for stabilization evaluation. Temperatures measured at the surface are affected to some extent by the difference between ambient air and groundwater temperatures and thus can vary over short periods. Upon WQP stabilization, the groundwater sample was collected from the end of the tubing and placed into appropriate, laboratory-supplied containers.

4.3 Decontamination and Investigation Derived Waste Management

Disposable sampling equipment was used to the extent practicable in order to minimize the potential for cross contamination and liquid IDW generated from decontamination. Non-disposable soil sampling equipment (e.g., Geoprobe® tools, stainless steel bucket augers) was decontaminated in accordance with the approved Work Plan (Baker 2011). The stainless steel bladder pump and its components were decontaminated in accordance with procedures described in the USEPA low stress (low flow) purging and sampling guidance document (USEPA, 1998).

There were no IDW samples collected as part of this investigation. The small volume of decontamination liquid (approximately three gallons) was containerized with the JP-5 Hill and DFM area liquids as the two investigations were conducted within the same timeframe. The minimal volume of remaining soil from the borings was placed back into each respective borehole.

4.4 Utility Clearance

Base utility mapping was reviewed to verify the presence/absence of subsurface utilities in the vicinity of the proposed boring locations. In addition, the boring locations were field-located using a survey-grade global positioning system (GPS) unit, and the presence/absence of subsurface utilities was field-verified to the extent practicable. Subsurface utilities were not encountered during the investigation.

4.5 Surveying

Prior to entering the field, an electronic "shape file" that included each proposed boring location was obtained from the Computer Aided Design and Drafting (CADD)/Geographic Information System (GIS) at Baker and uploaded to the GPS unit. Once in the field, the GPS unit was used to navigate to each boring location. Each boring location was then flagged and numbered accordingly.

Subsequent to sampling, the boring locations were more accurately surveyed by Pedro Davila Colon, Inc. of San Juan, Puerto Rico using conventional survey methods. The locations were surveyed for topographic elevation and horizontal position. The vertical data was to the nearest 0.01-foot and referenced to the mean low water plus 100.00 feet as established by the U.S. Navy Survey Section (November 1941). The horizontal data was to the nearest 0.05-foot and referenced to the U.S. State Plane coordinate system, Puerto Rico/Virgin Island 5200, North American Datum (NAD) 1983. Survey data is provided on Table 4-4.

4.6 QA/QC Sampling

Field QA/QC samples were collected during the Phase II CMS Investigation to assess the precision, accuracy, and representativeness of the data and included field duplicate samples, MS/MSD samples, trip blanks, a field blank, and equipment rinsate blanks. Summary matrices of the QA/QC samples collected and the associated analyses are presented on Tables 4-1 and 4-2.

4.6.1 Field Duplicate Samples

Field duplicate samples were collected at a minimum frequency of approximately 10 percent for each group of primary environmental samples of a similar matrix, as follows:

- Surface Soil – Two duplicate samples (74SB748-00D and 74SB759-00D) corresponding to 13 surface soil samples

- Subsurface Soil – One duplicate sample (74SB748-01D) corresponding to six subsurface soil samples

- Groundwater – One duplicate sample (74GW246BD) corresponding to one groundwater sample

The duplicate samples consisted of one unique sample, split into two aliquots, and analyzed independently for the same parameters as the corresponding original samples. Duplicate soil samples analyzed for parameters other than VOCs and TPH GRO were homogenized and split. Samples for VOC and TPH GRO analyses were not homogenized, but select segments of the soil were collected. The duplicate water sample was collected simultaneously. The results were used to evaluate the consistency with which the environmental samples were collected. In addition, the results were used to evaluate the degree of variability of reported concentrations in the samples.

4.6.2 MS/MSD Samples

MS/MSD samples were collected at a minimum frequency of approximately 5 percent for each group of primary environmental samples of a similar matrix, as follows:

- Surface Soil – Two MS/MSD samples (74SB748-00 and 74SB759-00) corresponding to 13 surface soil samples

- Subsurface Soil – One MS/MSD sample (74SB748-01) corresponding to six subsurface soil samples

- Groundwater – One MS/MSD sample (74GW246B) corresponding to one groundwater sample

The samples were collected in the field using the same procedures as duplicate samples and analyzed independently for the same parameters as the corresponding original samples. The results were used to evaluate the effect of each type of matrix on the analytical methods.

4.6.3 Trip Blanks

Trip blanks were samples of analyte-free water prepared at the laboratory before commencement of the sampling event and shipped to the sampling team along with the unopened sample containers. The trip blanks were then randomly selected and included in each cooler containing samples for volatile organics analysis. A total of three trip blanks (74TB114, 74TB115, and 74TB117) were analyzed for Appendix IX VOCs and TPH GRO. The results were used to verify that the sample containers and method of sample container handling used throughout the sampling program did not contribute to contamination of the samples. In addition, the results were used to identify other potential sources of field or laboratory contamination.

4.6.4 Field Blanks

One field blank (74FB01) was collected from the laboratory-grade deionized water used as the source water for the equipment rinsate blanks. No store-bought distilled water was used for decontamination purposes during this investigation, so an additional field blank was not necessary. The sample was analyzed for Appendix IX VOCs, LLPAHs, metals (total fraction), and TPH GRO and DRO. The results were used to determine whether the water used for collecting the equipment rinsate blanks was free of chemicals at levels of concern for the SWMU. In addition, the results were used to identify other potential sources of field or laboratory contamination.

4.6.5 Equipment Rinsate Blanks

A total of four equipment rinsate blanks were collected from the disposable and non-disposable sampling equipment, as follows:

- 74ER114 – Acetate liner/stainless steel spoon/disposable pan
- 74ER115 – Stainless steel bladder pump
- 74ER116 and 74ER117 – Stainless steel bucket auger

The equipment rinsate blanks were collected under representative field conditions by running laboratory-grade deionized water over/through the sampling equipment and placing it into the appropriate sample containers for laboratory analyses. The samples were analyzed for the same parameters as the corresponding primary environmental samples. The results were used to verify that the sampling equipment did not contribute to contamination of the samples.

4.7 Laboratory Analyses

Samples collected for laboratory analyses were stored on ice in coolers at approximately 4° Celsius and delivered by Federal Express to Test America in Savannah, Georgia. Chain-of-custody forms (Appendix A) were completed and enclosed in the shipping packages.

Summary matrices showing the primary environmental and QA/QC samples collected and the associated analyses are presented on Tables 4-1 and 4-2. The analytical parameter lists and CRQLs are presented on Table 4-3. The data was certified by a Puerto Rico-certified chemist. The laboratory analytical results are included in Appendix B, and the Puerto Rico chemist certificates are included in Appendix C.

4.8 Data Validation

Independent, third-party data validation services were provided by DataQual Environmental Services of St. Louis, Missouri. Laboratory analytical results were evaluated to assess the technical adequacy and usability of the data. The data were validated in accordance with the SW-846 methods utilized by the laboratory, specifications set forth in the USEPA Region II Standard Operating Procedures for Validation of Organic Data Acquired using SW-846 Methods, and professional judgment. It should be noted that Region II has not developed a validation checklist SOP for the methods used to assess TPH GRO and DRO (SW-846 Method 8015) and inorganics (SW-846 Methods 6020 and 7470/7471). Therefore, alternative worksheets were provided. Region II flagging conventions were used. A summary of the data validation/usability assessment is presented in Section 6.5, and the data validation report summaries for each Sample Delivery Group (SDG) are included in Appendix C.

4.9 References

Baker. 2011. Addendum A (Phase II of the CMS Investigation Work Plan), Final Corrective Measures Study Work Plan – SWMU 74, Naval Activity Puerto Rico, Ceiba, Puerto Rico. March 4, 2011.

USEPA. 1998. Ground Water Sampling Procedure, Low Stress (Low Flow) Purging and Sampling. GW Sampling SOP, Final. March 16, 1998.

5.0 PHYSICAL RESULTS

The following sections provide a brief discussion of the current conditions and geology/hydrogeology at the Fueling Piers Area of SWMU 74 at the time of this Phase II CMS Investigation (April 2011).

5.1 Current Conditions

The Fueling Piers Area is located adjacent to the Ensenada Honda and consists of the underground pipeline along Forrestal Drive and the spurs that lead to the Deep Water Fueling Pier (Pier No. 1) and Berthing Pier (Pier No. 3) (see Figure 4-1). One valve pit (VP-56) is present within the Fueling Piers Area near the intersection of Forrestal Drive and Palau Street. No tanks are located within the area. Land use in the immediate vicinity is predominantly industrial. An unnamed asphalt roadway leads to the Phase II CMS Investigation area and the Berthing Pier. Buildings/structures within the investigation area primarily include the Emergency Fire Deluge System Building (SWMU 75), an open-aired structure (canopy) that contains hose racks, an open-aired structure that covers a portion of the SWMU 74 fuel pipelines and valves, and an electrical substation for the Berthing Pier.

Prior to operational closure of NSRR on March 31, 2004, the upland vegetative community within the boundary of the Fueling Piers Area consisted of maintained grasses of unknown species composition. Although the Navy continues to conduct grass cutting operations base wide, these operations are generally restricted to areas immediately adjacent to primary roads. Observations during the Phase II CMS Investigation indicated that cutting operations at the Fueling Piers Area are restricted to locations immediately adjacent to Forrestal Drive, and the once maintained grasses are undergoing secondary succession (likely toward a coastal scrub forest community). Vegetation primarily includes white lead tree (*Leucaena leucocephala*) and monkeypod (*Pithecellobium dulce*).

Other than the Ensenada Honda, there are no watercourses or isolated, aquatic natural resources (e.g., streams, wetlands) in the immediate vicinity of the Fueling Piers Area. Most of the surface drainage infiltrates into the ground or discharges into the Ensenada Honda via several storm water conveyances and outfalls. The drainage features/boundaries in the vicinity of the Phase II CMS Investigation area are shown on Figure 5-1.

The Tow Way Fuel Farm (SWMU 7/8) is located immediately north of the Deep Water Fueling Pier (Pier No. 1) (see Figure 2-3). Petroleum impacts attributed to the fuel farm have been documented within the boundary of SWMU 74, and petroleum recovery has been historically conducted along Forestall Drive and leading out to the western most fueling pier. Other SWMUs that are located within and proximate to the Fueling Piers Area include SWMUs 10, 55, 75, and 76 (see Figures 2-2 and 4-1). SWMU 10 was a former area where electrical transformers were repaired; SWMU 55 is associated with a trichloroethene (TCE) plume in groundwater; and SWMU 75 was a former Emergency Fire Deluge System Building that housed water transfer pumps. SWMU 76 is the U.S. Army Reserve Boat Maintenance Facility. Contaminants potentially associated with this SWMU include metals and paint-related hydrocarbons.

5.2 Area Geology and Hydrogeology

The Fueling Piers Area is exclusively located along the coastal boundary of the Ensenada Honda waters and within the near-shore flat land regional geology area. The near-shore flat land areas are typically underlain by marine sand layers with coral and shell fragments, silt and clay layers, and occasional peat layers. In some near-shore areas, particularly by the harbor and Camp Moscrip in the southeastern portion of NAPR, fill material overlays the marine layers. The fill consists of rock fragments, debris (e.g., brick), sand, silt, and clay.

Sixty-four soil borings (see Figure 4-1) were advanced at the Fueling Piers Area during the Phase I/Phase II CMS Investigations. In general, lithologies identified in the borings were consistent with the near-shore flat land regional geology. Fill material is present along the pipeline and primarily consists of sands and gravels mixed with shell and coral fragments. Wood and concrete are also present within the fill material in localized areas. The depth of fill material generally ranged between 5 and 12 feet bgs (the total depth of most borings) but extended to a depth of 19 feet bgs in one boring. Marine deposits, generally consisting of sand and shell fragments, were present below the fill material in some borings. Peat was present in borings 74SB236 and 74SB256 at depths of 15 and 19 feet bgs, respectively. In addition, bedrock, consisting of relatively competent gabbro, was present in boring 74SB246 at a depth of 11 feet bgs. Test boring and well construction records are included in Appendix A of the Revised Final Phase I of the Corrective Measures Study Investigation, SWMU 74 – Fuel Pipelines and Hydrant Pits (Baker, 2010) and Appendix A of this report.

Groundwater is present at approximately 8 feet bgs and is likely influenced by the Ensenada Honda. However, no formal testing was performed during the Phase I/Phase II CMS Investigations to ascertain the porosity and interconnectivity to the surface water, including tidal influence and salinity. A groundwater table elevation contour map was not developed due to the spatial distribution of existing monitoring wells within the Fueling Piers Area. However, groundwater is anticipated to flow west-southwest towards the Ensenada Honda.

5.3 References

Baker. 2010. Revised Final Phase I of the Corrective Measures Study Investigation, SWMU 74 – Fuel Pipelines and Hydrant Pits, Naval Activity Puerto Rico, Ceiba, Puerto Rico. July 9, 2010.

6.0 ANALYTICAL RESULTS

This section discusses the analytical results of the samples collected during the Phase II CMS Investigation for the Fueling Piers Area of SWMU 74 and presents a summary of the data validation/usability assessment. The investigation included surface and/or subsurface soil sampling at 13 borings and groundwater sampling at one existing monitoring well. The samples were analyzed for Appendix IX VOCs, LLPAHs, metals, and/or TPH GRO and DRO, and the results were subjected to a formal, third-party data validation process.

Although TPH is not typically considered a RCRA-regulated constituent, and the PREQB screening value (100 mg/kg) is not strictly risk-based, TPH concentrations in soil were compared to the screening value and used as an indicator of potential petroleum-related impacts that may be attributed to the fuel pipelines and/or associated valve pits. In addition, metals detected in soil were compared to basewide background screening values (Upper Limit of the Mean [ULM]) established in the Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2010). Linear regression was used as a tool to ascertain whether there is a correlation between TPH concentrations and the Appendix IX constituents. Comparison of the analytical results to applicable ecological and human health screening values is presented in the ecological risk assessment (ERA) (Section 7.0) and human health risk assessment (HHRA) (Section 8.0). Detailed statistical evaluations of the analytical results are also presented in the ERA and HHRA.

6.1 Surface Soil

Fifteen surface soil samples (including two field duplicates) were collected from 13 boring locations (74SB748 through 74SB760) and analyzed for Appendix IX VOCs, LLPAHs, metals, and TPH GRO and DRO. The laboratory analytical results for detected constituents are presented on Tables 6-1 through 6-3. A complete set of analytical results is included in Appendix B.

Total TPH (19 J to 2,790 J mg/kg) was detected in each of the 15 samples. The concentrations in samples 74SB748-00 (and the corresponding field duplicate), 74SB749-00, 74SB753-00, and 74SB755-00 exceeded the PREQB screening value (100 mg/kg). Sample 74SB748-00 was primarily comprised of GRO, while the remaining four samples were primarily comprised of DRO. The highest area of TPH-impacted surface soil (2,790 J mg/kg at boring 74SB748 as shown on Figure 6-1) is located beneath an asphalt surface thereby eliminating any associated direct contact exposure pathways. In addition, sample 74SB753-00 was collected adjacent to the unnamed asphalt roadway that leads to the Berthing Pier (Pier No. 3), and the presence of elevated TPH at this location may be attributed to surface runoff from the roadway. It is also important to note that the areas of TPH exceedances are isolated and limited to surface soil (0 to 1 foot bgs); the fuel pipeline is buried in the Fueling Piers Area. Therefore, the presence of TPH in surface soil likely is not attributed to a release from the SWMU.

Carbon disulfide was the only VOC detected in the sample set and was present in two of the 15 samples at low concentrations (5.5 J to 5.9 micrograms per kilogram [µg/kg]).

Sixteen LLPAHs were detected in the sample set. Of these LLPAHs, the following ten were detected in 50 percent or more of the samples: benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, fluoranthene, indeno[1,2,3-cd]pyrene, phenanthrene, and pyrene. LLPAHs were most prevalent in samples 74SB756-00, 74SB759-00, and 74SB760-00, and the majority of maximum detections were present in sample 74SB760-00. These three samples were located furthest from the fuel pipeline (approximately 60 to 110 feet) and were not co-located with the aforementioned TPH exceedances (see Figure 6-1). This evidence suggests that the presence of LLPAHs likely is not attributed to a release from the SWMU.

Sixteen metals were detected in the sample set. Of these metals, the following eight exceeded the basewide background screening values: arsenic, cadmium, copper, lead, mercury, nickel, selenium, and zinc. The largest number of background exceedances were present in sample 74SB756-00 which is relatively distant from the fuel pipeline and is not co-located with the TPH exceedances in surface soil. Arsenic (1.5 to 21 mg/kg) was the most prevalent metal detected at elevated concentrations and exceeded the background screening value (2.65 mg/kg) in 11 of the 15 samples; the maximum arsenic concentration was detected in sample 74SB756-00. Arsenic concentrations at the locations where the highest Total TPH was detected (74SB748 and 74SB753 were below background indicating that the occurrence of arsenic is likely not related to SWMU 74. Cadmium (0.046 J to 1.8 mg/kg) exceeded the background screening value (1.02 mg/kg) in two of the 13 samples. Copper (7.1 to 550 mg/kg) exceeded the background screening value (168 mg/kg) in only one of 13 samples. Lead (3.5 to 120 mg/kg) exceeded the background screening value (22 mg/kg) in five of the 13 samples. It should be noted that lead in two of the samples was qualified as rejected (R) by the data validator (see Section 6.5). Additionally, lead concentrations in excess of background were not present at the locations where the two highest Total TPH concentrations were detected. Mercury (0.0085 J to 0.21 mg/kg) exceeded the background screening value (0.109 mg/kg) in only one of 13 samples. Nickel (2.2 to 27 mg/kg) exceeded the background screening value (20.7 mg/kg) in only one of 13 samples. Selenium (0.77 J to 1.8 mg/kg) exceeded the background screening value (1.48 mg/kg) in two of 13 samples. Zinc (10 to 920 mg/kg) exceeded the background screening value in three of 13 samples. In general, the samples where mercury, nickel, selenium and zinc exceeded background were not co-located with samples exhibiting the highest Total TPH concentrations.

6.2 Subsurface Soil

Seven subsurface soil samples (including one field duplicate) were collected from six boring locations (74SB748 through 74SB753) and analyzed for Appendix IX VOCs, LLPAHs, metals, and TPH GRO and DRO. The laboratory analytical results for detected constituents are presented on Tables 6-4 through 6-6. A complete set of analytical results is included in Appendix B.

Total TPH (26 J to 68 J mg/kg) was detected in each of the seven samples, but the concentrations were below the PREQB screening value (100 mg/kg).

VOCs were not detected in the sample set. However, 12 LLPAHs were detected in one or more of the samples. Of these LLPAHs, benzo[a]pyrene and benzo[k]fluoranthene were detected in 50 percent or more of the samples. LLPAHs were most prevalent in sample 74SB750-01, but the majority of maximum detections were present in sample 74SB751-01.

Fifteen metals were also detected in the sample set. Of these metals, cadmium (2.8 mg/kg), lead (110 mg/kg), and zinc (110 mg/kg) exceeded the basewide background screening values (0.57, 6.2, and 92 mg/kg, respectively) in sample 74SB749-01. Lead (6.4 mg/kg) also exceeded the background screening value in sample 74SB753-01.

6.3 Groundwater

Benzo[a]anthracene (0.036 J µg/L) was detected at a low, estimated concentration in the groundwater sample collected from monitoring well 74SB246 in May 2008 (Phase I CMS

Investigation). The concentration exceeded the USEPA RSL for tap water. As a result, this well was re-sampled on April 19, 2011 and analyzed for LLPAHs to confirm the detection. No LLPAHs were detected in the sample. The laboratory analytical results are included in Appendix B.

6.4 Linear Regression Analysis

A linear regression analysis was performed to evaluate potential correlations between constituents detected in soil and TPH GRO, TPH DRO, and Total TPH, and to determine if their presence may be attributed to a release from the Fueling Piers Area of SWMU 74. Each of the soil samples were analyzed for TPH GRO and DRO, Appendix IX VOCs and metals, and LLPAHS. Pairwise linear regressions were performed between GRO, DRO, or Total TPH and individual Appendix IX VOC, metal, or LLPAH constituent results. Linear regressions were not performed for constituents that were detected at a frequency of less than 50 percent as this can add uncertainty to the interpretation of regression results because chemicals are assumed to be present at reporting limits. In addition, linear regressions were only performed for those metals that exceeded the basewide background screening values. A summary of the linear regression results, including frequencies of detection, is presented on Table 6-7; the linear regression reports are included in Appendix B.

NCSS Statistical & Power Analysis Software (1997 Version) (http://www.ncss.com) was used to facilitate the data analysis. Surface and subsurface soil data from the Phase II CMS Investigation were combined into a single, unified data set. In addition, surface and subsurface soil data from borings 74SB231 and 74SB232 (Phase I CMS Investigation, May 2008) were included in the data set because these two locations were within the Phase II Investigation area. Duplicate samples were treated as independent data points, and non-detect data were evaluated at the reporting limit (i.e., limit of detection).

6.4.1 TPH and VOCs

Carbon disulfide was the only VOC detected in the surface and subsurface soil samples. As shown on Table 6-7, because of a low frequency of detection (11%), the potential correlation between carbon disulfide and TPH was not evaluated.

6.4.2 TPH and LLPAHs

The relationship between LLPAHs and TPH was explored to ascertain whether detected LLPAHs are indicative of a fuel-related release from SWMU 74. Sixteen LLPAHs were detected in the surface and subsurface soil sample data set. Of these 16 constituents, the potential correlation between the LLPAH and TPH was not evaluated for six constituents because of a low frequency of detection. Separate linear regressions were performed on the remaining ten LLPAH compounds compared to GRO, DRO and Total TPH.

With the exception of one compound, indeno[1,2,3-cd]pyrene, the results of this evaluation show that there is no strong correlation between GRO, DRO, or Total TPH and any of the detected LLPAH compounds. As shown on Table 6-7, the correlation coefficient for all PAHs (except indeno[1,2,3-cd]pyrene) was less than 0.12. Note that a correlation coefficient of greater than 0.2 may conservatively be considered to have some significance. The regression of indeno[1,2,3-cd]pyrene and DRO showed a correlation coefficient of 0.25 indicating a possible linear relationship. Although there may be a correlation between DRO and indeno[1,2,3-cd]pyrene, the overall results of this evaluation indicate that the detection of LLPAHs in the soil is not necessarily the result of a release from SWMU 74.

6.4.3 TPH and Metals

A similar evaluation was conducted on the detected metal concentrations in soil to explore the potential relationship between TPH and the detected metal. In this evaluation, detected metal concentrations in the combined soil data set were first compared to NAPR Basewide background concentrations. The frequency of detection was then examined for those metals exceeding background; detected metals with a low frequency of detection (less than 50%) were not further evaluated using linear regression. The relationship between the remaining metals and GRO, DRO and Total THP was then evaluated using linear regression.

Sixteen metals were detected in the surface and subsurface soil at the Fueling Piers Area of SWMU 74. Of these 16 detected metals, eight (antimony, barium, beryllium, chromium, cobalt, silver, thallium and vanadium) were not detected above background and were therefore not further evaluated using linear regression. One metal, selenium was not evaluated because of a low frequency of detection (less than 50%). Separate linear regressions were then run on each of the remaining seven metals (arsenic, cadmium, copper, lead, mercury, nickel and zinc)

The results of this evaluation show that there is no strong correlation between TPH GRO, DRO or Total TPH and the individual metal concentrations in soil. The correlation coefficients for all regressions were less than 0.08 (note that a correlation coefficient of greater than 0.2 may conservatively be considered to have some significance). The lack of a correlation between GRO, DRO or Total TPH and the detected metal concentrations indicates that the presence of arsenic, cadmium, copper, lead, mercury, nickel or zinc in soil is not necessarily the result of a release from the Fueling Piers Area of SWMU 74. The linear regression analysis is summarized in Table 6-7 and regression plots are provided in Appendix B.

6.5 Data Validation/Usability Assessment

A discussion of the constituents detected in the field QA/QC blank samples and a summary of the data validation/usability assessment is presented below.

6.5.1 Summary of Constituents Detected in Blank Samples

Blank samples (e.g., trip blanks, field blanks, equipment rinsate blanks) were collected during the Phase II CMS Investigation to provide a measure of potential contamination that may have been introduced into the sample set during collection, transportation, preparation, and/or analysis of the samples (see Section 4.6). A summary matrix showing the blank samples collected and the associated analyses is presented on Table 4-2. The laboratory analytical results for detected constituents are presented on Table 6-8. A complete set of analytical results is included in Appendix B.

Three trip blanks (74TB114, 74TB115, and 74TB117) were analyzed for Appendix IX VOCs and TPH GRO. No constituents were detected in the trip blanks.

One field blank (74FB01) was collected from the laboratory-grade deionized water used as the source water for the equipment rinsate blanks and analyzed for Appendix IX VOCs, LLPAHs, metals (total fraction), and TPH GRO and DRO. Low concentrations of barium (9.1 µg/L) and TPH DRO (0.034 J µg/L) were detected in the field blank.

Four equipment rinsate blanks (74ER114 through 74ER117) were collected and analyzed for Appendix IX VOCs, LLPAHs, metals (total fraction), and/or TPH GRO and DRO. Four VOCs (acetone, chloroform, methylene chloride, and toluene), one LLPAH (naphthalene), two metals (barium and copper), and TPH GRO and DRO were detected at low concentrations in one or more of the equipment rinsate blanks. It should be noted that acetone, methylene chloride, and toluene are common laboratory contaminants, and their presence is likely attributed to laboratory-type preparation/cleaning.

Overall, the constituents and respective concentrations detected in the blank samples did not negatively impact the usability of the analytical data, and the associated results are considered usable as qualified by the validator. Data qualifications required based on validation/evaluation of the blank results are discussed in the data validation narrative reports (Appendix C).

6.5.2 Laboratory Data Validation Summary

Independent, third-party data validation services were provided by DataQual Environmental Services of St. Louis, Missouri. The data were validated in accordance with the SW-846 methods utilized by the laboratory, specifications set forth in the USEPA Region II Standard Operating Procedures for Validation of Organic Data Acquired using SW-846 Methods, and professional judgment. There were a total of three SDGs for the Phase II CMS Investigation. The data validation narrative reports and Puerto Rico chemist certificates for each SDG are included in Appendix C.

The data validation indicted that sample preparation and analyses were performed within USEPA Region II and/or method holding time requirements. Some analytical results were “qualified” with an associated explanatory note based on the requirements set forth in the aforementioned guidelines. These results represent minor quality control problems (e.g., typical analytical difficulties or the result of sample matrix issues) and do not affect data usability. Qualification of the results due to application of the data validation objectives did not significantly compromise the data quality objectives, and the data generated are acceptable, as qualified by the validator, for its intended use except for the rejected results discussed below.

The MS/MSD analysis associated with SDG 68067543 exhibited a non-compliant relative percent difference greater than 125 percent for lead. The percent recoveries for this analyte were not assessed because the concentration of the target in the native sample was greater than four times the spike amount. However, the large variance in recoveries between spike aliquots indicates a potential for matrix issues in the lead results. Consequently, lead results for the associated samples (74SB754-00 and 74SB755-00) were qualified as rejected (R) in accordance with USEPA Region II guidance for matrix duplicate results. No other results in the three SDGs were rejected or considered unusable.

6.5.3 Data Completeness Summary

For project completeness, 90 to 95 percent of all sample data for a given analyte must represent valid measurements (Baker, 1995). As shown on Table 6-9, 99.9 percent of the validated data was considered usable. Therefore, project completeness goals have been achieved, and the limited amount of rejected data is not expected to significantly compromise the usability of the data set. The data that was rejected were not chemicals of potential concern for the Fueling Piers Area. In addition, it is not expected that this will impact the results of the ERA and HHRA (i.e. underestimate potential risk).

6.6 References

Baker. 2010. Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds, Naval Activity Puerto Rico, Ceiba, Puerto Rico. July 30, 2010.

Baker. 1995. Final RCRA Facility Investigation Management Plans, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. September 14, 1995.

7.0 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT AND STEP 3A OF THE BASELINE ECOLOGICAL RISK ASSESSMENT

This section presents a screening level ecological risk assessment (SERA) and Step 3a of the baseline ecological risk assessment (BERA) for the Fueling Piers Area of SWMU 74 – Fuel Pipelines and Hydrant Pits, located at NAPR, Ceiba, Puerto Rico. The SERA and Step 3a of the BERA were performed in accordance with Navy policy for conducting ERAs (Chief of Naval Operations [CNO], 1999) and Navy guidance for conducting ERAs (available at http://web.ead.anl.gov/ecorisk/), as well as guidance provided by the USEPA (1997).

The Navy ERA process (see Figure 7-1) consists of eight steps organized into three tiers and represents a clarification and interpretation of the eight-step ERA process outlined in the USEPA ERA guidance for the Superfund program (USEPA, 1997). Tier 1 of the Navy ERA process represents the SERA:

- Screening level problem formulation and ecological effects evaluation (Step 1).

- Screening level exposure estimate and risk calculation (Step 2).

Under Navy policy (CNO, 1999), if the results of Steps 1 and 2 (Tier 1 SERA) indicate that, based on a set of conservative exposure assumptions, there are chemicals present in environmental media that may present a risk to receptor species/communities (i.e., ecological chemicals of potential concern [COPCs]), the ERA process proceeds to the BERA. According to Superfund guidance (USEPA, 1997), Step 3 represents the problem formulation phase of the BERA. Under Navy policy, the BERA is defined as Tier 2, and the first activity under Tier 2 is Step 3a. In Step 3a, the conservative exposure assumptions applied in Tier 1 are refined and risk estimates are recalculated using the same conceptual site model. The evaluation of risks in Step 3a also may include consideration of available background data and chemical bioavailability. If the re-evaluation of the conservative exposure assumptions in Step 3a does not support an acceptable risk determination for all potential chemical-pathway-receptor combinations, CAOs will be established to address potential ecological risks.

7.1 Environmental Setting

The sections that follow provide a description of the habitats occurring within and contiguous to the Fueling Piers Area, as well as the biota that may be present. The description of habitats and biota relies on literature-based information for Puerto Rico and NAPR, and is supplemented by observations made during the 2008 Phase I and 2011 Phase II CMS field investigations.

7.1.1 Terrestrial Habitats

The upland habitat bounded by NAPR is classified as subtropical dry forest (Ewel and Witmore, 1973). Similar to other forested areas of Puerto Rico, this region was previously clear-cut in the early part of the twentieth century, primarily for pastureland (Geo-Marine, Inc., 1998). After acquisition by the Navy, a secondary growth of thick scrub, dominated by lead tree (*Leucaena* spp.), Christmas tree (*Randia aculeata*), sweet acacia (*Acacia farnesiana*), and Australian corkwood (*Sesbania grandiflora*) grew in the previously grazed sections (Geo-Marine, Inc., 1998). Secondary growth communities (upland coastal forest communities and coastal scrub forest communities) exist today throughout NAPR's undeveloped upland.

The Fueling Piers Area (see Figures 2-4 and 2-6) consists of the underground pipeline along Forrestal Drive and associated spurs that lead to the Deep Water Fueling Pier (Pier No. 1) and the Berthing Pier (Pier No. 3). A single valve pit (VP-56), located near the intersection of Palau Street with Forrestal Drive (see Figure 2-6) is also included within the Fueling Piers Area. Prior to the operational closure of NSRR on March 31, 2004, the upland vegetative community within the boundary of the Fueling Piers Area consisted of maintained grasses of unknown species composition (likely to include *Bothriochloa ischaemum* [yellow bluestem], *Chloris barbata* [swollen fingergrass], and *Digitaria* spp. [crabgrass] based on maintained grasses identified during a habitat characterization conducted at SWMUs 1, 2, and 45 in May 2000 [(Geo-Marine, Inc., 2000)]. Although the Navy continues to conduct grass cutting operations basewide, these operations are generally restricted to areas immediately adjacent to primary roads. Observations during the 2011 Phase II CMS field investigation indicate that cutting operations at the Fueling Piers Area are restricted to locations immediately adjacent to Forrestal Drive. This observation is supported by aerial photography dated November 29, 2006 and September 21, 2009 (see Figures 7-2 and 7-3, respectively). The aerial photograph dated November 29, 2006 shows evidence of grass cutting operations throughout the entire Fueling Piers Area. However, the September 21, 2009 photograph, as well as photographs taken during the 2011 Phase II CMS field investigation (see Appendix A), show that the once maintained grasses are undergoing secondary succession (likely toward a coastal scrub forest community). Vegetation identified from the photographs provided within Appendix A includes white lead tree (*Leucaena leucocephala*) and monkeypod (*Pithecellobium dulce*).

Cobana negra (*Stahlia monosperma*), a federally threatened tree species, is known to occur between the boundary of black mangrove communities and upland coastal forest communities. This species is also known to occur in coastal forests of southeastern Puerto Rico (Little and Wadsworth, 1964). A single individual was encountered at NAPR during recent surveys conducted by Geo-Marine, Inc. (NAVFAC, 2006). This individual is located within a coastal scrub forest community near the Capehart housing area, west of American Circle, approximately 2.7 miles southwest of the Fueling Piers Area spur leading to the Berthing Pier. No other plant species listed under the provisions of the Endangered Species Act of 1973 are known to occur or have the potential to occur at NAPR (Geo-Marine, Inc., 2000 and NAVFAC, 2006).

7.1.2 Aquatic Habitats

Approximately 460 acres at NAPR are covered by palustrine habitat, which includes all freshwater wetlands. These wetlands include wet meadows and marshes, dominated by cattails (*Typha* spp.) and grasses (*Panicum* spp. and *Paspalum* spp.), as well as wet coastal scrub forests. The marine environment surrounding NAPR includes mudflats, mangroves and seagrass beds. The total area of mudflats, mangroves, and seagrass beds in the offshore environment is approximately 161 acres, 2,700 acres, and 1,900 acres, respectively (Geo-Marine, Inc., 1998). Coral reefs are also located in the offshore marine environment (see Figure 7-4). Coral reef types within the waters surrounding NAPR, as well as their associated acreage cover are listed below (Department of Navy [DoN], 2007):

Reef Habitat Type	Area (acres)
Colonized bedrock	266
Linear reef	84
Patch reef (aggregated)	146
Patch reef (individual)	175
Scattered coral-rock	5

Mangroves at NAPR mainly consist of red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*) (Geo-Marine, Inc., 2000 and 2005). Red mangroves tolerate relatively deep water levels, grow in unstable, soft soil, and tolerate a salinity range of 10 to 55 parts per thousand (ppt). They develop large prop roots which usually extend above the water surface. Black and white mangroves generally grow in areas that are not inundated by water. Mangroves at NAPR are natural filters for upland runoff and protect the coastline from storm damage (Lewis, 1986). They also provide habitat for wildlife, fish, and benthic invertebrates. Lewis (1986) reported 112 species of birds that use the NAPR mangroves as habitat for feeding, nesting, and roosting. The red mangrove prop root habitat in Puerto Rico also is used by at least 13 species of fish (including the gray snapper [*Lutijanus griseus*], lane snapper [*Lutijanus synagris*], and gold and black tricolor [*Holocanthus tricolor*]), several crustaceans (including the flat tree oyster [*Isognomon alatus*]), gastropods (including the coffee bean snail [*Melampus coffeus*] and mangrove periwinkle [*Littorina angulifera*]), echinoids (including the long-spined sea urchin [*Diadema antillarum*] and pencil sea urchin [*Eucidaris tribuloides*]), sponges (including the fire sponge [*Tedania ignis*]), ascidians (including the black tunicate [*Acsidia nigra*]), and hydroids (including the feathered hydroid [*Halocordyle disticha*]) (Geo-Marine, Inc., 2005).

The seagrass beds in eastern Puerto Rico are typical of well developed climax meadows found throughout the tropical Atlantic and Caribbean basin, consisting primarily of a dense continuous coverage of turtle grass (*Thalassia testudinum*) with lesser amounts of manatee grass (*Syringodium filiforme*) and a wide diversity of calcareous algae (Reid et al., 2001). Patchy and sparse beds of mixed species, including shoal grass (*Halodule wrightii*), manatee grass, and paddle grass (*Halophila decipiens*), occur in localized areas affected and maintained by different wave regimes, substrate type, and turbidity than what is normally found in association with the climax turtle grass meadows.

The nearest open water marine habitat to the Fueling Piers Area is the Ensenada Honda. Sea grass beds are prevalent throughout much of this embayment (see Figure 7-4). Seagrass meadows within the Ensenada Honda are dominated by a nearly continuous cover of turtle grass with a high abundance of calcareous green algae (*Avranvilla* spp., *Ventricaria ventricosa*, *Caulerpa* spp., *Valonia* spp., and *Udotea* spp.) (Reid et al., 2001). The turtle grass climax meadows of the Ensenada Honda represent grazing areas for the West Indian manatee, a federally endangered species in Puerto Rico, and the green sea turtle (*Chelonia mydas*), a federally threatened species in Puerto Rico (see Sections 7.1.3.1 and 7.1.3.3, respectively).

A map showing the spatial relationship of the Fueling Piers Area to the Ensenada Honda, as well as freshwater and estuarine wetlands, is depicted on Figure 7-5. The wetlands depicted on Figure 7-5, identified by the Cowardin Wetland Classification System (Cowardin et al., 1979 [see Figure 7-6]), were delineated by Geo-Marine, Inc. in December 1999 from 1993 color infrared and 1998 true color aerial photography. Twenty percent of the wetlands delineated by aerial photography were field checked to verify the accuracy of the delineations. Field verification was based on the 1987 Corps of Engineers wetland delineation manual (U.S. Army Corps of Engineers [USACE], 1987). As evidenced by Figure 7-5, there are no freshwater or estuarine wetlands in the immediate vicinity of the underground pipeline along Forrestal Drive or the spurs leading to the Deep Water Fueling and Berthing Piers (Pier Nos. 1 and 3). An Estuarine, Intertidal, Scrub-Shrub, Broad-Leaved Evergreen (E2SS3) wetland is located approximately 700 feet northwest of the spur leading to the Deep Water Fueling Pier. An E2SS3 wetland unit is also located approximately 450 feet southeast of the spur leading to the Berthing Pier. There are no apparent transport pathways from the Fueling Piers Area to these wetland units.

7.1.3 Fauna

A description of the fauna occurring in Puerto Rico and the landmass encompassed by NAPR is provided in the sections that follow. The description relies on literature-based information for Puerto Rico and NAPR, and is supplemented by observations made during the 2008 Phase I and 2011 Phase II CMS field investigations conducted at the Fueling Piers Area.

7.1.3.1 Mammals

A total of twenty-two terrestrial mammal species are known historically from Puerto Rico; however, all mammals except bats (thirteen species) have been extirpated (Mac et al., 1998). None of the bats found on Puerto Rico are exclusive to the island, nor are they listed under provisions of the Endangered Species Act of 1973. The specific bat species known to occur on Puerto Rico are listed below:

- Fruit-eating bats: Jamaican fruit bat (*Artibeus jamaicensis*), Antillean fruit bat (*Brachyphylla cavernarum*), and red fig-eating bat (*Stenoderma rufum*)

- Nectivorous bats: brown flower bat (*Erophylla sezekoni*) and greater Antillean long-tounged bat (*Monophyllus redmani*)

- Insectivorous bats: Antillean ghost-faced bat (*Mormoops blainvillii*), Parnell's mustached bat (*Pteronotus parnellii*), sooty mustached bat (*Pteronotus quadridens*), big brown bat (*Eptesicus fuscus*), red bat (*Lasiurus borealis*), velvety free-tailed bat (*Molossus molossus*), and Brazilian free-tailed bat (*Tadarida brasiliensis*)

- Piscivorous bats: Mexican bulldog bat (*Noctilio leporinus*)

Vegetation growing along the pipeline spur leading to the Berthing Pier includes plants known to be used as a source of food by bats on Puerto Rico (white lead tree [nectar/pollen]; Gannon et al., 2005).

Of the endangered/threatened marine mammals that may occur in Puerto Rico, only the West Indian manatee is known to occur in the marine environment surrounding NAPR (DoN, 2007). Manatee populations in Puerto Rico's coastal waters have been documented during three aerial surveys conducted from 1978 to 1979, 1984 to 1985, and in 1993 (United Nations Environmental Programme [UNEP], 1995), a radio tracking study of manatee distribution and abundance (Reid and Kruer, 1998), and a year-long study of manatee distribution and abundance (Woods et al., 1984). Historical manatee sightings at NAPR are summarized on Figure 7-7. The figure (reproduced from DoN, 2007) includes information from most of the studies identified above. Feeding manatees are most often recorded within Pelican Cove and the Ensenada Honda. As discussed in Section 5.2, Fueling Piers Area groundwater is believed to be directly connected to Ensenada Honda surface water. As such, this surface water body is a potential exposure point for West Indian manatee dietary exposures to chemicals in groundwater.

A review of the groundwater analytical data for the Fueling Piers Area shows that three organic chemicals identified by the USEPA (2000a) as important bioaccumulative compounds were detected in a single groundwater sample (74GW246) collected from monitoring well 74SB246 during the 2008 Phase I CMS Field Investigation (benzo[a]anthracene was detected at 0.036J µg/L, chrysene was detected at 0.086J µg/L, and fluoranthene was detected at 0.073J µg/L [Baker, 2010a]). Based on the low magnitude of detections, it is unlikely that these three PAHs are migrating with groundwater to Ensenada Honda surface water and sediment at concentrations that would adversely impact West Indian manatees. It is noted that monitoring well 74SB246 was re-sampled during the 2011 Phase II CMS field investigation and analyzed for PAHs to confirm these low, estimated concentrations. As evidenced by the groundwater analytical data included within Appendix B, PAHs were not detected in the 2011 Phase II CMS groundwater sample (74SB246B). In addition to these three organic chemicals, eight bioaccumulative metals (arsenic, cadmium, chromium, copper, nickel, selenium, silver, and zinc) were detected within the total recoverable fraction of one or more of the groundwater samples collected during the 2008 Phase I CMS field investigation (Baker, 2010a). However, maximum detected concentrations are less than ULM concentrations for basewide background groundwater contained in the Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds for NAPR (Baker, 2010b). Therefore, it can be concluded that these eight metals are not migrating to the Ensenada Honda at concentrations greater than what would be expected under background conditions.

Several mammals have been introduced into Puerto Rico, including the black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), and small Indian mongoose (*Herpestes javanicus*). These nonindigenous mammals have been implicated in the decline of native bird and reptile populations (Mac et al., 1998 and U.S. Fish and Wildlife Service [USFWS], 1996a).

7.1.3.2 Birds

A total of 239 bird species are native to Puerto Rico (Raffaele, 1989). This total includes breeding permanent residents and non-breeding migrants. In addition, many nonindigenous bird species have been introduced to Puerto Rico, including the shiny cowbird (*Molothrus bonariensis*) and several parrot species, such as the budgerigar (*Melopsittacus undulates*), orange-fronted parrot (*Aratinga canicularis*), and monk parrot (*Myiopsitta monaqchus*). Of the 239 species native to Puerto Rico, twelve are endemic to the island (Raffaele, 1989).

Numerous native and migratory bird species have been reported at NAPR (Geo-Marine, Inc., 1998). A list of bird species reported at NAPR or having the potential to occur is provided in Table 7-1. The list, compiled from literature-based information pre-dating 1990, includes the great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), little blue heron (*Florida caerulea*), black-crowned night heron (*Nycticorax nycticorax*), belted kingfisher (*Ceryle alcyon*), spotted sandpiper (*Actitis macularia*), greater yellowlegs (*Tringa melanoleauca*), black-bellied plover (*Squatarola squatarola*), clapper rail (*Rallus longirostris*), Royal tern (*Thalasseus maximus*), sandwich tern (*Thalasseus sandvicensis*), least tern (*Stema albifrons*), yellow warbler (*Dendroica petechia*), palm warbler (*Dendroica palmarum*), prairie warbler (*Dendroica discolar*), magnolia warbler (*Dendrocia magnolia*), mourning dove (*Zenaida macroura*), red-legged thrush (*Mimocichla plumbea*), common nighthawk (*Chordeiles minor*), and red-tailed hawk (*Buteo jamaicensis*). Endemic species reported from NAPR include the Puerto Rican lizard cuckoo (*Saurothera vieilloti*), Puerto Rican flycatcher (*Myiarchus antillarum*), Puerto Rican woodpecker (*Malanerpes portoricensis*), Puerto Rican emerald (*Chlorostilbon maugaeus*), and yellow-shouldered blackbird (*Agelaius xanthomus*).

The yellow-shouldered blackbird is a federally endangered species. One of the principal reasons for the status of this species is attributed to parasitism by the nonindigenous shiny cowbird, which lays its eggs in blackbird nests and sometimes punctures the host's eggs (USFWS, 1983). Other factors contributing to the status of this species include nest predation by the introduced black rat, Norway rat, and mongoose, as well as habitat modification and destruction (USFWS, 1996a). The entire land area of NAPR was declared critical habitat for the yellow-shouldered blackbird in 1976; however, a 1980 agreement between the Navy and the USFWS exempted certain areas from this categorization (Geo-Marine, Inc., 1998). The Fueling Piers Area is not located within the critical habitat designation. A study conducted by the Naval Facilities Engineering Service Center (NFESC, 1996) reported that the mangrove forests surrounding NAPR should be considered the most important nesting habitats for the yellow-shouldered blackbird. A survey conducted in July 2002 by the Puerto Rico Department of Natural Resources (PRDNR, 2002) reported fifteen yellow-shouldered blackbirds (including five juveniles) at NAPR. At the time of the survey, the birds were using the structures at the NAPR airport for resting cover. Although nesting pairs were not observed (the survey was not conducted during the breeding season), the airport structures contained several inactive nests. The inactive nests and juvenile birds indicate that a small breeding population is present at NAPR. As discussed in Section 7.1.1, trees (e.g., white lead tree and monkeypod) have become established along the pipeline spur leading to the Berthing Pier, including the area with potential fuel-related impacts investigated during the 2011 Phase II CMS field investigation (i.e., area contiguous to 2008 Phase I CMS boring location 74SB231). Because yellow-shouldered blackbirds are arboreal feeders that forage within the canopy and sub-canopy of trees (USFWS, 1996a), the trees represent potential foraging habitat for the yellow-shouldered blackbird. However, arboreal insectivores, such as the yellow-shouldered blackbird, would not be expected to experience any significant exposures to chemicals in surface and subsurface soil. This line of reasoning is consistent with USEPA's approach to ecological soil screening level (Eco-SSL) development. As discussed in Guidance for Developing Ecological Soil Screening Levels (USEPA, 2005a), aerial and arboreal insectivorous birds were excluded from Eco-SSL development because they are considered inappropriate (i.e., they do not have a clear or indirect exposure pathway link to soil [indirect exposure pathways involve ingestion of prey that have direct contact with soil]).

Other federally listed bird species that have the potential to occur at NAPR are the piping plover (*Charadrius melodus*) and roseate tern (*Sterna dougallii*) (Geo-Marine, Inc., 1998). The piping plover is a rare, non-breeding winter visitor in Puerto Rico (Raffaele, 1989). This species breeds only in North America in three geographic regions (Atlantic Coast population [threatened], Great Lakes population [endangered], and Northern Great Plains population [threatened]; USFWS, 1996b). No piping plover observations were reported at NAPR during the 1990s or during sea turtle nesting surveys conducted in 2002 and 2004 (Geo-Marine, Inc., 2005). No historic evidence is available to indicate whether the roseate tern (threatened in Puerto Rico) has ever nested at NAPR and no roseate tern observations have been noted in or over coastal waters adjacent to NAPR (DoN, 2007). The nearest active roseate tern colony likely occurs on the eastern end of Vieques Island (more than twenty miles east of NAPR) (DoN, 2007).

7.1.3.3 Reptiles and Amphibians

A total of twenty-three amphibians and forty-seven reptiles are known from Puerto Rico and the adjacent waters (Mac et al., 1998). Fifteen of the amphibians and twenty-nine of the reptiles are endemic, while four amphibian species and three reptilian species have been introduced (Mac et al. 1998). Puerto Rico's native amphibian species include sixteen species of tiny frogs commonly called coquis. On the coastal lowlands, almost all coqui species are arboreal. The only amphibians listed under provisions of the Endangered Species Act of 1973 are the Puerto Rican crested toad (*Peltophryene lemur*) and the golden coqui (*Eleutherodactylus jasperi*). Both species are listed as threatened (USFWS, 2011). Distribution of the golden coqui is restricted to areas of dense bromeliad growth. All specimens to date have been collected from a small semicircular area of a 6-mile radius south of Cayey (approximately 30 miles southwest of NAPR), generally at elevations above 700 meters (USFWS, 1984). The Puerto Rican crested toad occurs at low elevations (below 200 meters) where there is exposed limestone or porous, well drained soil offering an abundance of fissures and cavities (USFWS, 1987). A single large population is known to exist from the southwest coast in Guánica Commonwealth Forest, and a small population is believed to survive on the north coast near Quebradillas, Arecibo, Barceloneta, Vega Baja, and Bayamón (USFWS, 1987). It also has been collected on the southeastern coastal plain near Coamo (USFWS, 1987). Given the habitat preferences and locations of known occurrences, these two amphibian species are not expected to occur at NAPR.

Puerto Rico's native reptilian species include thirty-one lizards, eight snakes, one freshwater turtle, and five sea turtles (Mac et al., 1998). Of the five sea turtles, only the green sea turtle, hawksbill sea turtle (*Eretmochelys imbricata*), and loggerhead sea turtle (*Dermochelys coriacea*) nest within Puerto Rico. These three sea turtles, as well as the leatherback sea turtle (*Caretta caretta)* are listed under the provisions of the Endangered Species Act of 1973 (hawksbill sea turtle and leatherback sea turtle are listed as endangered, while the green sea turtle [Caribbean population] and loggerhead sea turtle are listed as threatened; USFWS, 2011). Aerial surveys of turtles were performed from March 1984 through March 1995 along the Puerto Rican Coast. This information is summarized in the Draft NAPR Disposal Environmental Assessment (Geo-Marine, Inc., 2005). Figures 7-8 and 7-9, reproduced from Geo-Marine, Inc. (2005), present cumulative sea turtle sightings and potential turtle nesting sites at NAPR, respectively. Significant turtle observations were made near the mouth of the Ensenada Honda, the northern shore of Pineros Island, Pelican Bay, and the Medio Mundo Passage with the frequency of turtle observations listed as green > hawksbill > loggerhead > leatherback. Based on the life history information for each turtle species (summarized in Baker, 2006a and 2006b) and the availability of forage material (in the form of sea grasses), the green sea turtle has the potential to forage within the Ensenada Honda. Given that the Ensenada Honda represents a potential discharge point for Fueling Piers Area groundwater, this surface water body represents a potential exposure point for green sea turtle dietary exposures to chemicals in groundwater. However, as discussed in Section 7.1.3.1, bioaccumulative organic chemicals (i.e., benzo[a]anthracene, chrysene, and fluoranthene) were detected at a low magnitude in groundwater and are not likely to be migrating to the Ensenada Honda at concentrations that would adversely impact green sea turtles. In addition, bioaccumulative metals (i.e., arsenic, cadmium, chromium, copper, nickel, selenium, silver, and zinc) where not detected in Fueling Piers Area groundwater at concentrations greater than basewide background concentrations.

The Puerto Rican boa (*Epicrates inornatus*) is a federally endangered species. Four Puerto Rican boa sightings were reported at NAPR prior to 1999 and an additional four occurrences were reported between 2001 and 2003 (Geo-Marine, Inc., 2005). However, no boas were observed during 211 man-hours of surveys conducted within potential boa habitat in 2004 (Tolson, 2004). The Puerto Rican boa uses a variety of habitats but is most commonly found in Karst forest habitat (forested limestone hills). Based on the absence of preferred habitat, there is low probability of occurrence of this species at the Fueling Piers Area and adjacent habitats.

7.1.3.4 Fish and Aquatic Invertebrates

A diverse fish and invertebrate community can be found in the marine environment surrounding NAPR. This can be attributed to the varied habitats that include open water marine and estuarine habitat, mud flats, sea grass beds, and mangrove forests. The fish community is represented by stingrays, herrings, groupers, needlefish, mullets, barracudas, jacks, snappers, grunts, snooks, lizardfishes, parrotfishes, gobies, filefishes, wrasses, damselfishes, and butterflyfish (Geo-Marine, Inc., 1998). The benthic invertebrate community includes sponges, corals, anemones, sea cucumbers, sea stars, urchins, and crabs.

The specific species inhabiting the Ensenada Honda have not been documented in the literature or during previous investigations. However, a marine reconnaissance survey was conducted within a small embayment associated with SWMU 45 in May 2000 [(Geo-Marine, Inc., 2000)]. Marine invertebrates observed within this embayment included sea urchins (*Echinometra lucunter* and *Echinometra viridis*), encrusting fire coral (*Millipora alcicormus*), common sea fan (*Gorgonia venalina*), starlet coral (*Siderastrea ammulatta*), pincushin starfish (*Oreaster reticulates*), and corkscrew anemone (*Bartholomea annulatta*), as well as two species of sea cucumbers (*Actinopyga agassizii* and *Holothuria mexicana*). In addition to invertebrates, sixteen fish species were observed within the cove. The specific species encountered included sergeant major (*Abudefduf saxatillis*), dusky damselfish (*Stegates fuscus*), tomtate (*Haemulon aurolineatum*), gray snapper (*Lutjanus griseus*), squirrelfish (*Holocentrus sp*.), yellow fin mojarra (*Gerres cinereus*), and silver jenny (*Eucinostomus gula*). Many of the species encountered during the marine reconnaissance survey are likely present within the Ensenada Honda.

7.2 Sources of Available Analytical Data

Sampling activities at the Fueling Piers Area have been conducted under two separate investigations: Phase I CMS field investigation and Phase II CMS field investigation. The Phase I CMS field investigation was conducted in April 2008 and involved the collection of five surface soil samples, sixty-nine subsurface soil samples, and six groundwater samples from forty-two boring locations. Surface soil was collected from the 0.0 to 1.0-foot depth interval, while subsurface soil was collected from the 1.0 to 3.0-foot, 3.0 to 5.0-foot, 5.0 to 7.0-foot, 7.0 to 9.0-foot, and 9.0 to 11.0-foot depth intervals. Each soil and groundwater sample was analyzed for Appendix IX VOCs, PAHs, and metals (total and dissolved fraction for groundwater), as well as DRO and GRO. Boring and well locations are depicted on Figure 2-6. A description of the Phase I CMS field investigation and associated analytical results were previously presented in Section 9.0 of the Revised Final Phase I of the Corrective Measures Study Investigation for SWMU 74 – Fuel Pipelines and Hydrant Pits (Baker, 2010a). A summary of the Phase I CMS field investigation and associated analytical results also is provided in Section 2.3.2 of this report. As discussed in the Revised Final Phase I CMS Report (Baker, 2010a), potential fuel-related impacts were detected at two surface soil sample locations (74SB221 and 74SB231) and fifteen subsurface soil sample locations (74SB215, 74SB216, 74SB218, 74SB221 through 74SB224, 74SB256, 74SB258, 74SB260, 74SB261, 74SB263 through 74SB265, and 74SB267). With the exception of 74SB231, potential contamination at these locations is most likely the result of known releases from SWMU 7/8.

The Phase II CMS field investigation at the Fueling Piers Area was conducted from April 18 through April 29, 2011 and involved the collection of thirteen surface soil samples (0.0 to 1.0-foot depth interval) and six subsurface soil samples (1.0 to 3.0-foot depth interval) from thirteen boring locations. Sampling activities were restricted to locations in the vicinity of 74SB231 (boring location installed during the 2008 Phase I CMS field investigation where potential fuel-related impacts were identified). In addition to soil, one groundwater sample was collected from an existing monitoring well (74SB246). Each surface and subsurface soil sample was analyzed for Appendix IX VOCs, PAHs, and metals, while the single groundwater sample was analyzed for Appendix IX PAHs. A description of the Phase II CMS field investigation is provided in Section 4.0, while associated analytical results are presented in Appendix B and discussed within Sections 6.1 through 6.3.

Analytical data for soil collected from the 0.0 to 1.0-foot depth interval at 74SB231 and 74SB232 during the 2008 Phase I CMS field investigation, as well as analytical data for soil collected from the 0.0 to 1.0-foot depth interval during the 2011 Phase II CMS field investigation were quantitatively evaluated as surface soil in the SERA. This depth interval is the most active biological zone (most soil heterotrophic activity occurs within the surface soil and soil invertebrates occur on the surface or within the oxidized root zone [Suter II, 1995]). Analytical data for soil collected from the 1.0 to 3.0-foot depth interval during the Phase II CMS field investigation were quantitatively evaluated as subsurface soil in the SERA. Available analytical data for subsurface samples collected from deeper depth intervals in the vicinity of 74SB231 were not evaluated since this depth is not likely to represent a significant exposure point for ecological receptors. Analytical data for soil collected during the 2008 Phase I CMS field investigation at locations with no potential fuel-related impacts, as well as analytical data for soil collected at locations with potential fuel-related contamination attributable to SWMU 7/8 were also omitted from evaluation in the ERA. Finally, the available groundwater data for the Fueling Piers Area were omitted from evaluation in the ERA since there is no indication that groundwater has been impacted by a fuel-related release (Baker, 2010a). The surface and subsurface soil analytical data quantitatively evaluated in the ERA are included as Appendix D, while sample locations are depicted on Figure 4-2. It is noted that the analytical laboratory reported non-detected results to the method detection limit (MDL) for soil samples collected during the 2008 Phase I CMS field investigation. However, for the 2011 Phase II CMS field investigation, the analytical laboratory reported non-detected results to the limit of detection (LOD).

7.3 Screening Level Problem Formulation

Problem formulation establishes the goals, scope, and focus of the ERA. The products of the screening level problem formulation are (1) the preliminary conceptual model and (2) the assessment and measurement endpoints. The purpose of the preliminary conceptual model is to describe how ecological receptors may be exposed to chemicals originating from the site. The preliminary conceptual model is developed using information regarding major habitats and ecological receptors, media of concern, and potential contaminant sources in conjunction with an understanding of potential transport pathways, exposure pathways, and exposure routes. The fate, transport, and toxicological properties of the chemicals present at the site are also considered during this process. Assessment and measurement endpoints define the ecological attributes to be protected. They are selected to evaluate those receptors for which complete and potentially significant exposure pathways are likely to exist.

7.3.1 Preliminary Conceptual Model

Figure 7-10 presents a preliminary conceptual model for the Fueling Piers Area. The conceptual model outlines potential sources of contaminants, transport pathways, exposure media, potential exposure routes, and receptor groups. Specific components of the preliminary conceptual model (i.e., source areas, transport pathways, and exposure pathways and routes) are discussed in the sections that follow.

7.3.1.1 Source Area

The pipelines and associated valve pits represent historical source areas for the release of fuel-related compounds to soil. Contaminated surface soil also represents a potential source for the release of chemicals to subsurface soil and down gradient surface soil. Finally, subsurface soil represents a potential source for the release of chemicals to groundwater.

7.3.1.2 Transport Pathways

A transport pathway describes the mechanisms whereby chemicals may be transported from a source of contamination to ecologically relevant media. As depicted on Figure 7-10, potential mechanisms for contaminant transport from potential source areas at the Fueling Piers Area are believed to include the following:

- Overland transport of chemicals with surface soil impacted by historical fuel releases via surface run-off to down gradient surface soil.

- Leaching of chemicals from surface soil by infiltrating precipitation and transport to subsurface soil.

- Uptake by biota from surface soil and subsurface soil and trophic transfer to upper trophic level receptors.

The following potential transport pathways are considered insignificant or incomplete:

- Leaching of chemicals from surface soil and/or subsurface soil by infiltrating precipitation and transport with groundwater to Ensenada Honda surface water and sediment.

- Overland transport of chemicals with storm water to Ensenada Honda surface water and sediment

Based on the findings of the Revised Final Phase I CMS Report, leaching of chemicals from surface soil and/or subsurface soil by infiltrating precipitation and transport with groundwater to Ensenada Honda surface water and sediment is considered a potentially complete, but insignificant transport pathway for the following reasons: (1) VOCs, PAHs, and total recoverable metals were not detected in groundwater collected at the Fueling Piers Area during the 2008 Phase I CMS field investigation above ecological-based screening values and/or ULM background concentrations (Baker, 2010a); (2) no total TPH detections were reported above the established screening value of 12.5 mg/L in groundwater collected from wells located at the Fueling Piers Area (Baker 2010a); and (3) no total TPH detections were reported above the established screening value of 25 mg/kg in subsurface soil collected at soil boring location 73SB231 during the 2008 Phase I CMS field investigation (boring location where potential fuel-related impacts were identified in surface soil; Baker, 2010a)

Overland transport of chemicals with storm water to Ensenada Honda surface water and sediment is considered an incomplete transport pathway. The single boring location where potential fuel related impacts were detected during the 2008 Phase I CMS field investigation (i.e., 74SB231), as well as boring locations established during the 2011 Phase II CMS field investigation are not located within the drainage boundary of any storm water outfall (see Figure 5-1). Furthermore, there are no drainage features (i.e., drainage ditches) along the pipeline spur leading to the Berthing Pier that convey storm water run-off to the Ensenada Honda.

7.3.1.3 Exposure Pathways and Routes

An exposure pathway links a source of contamination with one or more receptors via exposure to one or more media. Requirements for a complete exposure pathway are listed below.

- A source of contamination must be present

- Release and transport mechanisms must be available to move contaminants from the source to an exposure point

- An exposure point must exist where ecological receptors could contact affected media

- An exposure route must exist whereby the contaminants can be taken up by ecological receptors

As depicted on Figure 7-10, potentially complete and significant exposure pathways exist at the Fueling Piers Area. An exposure route describes the specific mechanism(s) by which a receptor is exposed to a chemical present in an environmental medium. Exposure pathways and routes applicable to the Fueling Piers Area are discussed in the paragraphs that follow.

The most common exposure routes are dermal contact, direct uptake, ingestion, and inhalation. Terrestrial plants may be exposed to chemicals present in soil directly through their root surfaces during water and nutrient uptake. Terrestrial invertebrates may be exposed to chemicals in soil through dermal adsorption and ingestion. Much of the toxicological data available for terrestrial invertebrates are based upon in situ studies that represent both pathways. Therefore, both pathways are typically considered together in SERAs. Invertebrates also represent a link between soil and upper trophic level receptors through food web transfer. As such, they are often included as prey items for upper trophic level dietary exposures.

Birds and mammals may be exposed to chemicals through: (1) the inhalation of gaseous chemicals or chemicals adhered to particulate matter; (2) the incidental ingestion of contaminated abiotic media (e.g., soil) during feeding or cleaning activities; (3) the ingestion of contaminated water; (4) the ingestion of contaminated plant and/or animal tissues for chemicals that have entered food webs; and/or (5) dermal contact with contaminated abiotic media. These exposure routes, where applicable, are depicted on Figure 7-10. Their relative importance depends in part on the chemical being evaluated. For chemicals having the potential to bioaccumulate (e.g., polychlorinated biphenyls [PCBs]), the greatest exposure to wildlife is likely to be from the ingestion of prey. For chemicals having a limited potential to bioaccumulate (e.g., aluminum), the exposure of wildlife to chemicals is likely to be greatest through the direct ingestion of abiotic media, such as surface soil.

Direct ingestion of drinking water is only considered if the salinity of a potential drinking water source is less than 15 ppt, the approximate toxic threshold for wildlife receptors (Humphreys, 1988). As evidenced by Figures 7-4 and 7-5, there are no potential drinking water sources (e.g., freshwater wetlands and drainage ditches) within or contiguous to the Fueling Piers Area. Therefore, ingestion of surface water is not considered an exposure pathway for upper trophic level terrestrial receptors.

Certain potential exposure pathways and/or routes depicted on Figure 7-10 are considered insignificant relative to other pathways due to low potential for exposure and low levels of relevant contaminants. For example, dermal exposures are not considered significant relative to ingestion exposures for upper trophic level receptors. This is supported by evidence outlined in Suter II et al. (2000) and the USEPA (2003a), including the general fate properties of the majority of compounds detected in soil (e.g., low affinity for dermal uptake), the low potential exposure frequency (EF) and exposure duration (ED), and the protection offered by feathers, fur, and scales to avian, mammalian, and reptilian receptors. In addition, literature reviews indicate that dermal exposures to wildlife from classes of chemicals known or suspected to be of concern via dermal adsorption (e.g., VOCs, organophosphorous pesticides, and petroleum compounds) are often overestimated in laboratory studies (where feathers/fur are removed) and do not represent realistic exposure scenarios (USEPA, 2003a). Furthermore, though burrowing reptiles (which would be expected to experience the most significant exposure) may inhabit the vegetative units within and immediately contiguous to the Fueling Piers Area, chemicals known or suspected to be of concern via dermal adsorption are not known to be associated with historical activities at the site (e.g., organophosphorous pesticides) or were detected at a low frequency and concentration (e.g., VOCs). Moreover, USEPA (2003a) calculated that the contribution of dermal exposures to the total dose received by terrestrial receptors to be 0.5 percent or less and therefore omitted the dermal pathway from consideration during Eco-SSL development. Incidental ingestion of soil during feeding and preening activities by upper trophic level receptors, as well as direct contact exposures by lower trophic level receptors (i.e., terrestrial invertebrates) are considered significant exposure routes (see Figure 7-10).

Inhalation of gaseous chemicals and chemicals adhered to particulate matter (e.g., soil) also is considered insignificant relative to ingestion pathways. As described above for dermal exposures, this approach is consistent with Suter II et al. (2000) and USEPA (1997 and 2003a), which recognize the relatively small contribution the inhalation pathway contributes to exposure estimates. For example, USEPA (2003a) estimates that the expected contribution to the total dose associated with the inhalation pathway is less than 0.01 percent for particulates and less than 1.0 percent for volatiles. Site conditions further reduce the importance of this exposure route relative to ingestion. The vegetative groundcover at the Fueling Piers Area will minimize the suspension of dust and the potential for exposure via inhalation of chemicals adhered to soil particles. Furthermore, inhalation of gaseous chemicals that have volatilized from soil is likely to be insignificant given that VOCs were detected at a low frequency and concentration during the 2008 Phase I CMS field investigation (Baker, 2010a) and 2010 Phase II field investigation (see Appendix B).

7.3.2 Endpoints and Risk Questions

The conclusion of the screening level problem formulation includes the selection of ecological endpoints, which are based on the preliminary conceptual model. Two types of endpoints, assessment endpoints and measurement endpoints, are defined as part of the ERA process, as are risk hypotheses or risk questions (USEPA, 1997 and 1998). An assessment endpoint is an explicit expression of the environmental component or value that is to be protected. A measurement endpoint is a measurable ecological characteristic that is related to the component or value chosen as the assessment endpoint. The considerations for selecting assessment and measurement endpoints are summarized in USEPA (1992 and 1997) and discussed in detail by Suter II (1989, 1990, and 1993). Risk questions ask how the assessment endpoints could be affected by site-related constituents.

Endpoints in the SERA define ecological attributes that are to be protected (assessment endpoints) and a measurable characteristic of those attributes (measurement endpoints) that can be used to gauge the degree of impact that has or may occur. Assessment endpoints most often relate to attributes of biological populations or communities, and are intended to focus the risk assessment on particular components of the ecosystem that could be adversely affected by chemicals attributable to the site (USEPA, 1997). Assessment endpoints contain an entity (e.g., red-tailed hawk) and an attribute of that entity (e.g., survival rate). Individual assessment endpoints usually encompass a group of species or populations (the receptor) with some common characteristic, such as a specific exposure route or sensitivity to a specific contaminant, with the receptor then used to represent the assessment endpoint in the risk evaluation.

Assessment and measurement endpoints may involve ecological components from any level of biological organization, from individual organisms to the ecosystem itself (USEPA, 1992). Effects on individuals are important for some receptors, such as rare and endangered species; however, population- and community-level effects are typically more relevant to ecosystems. Population- and community-level effects are usually difficult to evaluate directly without long-term and extensive study. However, measurement endpoint evaluations at the individual level, such as an evaluation of the effects of chemical exposure on reproduction, can be used to predict effects on an assessment endpoint at the population or community level. In addition, use of criteria values designed to protect the vast majority (e.g., 95 percent) of the components of a community (e.g., National Ambient Water Quality Criteria [NAWQC] for the Protection of Aquatic Life) can be useful in evaluating potential community and/or population-level effects.

Table 7-2 summarizes the assessment endpoints, risk questions, and measurement endpoints selected for the SERA at the Fueling Piers Area. As evidenced by Table 7-2, the assessment endpoints selected are based on the survival, growth, and reproduction of lower trophic level terrestrial receptor groups (terrestrial plants and invertebrates), terrestrial reptiles and amphibians, and upper trophic level terrestrial birds (herbivores, omnivores, and carnivores), The population traits of interest for each of the assessment endpoints listed in Table 7-2 represent components of a healthy population. Failure or impairment of survival, growth, or reproduction will adversely affect the ability of the population to be healthy and viable and fill its appropriate role in an ecosystem.

7.3.2.1 Selection of Receptors

Because of the complexity of natural systems, it is generally not possible to directly assess the potential impacts to all ecological receptors present within an area. Therefore, specific receptor species (e.g., mourning dove) are often selected as surrogates to evaluate potential risks to larger components of the ecological community (e.g., avian herbivores) used to represent the assessment endpoints (e.g., survival, growth, and reproduction of avian herbivores). Selection criteria typically include those species that:

- Are known to occur, or are likely to occur, at the site;
- Have a particular ecological, economic, or aesthetic value;
- Are representative of taxonomic groups, life history traits, and/or trophic levels in the habitats present at the site for which complete exposure pathways are likely to exist;
- Can, because of toxicological sensitivity or potential exposure magnitude, be expected to represent potentially sensitive populations at the site; and
- Have sufficient ecotoxicological information available on which to base an evaluation.

Lower trophic level receptor species were evaluated based on those taxonomic groupings (e.g., terrestrial plants and invertebrates) for which screening values have been developed. These groupings and screening values are used in most ERAs. As such, specific receptor species of lower trophic level terrestrial biota were not chosen because of the limited species-specific information available. These receptors were instead dealt with on a community level via a comparison to soil screening values.

The upper trophic level receptor species listed below were chosen for dietary exposure modeling to chemicals in Fueling Piers Area surface and subsurface soil (1.0 to 3.0-foot depth interval) based on the criteria listed above, the general guidelines presented in USEPA (1991), the description of habitats and biota presented in Section 7.1, and the assessment endpoints (see Table 7-2).

- Mourning dove (*Zenaida macroura*) (avian herbivore)
- American robin (*Turdus migratorius*) (avian omnivore)
- Red-tailed hawk (*Buteo jamaicensis*) (avian carnivore)

- Brow flower bat (*Erophylla sezekorni*) (mammalian nectivore)

The mourning dove and red-tailed hawk are known to occur in Puerto Rico (Raffaele, 1989). These two species also have been reported at NAPR (see Table 7-1). The American robin was selected as a surrogate species to represent birds reported from NAPR with similar feeding habits and dietary preferences (e.g., red-legged thrush). The Fueling Piers Area is not located within the critical habitat designation for the yellow-shouldered blackbird. However, based on their arboreal feeding habits, the yellow-shouldered blackbird could potentially forage within the trees that have become established along the pipeline spur leading to the Berthing Pier. As discussed in Section 7.1.3.2, arboreal insectivores, such as the yellow-shouldered blackbird, would not be expected to experience any significant exposures. Regardless, aspects of the feeding ecology of the American robin and yellow-shouldered blackbird indicate that the American robin can be protectively used as a surrogate receptor:

- The American robin forages on the ground for soft-bodied invertebrates, whereas the yellow-shouldered black bird is an arboreal feeder that forages within the canopy and sub-canopy of trees (USFWS, 1996a). The invertebrate prey item consumed by the American robin is assumed to be earthworms for the SERA. Because earthworms are in direct contact with soil, they will bioaccumulate soil contaminants at higher concentrations than the arboreal invertebrates consumed by the yellow-shouldered blackbird. Therefore, modeled dietary intakes that include earthworm ingestion will result in a conservative estimate of dietary exposures for the yellow-shouldered blackbird.

- The diet of the American robin is assumed to include 10.5 percent soil, whereas soil consumption by the yellow-shouldered blackbird is likely to be negligible based on their arboreal feeding behavior. Modeled dietary intakes that include soil ingestion also will result in a conservative estimate of food web exposures for the yellow-shouldered blackbird.

Although potentially complete and significant exposure pathways exist at the Fueling Piers Area for terrestrial ground mammals (i.e., incidental ingestion of surface soil, and ingestion of contaminated plant and/or animal tissues for chemicals that have entered food webs), a terrestrial ground mammal was not selected as an ecological receptor for the following reasons.

- All native terrestrial ground mammals have been extirpated from Puerto Rico (Mac et al., 1998).

- The terrestrial ground mammals represented by potentially complete exposure pathways are limited to nonindigenous, nuisance species (i.e., Norway rat, black rat, and mongoose) that have been implicated in the decline of native reptilian and bird populations (Mac et al., 1998 and USFWS, 1996a).

As discussed in Section 7.1.3.1, vegetation located along the pipeline spur leading to the Berthing Pier includes plants known to be used as a source of food by bats on Puerto Rico (white lead tree). Therefore, a nectivorous bat (i.e., brown flower bat) was selected as an ecological receptor for upland habitat at the SWMU. This species is common and found throughout Puerto Rico (Gannon et al., 2005). As discussed in Section 7.1.3.2, the USEPA has excluded aerial and arboreal insectivorous birds from Eco-SSL development because they are considered inappropriate (i.e., they do not have a clear or indirect exposure pathway link to soil [indirect exposure pathways involve ingestion of prey that have direct contact with soil]). For this same reason, the USEPA has also excluded aerial insectivorous mammals (i.e., bats) from Eco-SSL development. As such, an aerial insectivorous bat (i.e., Antillean ghost-faced bat, Parnell's mustached bat, sooty mustached bat, big brown bat, red bat, velvety free-tailed bat, or Brazilian free-tailed bat) was not selected as an ecological receptor. A frugivorous bat (i.e., Jamaican fruit bat, Antillean fruit bat, or red fig-eating bat) also was excluded from evaluation based on the absence of fruit-bearing vegetation known to be used as a source of food by bats on Puerto Rico. Finally, a piscivorous bat (i.e., Mexican bulldog bat) was excluded from evaluation since there are no surface water bodies within the area of investigation (i.e., area encompassed by borings installed during the 2011 Phase II CMS field investigation), nor are there potentially complete and significant transport pathways from the Fueling Piers Area to an exposure point (see Section 7.3.1.2).

While exposure pathways to terrestrial reptiles and amphibians are likely to be complete, specific reptilian and amphibian species were not selected as receptors in the SERA since the life history and toxicological database concerning the effects of chemicals on herpafauna is severely limited, rendering a quantitative evaluation problematic (USEPA, 2000b and 2005a). It is assumed that reptiles and amphibians potentially present at the site are not exposed to significantly higher concentrations of chemicals and are not more sensitive to chemicals than the other upper trophic level receptor species evaluated in the risk assessment. Although this assumption is a source of uncertainty in the SERA, this approach is consistent with USEPA Region III guidance (USEPA, 2010a; available at http://www.epa.gov/reg3hwmd/risk/eco/index.htm), which states that "*As a general rule in Region 3, impacts to reptiles do not have to be considered as an assessment endpoint in the screening level ERA. However, the screening ERA would need to state that impacts to reptiles are being assessed qualitatively through the use of surrogate receptors. An exception to this rule is when a threatened or endangered reptile has been identified as a potential receptor on the site. In this situation, it may be appropriate to consider impact on reptiles when identifying assessment endpoints*."

7.3.3 Fate and Transport Mechanisms

In the absence of measured values of chemicals within biotic media, the transport and partitioning of constituents into particular environmental compartments, and their ultimate fate in those compartments, can be predicted from key physical-chemical characteristics. The physical-chemical characteristics that are most relevant for exposure modeling in this assessment include water solubility, adsorption to solids, octanol-water partitioning, and degradability. These characteristics are defined below.

The water solubility of a compound influences its partitioning to aqueous media. Highly water-soluble chemicals, such as most VOCs, have a tendency to remain dissolved in the water column rather than partitioning to sediment (Howard, 1991). Compounds with high water solubility also generally exhibit a lower tendency to bioconcentrate in aquatic organisms and a greater likelihood of biodegredation, at least over the short term (Howard, 1991).

Adsorption is a measure of a compound's affinity for binding to solids, such as soil or sediment particles. Adsorption is expressed in terms of partitioning, either as the adsorption coefficient (K_d), a unitless expression of the equilibrium concentration in the solid phase versus the water phase, or the organic carbon partition coefficient (K_{oc}, K_d normalized to the organic carbon content of the solid phase; again unitless) (Howard, 1991). For a given organic chemical, the higher the K_{oc} or K_d, the greater the tendency for that chemical to adhere strongly to soil or sediment particles. K_{oc} values can be measured directly or can be estimated from either water solubility or the octanol-water partition coefficient using one of several available regression equations (Howard, 1991).

Octanol-water partitioning indicates whether a compound is hydrophilic or hydrophobic. The octanol-water partition coefficient (K_{ow}) expresses the relative partitioning of a compound between octanol (lipids) and water. A high affinity for lipids equates to a high K_{ow} and vice versa. K_{ow} has been shown to correlate well with adsorption to soil or sediment particles and the potential to bioaccumulate in the food chain (Howard, 1991). Typically expressed as log K_{ow}, a value of 3.0 or less generally indicates that the chemical will not bioconcentrate to a significant degree (Maki and Duthie, 1978). Log K_{ow} and K_{oc} values for organic chemicals analyzed for in environmental media collected at the Fueling Piers Area during the 2008 Phase I and 2011 Phase II CMS investigations (i.e., Appendix IX VOCs and PAHs) are presented in Table 7-3. The Log K_{ow} values listed in Table 7-3 were obtained from the USEPA (1995 and 2011), while K_{oc} values were estimated using the following regression equation (USEPA 1993a and 1996):

$$Log\ K_{oc} = 0.00028 + (0.983)(Log\ K_{ow})$$

Degradability is an important factor in determining whether there will be significant loss of mass or change in the form of a chemical over time in the environment. The half-life of a compound is typically used to describe losses from either degradation (biological or abiotic) or from transfer from one compartment to another (e.g., volatilization from soil to air). The half-life is the time required for one-half of the mass of a compound to undergo the loss or degradation process.

7.4 Screening Level Effects Evaluation

The purpose of the screening level effects evaluation is the establishment of chemical exposure levels (screening values) that represent conservative thresholds for adverse ecological effects. One set of screening values is typically developed for each selected assessment endpoint. For the SERA at the fueling piers area, two types of screening values were developed (media-specific screening values and toxicity reference values [TRVs]). Media-specific screening values were developed for soil (surface and subsurface soil), while TRVs were developed for the evaluation of potential risks to upper trophic level terrestrial receptors (i.e., avian omnivores, avian and mammalian herbivores, and avian carnivores from food web (dietary) exposures (i.e., ingested chemical doses).

7.4.1 Soil Screening Values for Terrestrial Plants and Invertebrates

The literature-based toxicological benchmarks selected for use as screening values for chemicals in surface soil (0.0 to 1.0-feet bgs]) and subsurface soil (1.0 to 3.0-feet bgs) are summarized in Table 7-4. USEPA Eco-SSLs (documentation is available at http://www.epa.gov/ecotox/ecossl/) for terrestrial plants and invertebrates were preferentially selected as soil screening values. For a given chemical, if an Eco-SSL was available for both receptor groups, the lowest value was selected as the soil screening value. In the case of chromium and vanadium, insufficient data are available from the literature for derivation of plant- and invertebrate-based Eco-SSLs (USEPA, 2008 and 2005b). However, both Eco-SSL documents list toxicological data from studies eligible for Eco-SSL derivation. The chromium Eco-SSL document cites two studies (Van Gestel et al., 1992 and 1993) that investigated the effect of chromium on earthworm (*Eisenia andrei*) reproduction, while the vanadium Eco-SSL document cites two studies (Kaplan et al., 1990) that investigated the effect of vanadium on broccoli (*Brassica oleracea*) growth. The chromium studies using earthworms reported Maximum Acceptable Toxicant Concentration (MATC) values of 57 mg/kg, while the vanadium studies using broccoli reported either a Lowest Observed Adverse Effect Concentration (LOAEC) of 100 mg/kg or a No Observed Adverse Effect Concentration (NOAEC) of 100 mg/kg. For this ERA, the MATC value of 57 mg/kg based on earthworm reproduction was used as the soil screening value for chromium, while the LOAEC value based on broccoli growth (with a safety factor of 5; Wentsel et al., 1996) was used as the soil screening value for vanadium.

For those chemicals lacking terrestrial plant and invertebrate Eco-SSLs or toxicological data eligible for Eco-SSL derivation, the literature-based toxicological benchmarks listed below were selected as soil screening values.

- USEPA Region 5 (2003b) ecological screening levels (ESLs) for soil based on exposures to plants or terrestrial invertebrates

- Toxicological thresholds for earthworms and microorganisms (Efroymson et al., 1997a)

- Toxicological thresholds for plants (Efroymson et al., 1997b)

Identical to the Eco-SSLs, if more than one screening value was available for a given chemical from USEPA (2003b) and Efroymson et al. (1997a and 1997b), the lowest value was selected as the soil screening value. For those chemicals lacking an Eco-SSL, toxicological data eligible for Eco-SSL derivation, USEPA Region 5 ESLs based on exposures to plants or terrestrial invertebrates, and a toxicological threshold from Efroymson et al. (1997a and 1997b), the following literature-based values, listed in their order of decreasing preference, were used as soil screening values:

- Toxicity reference values for plants and invertebrates listed in USEPA (1999)

- Soil standards developed by the Ministry of Housing, Spatial Planning and Environment (MHSPE, 2000)

- Canadian soil quality guidelines (agricultural land use) developed by the Canadian Council of Ministers of the Environment (CCME, 2001 and 2007)

- Ecological soil screening values compiled by Friday (1998)

Soil screening values based on MHSPE soil standards represent an average of the target and intervention soil standards. Values are based on a default organic carbon content of 2.0 percent, which represents the minimum value within the adjustment range (2.0 to 30.0 percent). Soil quality guidelines developed by CCME (2001 and 2007), as well as ecological soil screening values compiled by Friday (1998) were given the lowest preference since many are based on background concentrations or detection limits, not effect-based concentrations.

As evidenced by Table 7-4, soil screening values were not identified from the literature for twenty-eight VOCs. The uncertainty associated with the lack of soil screening values for these organic chemicals is discussed within Section 7.7.

7.4.2 Toxicity Reference Values for Avian and Mammalian Dietary Exposures

TRVs for avian and mammalian dietary exposures to chemicals in surface and subsurface soil were compiled from the literature for each receptor species and chemical evaluated for dietary exposures. If available, TRVs identified and used by the USEPA in the derivation of avian and mammalian Eco-SSLs were preferentially used to evaluate risks from ingested dietary doses.
For chemicals lacking an avian/mammalian Eco-SSL, toxicological information from the literature for wildlife species most closely related to the receptor species was used if available.

This information was supplemented by laboratory studies of non-wildlife species when necessary. Chronic No Observed Adverse Effects Levels (NOAELs) based on growth or reproduction endpoints were preferentially used as TRVs for upper trophic level receptors. NOAELs represent the highest dose of a chemical at which an effect being measured in a toxicity test does not occur. If several chronic toxicity studies were available from the literature, the most appropriate study was selected for each receptor species based on study design, study methodology, study duration, study endpoint, and test species. When chronic NOAEL values were unavailable, estimates were derived or extrapolated from chronic Lowest Observed Adverse Effects Levels (LOAELs) or median lethal dose (LD_{50}) acute values. LOAELs represent the lowest dose of a chemical at which an effect being measured in a toxicity test occurs, while an LD_{50} represents the dose of a chemical at which half of the organisms being tested die. An uncertainty factor of 5 was used to convert a reported chronic LOAEL to a chronic NOAEL (Wentsel et al., 1996), while an uncertainty factor of 100 was used to convert the acute LD_{50} to a chronic NOAEL (i.e., the LD_{50} was multiplied by 0.01 to obtain the chronic NOAEL [Wentsel et al., 1996 and USEPA, 1997]). In some cases, TRVs for one chemical were used as surrogate values for chemicals within the same class that lack literature-based values.

TRVs, expressed as milligrams of the chemical per kilogram body weight of the receptor per day (mg/kg-BW/day), for the avian species selected as ecological receptors (i.e., American robin, mourning dove, and red-tailed hawk), are provided in Table 7-5. Sample et al. (1996) consider a scaling factor of 1.0 most appropriate for interspecies extrapolation between birds. Therefore, the NOAEL and LOAEL values listed in Table 7-5 were not adjusted to reflect differences in body weights between avian test species and avian receptor species. TRVs for the mammalian species selected as an ecological receptor (i.e., brown flower bat) are provided in Table 7-6. Studies have shown that numerous physiological functions such as metabolic rates, as well as responses to toxic chemicals, are a function of mammalian body size. Smaller mammals have higher metabolic rates and usually are more resistant to toxic chemicals because of more rapid rates of detoxification. Although body-weight scaling factors are typically used for interspecies extrapolation among mammals (Travis and White, 1988, Travis et al., 1990, and Sample et al., 1996), the mammalian TRVs were not adjusted in the SERA to account for differences between receptor and test organism body weights. This is considered a conservative approach since the body weight of the brown flower bat (0.016 to 0.0205 kg [Gannon et al., 2005]) is lower than the body weight of all the test species listed in Table 7-6. Differences in receptor and test species body weights were accounted for in Step 3a of the BERA (see Section 7.9).

Not all chemicals analyzed for in surface and subsurface soil were evaluated for avian and mammalian dietary exposures. The organic chemicals evaluated for dietary exposures are limited to those listed in Table 7-3 with the potential to bioaccumulate to a significant extent. Bioaccumulative organic chemicals are defined as those with a maximum reported log K_{ow} value greater than or equal to 3.0. Rational for using a log K_{ow} of 3.0 to define an organic chemical with the potential to bioaccumulate is included as Appendix E. For conservatism, all inorganic chemicals (i.e., metals) also were evaluated for dietary exposures. The list of chemicals selected for evaluation contains many chemicals that are not identified as "important bioaccumulative compounds" by the USEPA (2000a). Their inclusion in the evaluation of avian and mammalian dietary exposures is consistent with the conservatism of the SERA.

As evidenced by Tables 7-5, avian TRVs were not identified from the literature for nine bioaccumulative VOCs (1,1,1,2-tetrachloroethane, carbon tetrachloride, chlorobenzene, chloroform, ethylbenzene, pentachloroethane, styrene, toluene, and trichloroethene) and one metal (beryllium). In addition, mammalian TRVs were not identified from the literature for two VOCs (1,1,1,2-tetrachloroethane and pentachloroethane). The uncertainty associated with the lack of avian and mammalian TRVs for these chemicals is discussed within Section 7.7.

7.5 Screening Level Exposure Estimation

This section presents the analytical data, exposure assumptions, and the exposure models and input parameters that were used to estimate the potential exposure of ecological receptors to chemicals in soil and groundwater.

7.5.1 Selection Criteria for Analytical Data

The analytical data used in the SERA (described in Section 7.2 and presented in Appendix D) were reviewed against a set of selection criteria to identify specific data that would be used to estimate potential exposures to ecological receptors. The criteria used to select these analytical data are listed below.

- Data must have been validated by a qualified data validator using acceptable data validation methodology. Rejected ("R") values were not used in the SERA. Unqualified data and data qualified as estimated, "J" were treated as detected, while data qualified as "U" or estimated, "UJ" were treated as non-detected.

- The available soil analytical data were divided into surface soil data (i.e., analytical data for soil samples collected from the 0 to 1.0-foot depth interval) and subsurface soil data (analytical data for soil samples collected from the 1.0 to 3.0-foot depth interval), and evaluated independently from each other. The evaluation of available soil analytical data was limited to these depth ranges since most soil heterotrophic activity and soil invertebrates occur on the surface or within the oxidized root zone (Suter II, 1995).

- Maximum MDLs/LODs were conservatively used to estimate exposure for non-detected chemicals.

- In some instances, duplicate samples were collected in the field (see Section 4.6.1). The maximum concentration of each chemical (or the maximum non-detected value) in the original or duplicate sample was used as a conservative estimate of contaminant concentrations at a particular sampling point. Results from duplicate samples were not evaluated individually.

7.5.2 Exposure Estimation

Maximum detected concentrations in soil (surface and subsurface soil) were used to conservatively estimate potential chemical exposures for the ecological receptors selected to represent the assessment endpoints. For conservatism, maximum MDLs/LODs for chemicals that were analyzed for but not detected also were compared to media-specific screening values and (where appropriate) used for dietary exposure modeling. This was done to ensure that MDLs/LODs are similar to, or less than, chemical concentrations at which potential adverse effects to ecological receptors may occur. For samples with duplicate analyses, the higher of the two concentrations was used in the screening (when both values were detects or both values were non-detects). In cases where one result was a detection and the other a non-detect, the detected value was used in the assessment.

7.5.2.1 Terrestrial Receptor Groups

Maximum measured chemical concentrations in soil were compared to the media-specific screening values discussed in Section 7.4.1 and summarized in Table 7-4 to conservatively evaluate the potential for adverse ecological effects to the lower trophic level receptor groups selected as assessment endpoints (e.g., terrestrial plants and invertebrates).

7.5.2.2 Upper Trophic Level Receptors

Exposures for upper trophic level terrestrial receptor species via the food web were determined by estimating chemical-specific concentrations in each dietary component using uptake and food web models. Incidental ingestion of soil was also included when calculating the total level of exposure. As indicated previously, maximum measured soil concentrations were used in all calculations to provide a conservative assessment.

For the screening level exposure estimation, tissue concentrations were modeled for terrestrial plants (food item for the mourning dove and brown flower bat), soil invertebrates (food item for the American robin), and small mammals (food item for the red-tailed hawk). The omnivorous Norway rat was selected as the small mammal food item for the red-tailed hawk. A small mammal herbivore and/or insectivore were excluded as potential food items for the red-tailed hawk because they are not part of the Puerto Rican mammalian fauna (see Section 7.1.3.1).

7.5.2.2.1 Exposure Point Concentrations

The uptake of chemicals from the abiotic media into terrestrial food items is based (where available) on chemical-specific uptake equations (i.e., regressions based on measured soil and tissue concentrations) or conservative (e.g., maximum or 90th percentile) bioaccumulation factors (BAFs) from the literature. Generic models based on Log K_{ow} values (presented in USEPA [2007a]) or default factors of 1.0 were used for chemicals only when chemical-specific uptake equations and BAF data were unavailable from the literature. The methodology and models used to derive these estimates are described below.

Terrestrial plants. Tissue concentrations in the aboveground vegetative portion of terrestrial plants were estimated by chemical-specific uptake equations (i.e. regressions developed from measured soil and tissue data) or by multiplying maximum measured soil concentrations by conservative, chemical-specific BAFs (maximum or 90th percentile values) either obtained directly from the literature or derived from literature data sets (see Table 7-7). The chemical-specific BAF values listed in Table 7-7 are based on root uptake from soil and on the ratio between dry-weight soil and dry-weight plant tissue. Literature values based on the ratio between dry-weight soil and wet-weight plant tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content of terrestrial plants (15 percent [0.15]; Sample et al., 1997). Chemical-specific regressions developed by Bechtel Jacobs (1998) or USEPA (2007a) were given preference over high-end BAF values (i.e., maximum and 90th percentile values) if the regressions were significant ($p < 0.05$).

For bioaccumulative organic chemicals lacking significant regressions and chemical-specific BAFs, soil-to-plant BAFs were estimated from their Log K_{ow} using the rinsed foliage regression equation provided in Figure 5, Panel B of USEPA (2007a):

$$Log\ BAF = (-0.4057)\ (Log\ K_{ow}) + 1.781$$

where:

Log BAF = Log Soil-to-plant BAF (unitless; dry-weight basis)
$Log\ K_{ow}$ = Log Octanol-water partitioning coefficient (unitless)

The Log K_{ow} values used in this equation are listed in Table 7-3.

Earthworms. Tissue concentrations in soil invertebrates (earthworms) were estimated by chemical-specific uptake equations (i.e. regressions developed from measured soil and tissue data) or by multiplying maximum measured soil concentrations for each chemical by conservative, chemical-specific soil-to-invertebrate BAFs (90th percentile values) obtained directly from the literature or derived from literature data sets (see Table 7-7). The chemical-specific BAF values listed in Table 7-7 are based on the ratio between dry-weight soil and dry-weight earthworm tissue. Literature values based on the ratio between dry-weight soil and wet-weight earthworm tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content of earthworms (16 percent [0.16]; USEPA, 1993b). BAFs based on depurated analyses (soil was purged from the gut of the earthworm prior to analysis) were given preference over undepurated analyses since direct ingestion of surface soil is accounted for separately in the food web model. Chemical-specific regressions developed by Sample et al. (1998a) were given preference over high-end BAF values (i.e., 90th percentile values) if the regressions were significant ($p < 0.05$).

For inorganic chemicals without available chemical-specific uptake equations or high-end BAFs, an earthworm BAF of 1.0 was assumed. For organic chemicals lacking chemical-specific uptake equations or high-end BAFs, earthworm BAF values were estimated using the model presented in Section 3.2.2 and Table 5 of USEPA (2007a). In this model, the soil-to-earthworm BAF value is estimated using the following equation:

$$BAF = K_{ww}/K_d$$

K_{ww} is the biota to soil water partitioning coefficient (L soil pore water/kg worm tissue – dry weight), while k_d represents the soil to water partitioning coefficient (L soil pore water/kg soil – dry weight). For a given organic chemical, K_{ww} is a function of the K_{ow} value and lipid content of the organism. The following regression equation for K_{ww} (wet weight basis) was derived by Jager (1998) for earthworms based on data for sixty-nine organic chemicals with Log K_{ow} values ranging from 2.0 to 8.0:

$$Log\ K_{ww} = (0.87)(Log\ K_{ow}) - 2.0$$

K_{ww} can be converted to a dry weight basis by dividing the wet weight value by the estimated solids content of earthworms (16 percent [0.16]; USEPA, 1993b). K_d can be estimated by the following equation (USEPA 2007a):

$$K_d = (f_{oc})(K_{oc})$$

In this equation, f_{oc} is the fraction of organic carbon in soil (kg organic carbon/kg soil; assumed to be 0.01 [1.0 percent]) and K_{oc} is the organic carbon partition coefficient. For a given chemical, the Log K_{ow} and K_{oc} value used to estimate K_{ww} and K_d, respectively are those listed in Table 7-3.

Small mammals. Whole-body tissue concentrations in small mammals (i.e., Norway rats) were estimated using one of two methodologies. When available, chemical-specific uptake equations (i.e., regressions developed from measured soil and tissue data) or conservative, chemical-specific soil-to-small mammal BAFs (90th percentile values) obtained directly from the literature or derived from literature data sets were used to estimate whole-body tissue concentrations (see Table 7-8). The chemical-specific BAFs listed in Table 7-8 are based on the ratio between dry-weight soil and dry-weight tissue. Literature values based on the ratio between dry-weight soil and wet-weight tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content of small mammals (32 percent [0.32]; USEPA, 1993b). Chemical-specific regressions developed by Sample et al. (1998b) for general small mammals were given preference over high-end BAF values (i.e., 90th percentile values) if the regressions were significant ($p < 0.05$).

For those chemicals lacking chemical-specific uptake equations or literature-based BAF values, an alternate approach was used to estimate whole-body tissue concentrations. Because most chemical exposure for small mammal species is via the diet, it was assumed that the concentration of each chemical in a small mammal's tissues is equal to the chemical concentration in its diet multiplied by a diet to whole-body BAF (wet-weight basis) derived from the literature. For chemicals lacking literature-based diet to whole-body BAF values, a diet to whole-body BAF value of 1.0 was assumed. Resulting tissue concentrations (wet-weight) were converted to dry weight using an estimated solids content of 32 percent (see above). The use of a diet to whole-body BAF of 1.0 is likely to result in a conservative estimate of chemical concentrations for chemicals that are not known to biomagnify in terrestrial food chains (e.g., aluminum). For chemicals that are known to biomagnify, a diet to whole-body BAF value of one will likely result in a realistic estimate of tissue concentrations based on reported literature values. For example, a maximum BAF (wet weight) of 1.0 was reported by Simmons and McKee (1992) for PCBs based on laboratory studies with white-footed mice. Menzie et al. (1992) reported BAF values (wet-weight) for dichlorodiphenyltrichloroethane (DDT) of 0.3 for voles and 0.2 for short-tailed shrews. Reported BAF (wet-weight) values for dioxin are only slightly above one (1.4) for the deer mouse (USEPA, 1990).

7.5.2.2.2 Dietary Intakes

Dietary intakes for each upper trophic level receptor species were calculated using the following formula modified from USEPA (1993b).

$$DI_{xj} = \frac{[[\sum_i [(FIR_j)(FC_{xi})(PDF_i)]] + [(FIR_j)(SC_x)(PDS)]][AUF_j]}{BW_j}$$

where:

DI_{xj} = Dietary intake of chemical x by receptor j (mg chemical/kg body weight/day)
FIR_j = Food ingestion rate for receptor j (kilograms per day [kg/day]; dry-weight)
FC_{xi} = Maximum concentration of chemical x in food item i (mg/kg; dry weight)
PDF_i = Proportion of diet composed of food item i (unitless; dry weight basis)
SC_x = Maximum concentration of chemical x in soil (mg/kg; dry weight)
PDS = Proportion of diet composed of soil (unitless; dry weight basis)
BW_j = Body weight of receptor j (kilograms [kg]; wet weight basis)
AUF_j = Area use factor for receptor j (unitless)

Conservative, receptor-specific exposure parameters (maximum food ingestion rates and minimum body weights) for the American robin, mourning dove, red-tailed hawk, and brown flower bat are provided in Table 7-9. The food items selected for each receptor species are provided in Table 7-10. Although American robins are omnivores, an exclusive diet of earthworms was assumed for the SERA, allowing for the most conservative estimation of exposure. Table 7-9 contains exposure parameters and Table 7-10 contains a dietary composition for the Norway rat (assumed diet of the red-tailed hawk). This assumption is based on likely small mammal prey species present in Puerto Rico (rats). Identification of exposure parameters and food items was necessary when estimating small mammal whole body tissue concentrations for those chemicals that lack a literature-based soil-to-small mammal BAF (i.e., an exposure dose was necessary to estimate tissue concentrations). Identical to the American robin, an exclusive diet of earthworms was assumed.

For the SERA, an AUF of 1.0 was assumed (i.e., each receptor is assumed to spend 100 percent of its time on the site). As such, receptor-specific home ranges were not considered in the estimation of dietary intakes.

7.6 Screening Level Risk Calculation

The screening level risk calculation represents the final step in the SERA. In this step, maximum chemical concentrations in abiotic media or maximum exposure doses for upper trophic level receptor species are compared with the corresponding screening values to derive screening level risk estimates. The outcome of this step is a list of ecological COPCs for each media-pathway-receptor combination evaluated or a conclusion of negligible risk.

7.6.1 Selection of Ecological Chemicals of Potential Concern

Ecological COPCs were selected using the hazard quotient (HQ) method. For a given chemical, an HQ was calculated by dividing the maximum chemical concentration in the medium being evaluated by the corresponding medium-specific screening value or, in the case of upper trophic level receptors, by dividing the maximum exposure dose (derived by the equation presented in Section 7.5.2.2.2) by the corresponding TRV.

The following conservative methodology was used to identify ecological COPCs for lower trophic level receptor exposures to chemicals in soil (surface and subsurface soil):

- The maximum detected concentrations in surface soil and subsurface soil were used to calculate media-specific HQs. For a given medium, chemicals with HQs greater than 1.0 based on maximum detected concentrations were identified as ecological COPCs.

- For non-detected chemicals, maximum MDLs/LODs were used to calculate media-specific HQ values. For a given medium, non-detected chemicals with HQs greater than 1.0 based on maximum MDLs/LODs were identified as ecological COPCs.

- Detected and non-detected chemicals without media-specific screening values were identified as ecological COPCs.

To select ecological COPCs for dietary exposures, maximum chemical concentrations in soil (surface and subsurface soil) were used to estimate dietary doses for each receptor. HQs were calculated with NOAEL-, LOAEL-, and MATC-based TRVs. The MATC is derived by taking the geometric mean of the NOAEL and LOAEL. Calculations with NOAELs provide the most conservative risk estimate, while calculations with LOAELs provide the least conservative risk estimate. Calculations with MATCs provide realistic risk estimates since the MATC represents an estimation of the threshold concentration (i.e., the concentration above which a toxic effect on the test endpoint is produced). For the SERA, chemicals (detected and non-detected) with NOAEL-based HQs greater than 1.0 were identified as ecological COPCs. Identical to the media-specific screening evaluation, detected and non-detected chemicals without literature-based TRVs were also identified as ecological COPCs for upper trophic level receptor exposures.

HQs greater than 1.0 indicate the potential for risk since the chemical concentration or dose (exposure) exceeds the screening value (effect). However, risk estimates are derived using intentionally conservative assumptions (maximum media concentrations, maximum ingestion rates, and minimum body weights) such that HQs greater than 1.0 do not necessarily indicate that risks are present or impacts are occurring. Rather, they identify chemical-pathway-receptor combinations requiring further evaluation. Following the same reasoning, HQs less than 1.0 indicate that risks are very unlikely, enabling a conclusion of no unacceptable risk to be reached with high confidence.

In most cases, the SERA considered independent effects of chemicals. However, the potential does exist for multiple chemicals in environmental media to interact. Much uncertainty is involved with the interpretation of chemical interactions due to the complexity of potential effects (e.g., synergistic, antagonistic, or additive), and due to varying toxicities of compounds in different species. For these reasons, cumulative effects were not addressed for most chemicals in the SERA. Chemical interactions can be addressed by site-specific studies conducted in Step 6 of the Navy ERA process (i.e., site investigation and data analysis [see Figure 7-1]).

7.6.2 Screening Level Risk Calculation for Surface Soil, Subsurface Soil, and Upper Trophic Level Receptor Dietary Exposures

Screening level risk calculations (i.e., HQ calculations) for Fueling Piers Area surface soil and subsurface soil are presented in Tables 7-11 and 7-12, respectively. These calculations apply only to lower trophic level community exposures (i.e., HQ calculations for terrestrial plant and invertebrate exposures to chemicals in surface and subsurface soil). Screening level risk estimates for upper trophic level receptor dietary exposures are presented in Tables 7-13 (surface soil) and 7-14 (subsurface soil). Ecological COPCs were identified in Step 2 of the SERA using the procedures outlined in Section 7.6.1.

7.6.2.1 Surface Soil

Table 7-11 presents the results of the screening level risk calculation for plant and invertebrate exposures to chemicals in Fueling Piers Area surface soil. Carbon disulfide was detected in surface soil (5.9 µg/kg in 74SB754-00 and 5.5J µg/kg in 74SB755-00) and identified as an ecological COPC based on the lack of a soil screening value. An additional twenty-seven non-detected VOCs are identified as ecological COPCs based on the lack of soil screening values (see Table 7-11).

Sixteen PAHs were detected in Fueling Piers Area surface soil. Information available from the literature indicates that PAH toxicities in waters, tissues, and sediments are additive or nearly additive (USEPA 2003c). Assuming that PAH toxicities in soils also are additive or nearly additive, the combined toxicological contributions of the PAH mixture in Fueling Piers Area surface soil was considered. The USEPA (2007b) has developed Eco-SSLs for low molecular weight (LMW) and high molecular weight (HMW) PAHs (29,000 µg/kg and 18,000 µg/kg, respectively [soil invertebrate-based values]). LMW PAHs are defined as PAH compounds composed of fewer than four rings, while HMW PAHs are defined as PAH compounds composed of four or more rings (USEPA, 2007b). A total of eight LMW PAH compounds (i.e., 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene) and nine HMW PAH compounds (i.e., benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, dibenz[a,h]anthracene, chrysene, indeno[1,2,3-cd]pyrene, and pyrene) were analyzed for in Fueling Piers Area surface soil. The sum of maximum LMW PAH concentrations across the SWMU (745 µg/kg; maximum MDLs/LODs were used for PAHs that were not detected) is less than the LMW PAH Eco-SSL value (29,000 µg/kg). The sum of maximum HMW PAH concentrations across the SWMU (1,907 µg/kg; maximum MDLs/LODs were used for PAHs that were not detected) also is less than the HMW PAH Eco-SSL. Based on the comparison of maximum LMW and HMW PAH concentrations across the site to the invertebrate-based Eco-SSLs, PAHs are not identified as ecological COPCs for surface soil.

Sixteen metals were detected in surface soil. Of these, arsenic, copper, mercury, selenium, vanadium, and zinc are identified as ecological COPCs because maximum detected concentrations exceed soil screening values (i.e., HQs are greater than 1.0). Maximum HQs range from 1.17 for arsenic to 7.86 for copper (see Table 7-11). Although detected, antimony, barium, beryllium, cadmium, chromium, cobalt, nickel, silver, thallium, and tin are not identified as ecological COPCs because maximum detected concentrations are less than soil screening values (i.e., maximum HQs are less than 1.0).

In summary, arsenic, copper, mercury, selenium, vanadium, and zinc were detected and identified as ecological COPCs for Fueling Piers Area surface soil because maximum detected concentrations exceed soil screening values. Carbon disulfide was also detected and identified as an ecological COPC based on the lack of a soil screening value. In addition to these detected chemicals, twenty-seven non-detected VOCs were identified as ecological COPCs based on the lack of soil screening values.

7.6.2.2 Subsurface Soil

Table 7-12 presents the results of the screening level risk calculation for plant and invertebrate exposures to chemicals in Fueling Piers Area subsurface soil. As evidenced by the table, VOCs were not detected in subsurface soil. However, twenty-eight non-detected VOCs are identified as ecological COPCs based on the lack of soil screening values.

As discussed in Section 7.6.2.1, PAH toxicities in soil are assumed to be additive or nearly additive. The USEPA (2007b) has developed Eco-SSLs for LMW and HMW PAHs (29,000 µg/kg and 18,000 µg/kg, respectively [soil invertebrate-based values]). The sum of maximum LMW PAH concentrations across the SWMU (518 µg/kg; maximum MDLs/LODs were used for PAHs that were not detected) is less than the LMW PAH Eco-SSL value (29,000 µg/kg). The sum of maximum HMW PAH concentrations across the SWMU (621 µg/kg; maximum MDLs/LODs were used for PAHs that were not detected) also is less than the HMW PAH Eco-SSL (18,000 µg/kg). Based on the comparison of the sum of maximum LMW and HMW PAH concentrations to the invertebrate-based Eco-SSLs, PAHs are not identified as ecological COPCs for Fueling Piers Area subsurface soil.

Fifteen metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, silver, thallium, vanadium, and zinc) were detected in Fueling Piers Area subsurface soil. However, these fifteen metals are not identified as ecological COPCs because maximum detected concentrations are less than soil screening values (i.e., HQs are less than 1.0).

Although not detected, selenium is identified as an ecological COPC because the maximum MDL/LOD for this metal exceeds the soil screening value (i.e., HQ = 2.12; see Table 7-12).

In summary, selenium was identified as an ecological COPCs for SWMU 74 – Fueling Piers Area subsurface soil because the maximum MDL/LOD reported for this metal exceeds the soil screening value. Twenty-eight non-detected VOCs were also identified as ecological COPCs based on the lack of soil screening values.

7.6.2.3 Avian and Mammalian Dietary Exposures

Results of the screening level risk calculation for avian and mammalian dietary exposures to chemicals in Fueling Piers Area surface and subsurface soil are presented in Tables 7-13 and 7-14, respectively. A discussion of these results is presented in the sections that follow.

7.6.2.3.1 Avian and Mammalian Dietary Exposures: Surface Soil

Results of the screening level risk calculation for avian dietary exposures to chemicals in Fueling Piers Area surface soil are presented in Table 7-13. Based on the comparison of maximum exposure doses to NOAEL-based TRVs, ten detected metals (cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, vanadium, and zinc) have HQ values greater than 1.0 for the American robin and/or mourning dove. As such, these ten metals are identified as ecological COPCs for avian dietary exposures to chemicals in surface soil. The highest HQ values were calculated for the American robin, including an HQ of 40.27 for mercury, 9.18 for vanadium, and 8.00 for chromium. One detected metal (beryllium) and nine non-detected VOCs also are identified as ecological COPCs based on the lack of avian TRVs.

Results of the screening level risk calculation for brown flower bat dietary exposures to chemicals in surface soil are included within Table 7-13. Based on the comparison of maximum exposure doses to NOAEL-based TRVs, selenium has an HQ value greater than 1.0 (HQ = 1.18). As such, this detected metal is identified as an ecological COPC for mammalian dietary exposures to chemicals in surface soil. Two non-detected VOCs (1,1,1,2-tetrachloroethane and pentachloroethane) are also identified as ecological COPCs based on the lack of mammalian TRVs.

7.6.2.3.2 Avian and Mammalian Dietary Exposures: Subsurface Soil

Results of the screening level risk calculation for avian dietary exposures to chemicals in Fueling Piers Area subsurface soil are presented in Table 7-14. Based on the comparison of maximum exposure doses to NOAEL-based TRVs, seven detected metals (cadmium, chromium, copper, lead, mercury, vanadium, and zinc) have HQ values greater than 1.0 for the American robin. As such, these seven metals are identified as ecological COPCs for avian dietary exposures to chemicals in sub surface soil. The highest HQ values were calculated for mercury (HQ = 5.18), chromium (HQ = 3.85), and cadmium (HQ = 3.12). One detected metal (beryllium) and nine non-detected VOCs are also identified as ecological COPCs based on the lack of avian TRVs.

Results of the screening level risk calculation for brown flower bat dietary exposures to chemicals in subsurface soil are included within Table 7-14. Based on the comparison of maximum exposure doses to NOAEL-based TRVs, no detected or non-detected chemical with a mammalian TRV is identified as an ecological COPC for brown flower bat dietary exposures (maximum HQs are less than 1.0). However, two non-detected VOCs (1,1,1,2-tetrachloroethane and pentachloroethane) are identified as ecological COPCs based on the lack of mammalian TRVs.

7.7 Uncertainties Associated with the SERA

The procedures used in this evaluation to assess risks to ecological receptors, as in all such assessments, are subject to uncertainties because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. Reliance on results from a risk assessment can be misleading without a consideration of the uncertainties, limitations, and assumptions inherent in the process. The major uncertainties associated with the SERA for the Fueling Piers area are identified and discussed below.

Analytical Data

- Analytical data for many detected chemicals were qualified as estimated, "J" because the results fall between the MDL and method reporting limit (MRL). Although concentrations that fall between the MDL and MRL are considered detected and evaluated as such in the SERA, the confidence in the quantified values is low.

Identification of Ecological COPCs

- Chemicals without available screening values and/or TRVs were identified as ecological COPCs in step 2 of the SERA even if they were not detected. Non-detected chemicals with maximum MDLs/LODs greater than screening values and/or maximum exposure doses greater than NOAEL-based TRVs were also identified as ecological COPCs in the SERA. This approach likely overstates the number of actual COPCs.

- A second source of uncertainty related to the selection of ecological COPCs applies to the use of NOAEL-based TRVs in risk calculations for upper trophic level receptors. The use of NOAEL-based TRVs is extremely conservative since they give no indication as to how much higher a dose must be before adverse effects are observed. This uncertainty does not apply to avian TRVs obtained from Eco-SSL documents for arsenic, cadmium, chromium, cobalt, copper, lead, nickel, selenium, silver, vanadium, and zinc or mammalian TRVs obtained from Eco-SSL documents for HMW PAHs, LMW PAHs, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, vanadium, and zinc since these values are based on a compilation of NOAEL and LOAEL values.

Exposure Point Concentrations

- The maximum measured concentration provides a conservative estimate for immobile biota or those with a limited home range. The most realistic exposure estimates for mobile species with relatively large home ranges and for species populations (even those that are immobile or have limited home ranges) are those based on arithmetic mean concentrations or 95 percent upper confidence limit (UCL) of the mean concentrations in each medium to which these receptors are exposed. This is reflected in the wildlife dietary exposure models contained in the Wildlife Exposure Factors Handbook (USEPA, 1993b), which specify the use of average media concentrations. Given the mobility of the upper trophic level receptor species used in the SERA, the use of maximum chemical concentrations to estimate the exposure via food webs is very conservative.

Soil Screening Values

- Literature-based toxicological thresholds were not available for many of the chemicals evaluated in the SERA. Furthermore, many of the soil screening values used in the comparison to soil analytical data are based on background concentrations or detection limits (i.e., Canadian soil quality guidelines; see Section 7.4.1 and Table 7-4). Because screening values based on background concentrations or detection limits do not represent effect concentrations, their use in the SERA likely resulted in an overstatement of the actual number of ecological COPCs.

- When a toxicological threshold was available for both terrestrial plants and invertebrates, the minimum value was selected as the screening value. For several chemicals, only a plant or earthworm toxicological threshold was available from the literature. It was assumed in the SERA that the screening values selected for these chemicals are protective of both receptor communities. If a given chemical does not have an available screening value for both terrestrial plants and invertebrates, this approach will result in an underestimation of potential risks if the screening value is not based on the most sensitive receptor community.

Toxicity Reference Values

- Data on the toxicity of many chemicals to the receptor species were sparse or lacking, requiring the extrapolation of data from other wildlife species or from laboratory studies with non-wildlife species. This is a typical limitation for ERAs because so few wildlife species have been tested directly for most chemicals. The uncertainties associated with toxicity extrapolation were minimized through the selection of the most appropriate test species for which suitable toxicity data were available. The factors that were considered in selecting a test species to represent a receptor species included taxonomic relatedness, trophic level, foraging method, and similarity of diet. Regardless, the use of NOAEL and LOAEL values derived from laboratory studies with non-wildlife species may have resulted in an overstatement or understatement of potential risks if the sensitivities of the receptor and test species differ appreciably.

- As discussed in Section 7.4.2, the mammalian TRVs listed in Table 7-6 were not adjusted in the SERA to account for differences between receptor and test organism body weights. Given that the body weight of the brown flower bat (0.016 to 0.0205 kg [Gannon et al., 2005]) is lower than the body weight of all the test species listed in Table 7-6, this resulted in an overstatement of potential risks since smaller animals have higher metabolic rates and usually are more resistant to toxic chemicals because of more rapid rates of detoxification.

- A third source of uncertainty related to the derivation of TRVs applies to metals. Most of the toxicological studies on which the avian and mammalian TRVs for metals are based on used forms of the metal (such as salts [see Tables 7-5 and 7-6]) that have high water solubility and high bioavailability to receptors. Since the analytical samples on which site-specific exposure estimates were based measured total metal concentrations, regardless of form, and these highly bioavailable forms are expected to compose only a fraction of the total metal concentration, this is likely to result in an overestimation of potential risks for these chemicals.

- A fourth source of uncertainty related to the derivation of TRVs applies to mercury. The NOAEL-based mercury TRVs used in the Step 2 screening-level risk calculation for birds and mammals (0.026 mg/kg-BW/day and 0.032 mg/kg-BW/day, respectively) are based on organometallic (methylated) forms (methyl mercury dicyandiamide for birds and methyl mercury chloride for mammals). Avian and mammalian TRVs for inorganic forms of mercury are at least an order of magnitude higher (NOAEL-based avian TRV of 0.45 mg/kg-BW/day and NOAEL-based mammalian TRV of 1.0 mg/kg-BW/day for mercuric chloride [Sample et al., 1996]). The USEPA (2001) reports that between 0.5 to 5.3 percent of the total mercury in soil is present as methyl mercury. These data indicate that methyl mercury represents a fraction of the total mercury in soil. As such, the use of TRVs based on methylated forms, which assume that 100 percent of the detected mercury is present as methyl mercury, likely resulted in an overestimation of potential risks to avian and mammalian receptors.

Ecological Receptors

- Although exposure pathways to terrestrial reptiles and amphibians are likely to be complete, there is a paucity of data concerning the toxicological effects of chemicals for reptiles and amphibians, rendering a quantitative evaluation problematic (USEPA, 2000b and 2005a). Therefore, for a given ecological COPC, a conclusion of acceptable or unacceptable risk to the other receptor species evaluated in the ERA also was applied to terrestrial reptiles and amphibians. It was assumed that terrestrial reptiles and amphibians at the Fueling Piers Area are not exposed to significantly higher concentrations of ecological COPCs and are not more sensitive to ecological COPCs than the avian and mammalian receptors evaluated by the ERA. If terrestrial reptiles and amphibians are exposed to significantly higher concentrations of ecological COPCs and/or are more sensitive to ecological COPCs than the avian and mammalian receptors, this approach resulted in an underestimation of potential risks. However, reptiles and amphibians are poikilotherms (body temperature varies with environmental temperature), while birds and mammals are homeotherms (temperature is regulated, constant, and largely independent of environmental temperatures). Therefore, reptiles and amphibians tend to have much lower metabolic rates and lower caloric intake requirements than birds and mammals. As a consequence, birds and mammals are likely to consume more food than reptiles and amphibians on a daily dietary intake basis, assuming similar caloric content of the food items. Therefore, potential risks to terrestrial reptiles and amphibians are likely overstated when risk estimates for avian and mammalian receptors are applied to herpetofauna.

Exposure Routes

- Although inhalation and/or dermal adsorption represent potential exposure routes for upper trophic level receptors, they were not evaluated in the SERA because they were considered insignificant relative to ingestion exposures (see Section 7.3.1.3). While this is a reasonable assumption for the terrestrial birds and mammals selected as ecological receptors, the exclusion of inhalation and dermal adsorption represents a source of uncertainty that may have resulted in an underestimation of potential risks.

Dietary Exposure Modeling

- Chemical concentrations in avian food items (terrestrial plants, invertebrates, and small mammal omnivores) and mammalian food items (plants) were modeled from measured media concentrations and were not directly measured. The use of literature-derived uptake equations and BAFs introduces some uncertainty into the risk estimates and may have resulted in an overstatement or understatement of potential risks. The values selected and the methodologies employed were intended to provide a reasonable estimate of potential food web exposure concentrations.

- A second source of uncertainty related to the dietary exposure models is the use of default assumptions for exposure parameters such as BAFs. Although chemical-specific uptake equations and BAFs for many chemicals were readily available from the literature and were used in the ERA, the use of a default factor of 1.0 to estimate the concentration of some chemicals in receptor prey items is a source of uncertainty. The assumption that the chemical body burden in the prey item is at the same concentration as in soil is conservative for chemicals that are not known not to accumulate to any significant degree. However, if a chemical does accumulate in receptor prey items, the use of a default factor of 1.0 may have resulted in an underestimation of potential risks to the upper trophic level receptors evaluated by this ERA.

- A third source of uncertainty related to dietary exposure modeling applies to the assumed diet of the red-tailed hawk. In the SERA, it was assumed that the diet of the red-tailed hawk consisted solely of rodents (i.e., Norway rat). However, red-tailed hawks are opportunistic feeders and prey will vary with regional and seasonal availability. In Puerto Rico's El Yunque rainforest, the following food items were delivered to nestlings: rats (black rat and Norway rat), birds (such as the zenaida dove), lizards (*Anolis* spp.), snakes (such as the Puerto Rican racer [*Alsophis portoricensis*]), and coquis (*Eleutherodactylus* spp.) (Global Raptor Information Network, 2010). Santana and Temple (1988) reported the diet of red-tailed hawks in mountain rain and cloud forests of Puerto Rico consisted primarily of birds, reptiles, and amphibians captured from the tree canopy, while the diet of lowland hawks was comprised mostly of mammals. The diet of lowland hawks reported by Santana and Temple (1988) support the diet assumption used in the SERA. However, if red-tailed hawks at NAPR consume a mixed diet of rats, birds, and reptiles, and bioaccumulation of chemicals in birds and reptiles differ from their bioaccumulation in rats, an assumed diet of 100 percent rats may have resulted in an overestimation or underestimation of potential risks.

- A fourth source of uncertainty related to the food web models is the use of unrealistically conservative exposure parameters. The use of maximum food ingestion rates and minimum body weights resulted in a conservative estimate of exposure. In addition, AUFs were assumed to equal one. This is a conservative assumption since a significant percentage of each upper trophic level receptor species' time could be spent foraging off-site in areas not impacted by site-related chemicals or areas where chemical concentrations are expected to be significantly lower.

<u>Chemical Mixtures</u>

- The cumulative impacts of ecological COPCs in a given medium cannot be directly addressed by a SERA, which is specifically designed to compare individual chemical concentrations to individual chemical threshold values established by regulatory agencies or the scientific literature. Approaches exist to conservatively sum Step 2 risk estimates (i.e., hazard index (HI) values); however, they can vastly overestimate the potential for risk and have been identified as "*a conservative estimator of risk that may have little ecological relevance*" (Dyer et al., 2000).

  Although cumulative effects may be indirectly examined via detailed literature reviews and toxicity testing of site media, this level of investigation is reserved for a BERA (i.e., Steps 3b through 7 of the Navy ERA process; see Figure 7-1), which has a goal of collecting and interpreting site-specific information. It is important to note that Norwood et al. (2003)

performed a review of the impacts of mixtures of inorganic constituents on aquatic biota and found that additive, synergistic, and antagonistic responses were found with equal frequency. This finding indicates that generalizations cannot be made in Step 2.

7.8 SERA Decision Points and Recommendations

The results of the SERA for the Fueling Piers Area indicated that, based on a set of conservative exposure assumptions, there are one or more chemicals in surface and subsurface soil that may present ecological risks to one or more of the receptor species/receptor groups evaluated (see Section 7.6.2 and Tables 7-11 through 7-14). Under Navy policy, if the results of Steps 1 and 2 (Tier 1 SERA) indicate that there are chemicals present in environmental media that may present risks to receptor species/receptor groups, the ERA process proceeds to the BERA (i.e., Step 3a). Therefore, further evaluation of each medium in Step 3a of the BERA is warranted.

7.9 Step 3a of the BERA

The results of the screening level risk calculation indicated that, based on a set of conservative assumptions, there are one or more chemicals in each medium evaluated that may present risks to ecological receptors groups and/or specific receptor species. As such, the ERA process at the Fueling Piers Area proceeded to the BERA. According to Superfund guidance (USEPA, 1997), Step 3 initiates the problem formulation phase of the BERA. Under Navy guidance (CNO, 1999), the BERA is defined as Tier 2, and the first activity under Tier 2 is Step 3a (see Figure 7-1). In Step 3a, the conservative assumptions employed in the SERA (Tier 1) are refined and risk estimates are recalculated using the same conceptual model. Step 3a may also include consideration of background data and chemical bioavailability.

The specific assumptions, parameters, and methods that were modified for the recalculation of media-specific and dietary HQ values are identified below, along with justification for each modification. These refinements and methods were used in Step 3a of the BERA to weigh the evidence of potential risk for each ecological COPC identified for each medium and receptor to determine whether the ecological COPCs should be identified as ecological COCs.

- Non-detected chemicals lacking media-specific screening values (or, in the case of food web exposures, TRVs) were excluded from further evaluation in Step 3a of the BERA. It is not possible to quantitatively address the potential for risk from chemicals that are not detected and that do not have established screening values with which to compare them. Even considerations of the most conservative measurement (the maximum non-detected result) are not informative when no threshold value has been established. Because of these limitations, the approach follows that outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] 300, Appendix A), which does not establish a release when the sample measurement is less than the contract required detection limit as determined by a USEPA certified laboratory. As all samples were analyzed by a certified laboratory, and were validated by an independent third party, the exclusion of non-detected chemicals is considered reasonable and appropriate. Although eliminated from further evaluation, they remain ecological COPCs but are not considered ecological COCs. It is additionally noted that any site-specific studies, which may be conducted during a BERA (Steps 3a through 7 of the Navy ERA process; see Figure 7-1), would indirectly evaluate the impacts of non-detected chemicals.

- For those ecological COPCs in surface soil with media-specific screening values/TRVs, lower trophic level and upper trophic level risk estimates were refined using 95 percent UCL of the mean chemical concentrations rather than maximum concentrations (Parker et al., 2003). 95 percent UCL of the mean concentrations were calculated using USEPA ProUCL Version 4.1.00 software (USEPA, 2010a and 2010b; see Appendix F). For individual upper trophic-level receptor species, 95 percent UCL of the mean concentrations provide a better estimate of the likely level of chemical exposure because each receptor would be expected to forage in several different areas of the site, and, in many cases, off-site. 95 percent UCL of the mean concentrations are also appropriate for evaluating impacts *to populations* of lower trophic level receptors (e.g., terrestrial invertebrates). Because some of these receptors are relatively immobile, *individuals* are likely to be impacted by locations of maximum concentrations. However, an evaluation of exposure based on 95 percent UCL of the mean concentrations is more indicative of the level of impact that might be expected at the *population* level.

  Refined risk estimates using 95 percent UCL of the mean concentrations were derived only for those ecological COPCs in surface soil with data sets that have a minimum of eight detected values (arsenic, cadmium, chromium, copper, lead, mercury, vanadium, and zinc), as data sets with fewer detected values produce unreliable results (USEPA, 2010b). Based on the limited size of the subsurface soil data set (n = 6; see Appendix D), Step 3a of the BERA did not include a refinement of risk estimates for ecological COPCs using 95 percent UCL of the mean concentrations.

- The diets of the American robin and Norway rat (food item for the red-tailed hawk) were adjusted to reflect their omnivorous feeding behavior. Wheelwright (1986), as cited in USEPA (1993b), reported seasonal dietary compositions for American robins in the western United States. Martin et al. (1951) also reported seasonal dietary compositions for the American robin throughout North America. The highest percentage of invertebrates in the diet of the American robin was reported during the spring: 83.0 percent by Wheelwright (1986) and 78.9 percent by Martin et al. (1951). For conservatism, the contribution that earthworms have to the total diet of the American robin in the BERA was assumed to be 83.0 percent (highest seasonal contribution reported by Wheelwright (1986) and Martin et al. (1951). Using the relationship presented in Sample and Sutter II (1994), a diet of 83.0 percent earthworms extrapolates to a soil contribution of 8.7 percent to the total diet. The remainder of the diet was assumed to be plants (7.3 percent). This diet was used to refine risk estimates for American robin dietary exposures to ecological COPCs in soil (surface and subsurface soil). The diet of the Norway rat was assumed to be 49.0 percent terrestrial invertebrates, 49.0 percent terrestrial plants, and 2.0 percent soil. The specific diets used in Step 3a of the BERA for each ecological receptor are summarized in Table 7-15.

- Central tendency estimates (e.g., mean, median, midpoint) for body weights and food ingestion rates (see Table 7-16) were used to develop exposure estimates for upper trophic level receptors rather than the minimum body weights and maximum food ingestion rates used in the SERA. The use of central tendency estimates is more relevant because they represent the characteristics of a greater proportion of the individuals in the population. The evaluation of food web exposures still assumed an AUF of 1.0.

- The chemical-specific uptake equations used in the SERA to estimate tissue concentrations in terrestrial plants, invertebrates, and small mammals also were used in Step 3a of the BERA. However, 95 percent UCL of mean concentrations were used in the refinement of avian and mammalian dietary exposures for those ecological COPCs with data sets having a minimum of eight detected values. When chemical-specific BAFs were used to estimate prey item tissue concentrations, BAFs based on central tendency estimates (e.g., mean, median, midpoint) were used in place of maximum or high-end (e.g., 90th percentile) values. The chemical-specific uptake equations/BAFs that were used in Step 3a for those chemicals identified as ecological COPCs for brown flower bat, American robin and/or mourning dove dietary exposures are summarized in Tables 7-17. Chemical-specific uptake equations/BAFs that were used in Step 3a for those chemicals identified as ecological COPCs for red-tailed hawk dietary exposures are summarized in Table 7-18. A BAF of 1.0 was still used for those ecological COPCs lacking literature-based BAF and BSAF values. It is noted that maximum concentrations were still applied to the uptake equations presented in Tables 7-17 and 7-18 for the refinement of avian and mammalian dietary exposures to chemicals in subsurface soil (the subsurface soil data set for each ecological COPC was insufficient for the calculation of 95 percent UCL of the mean concentrations).

- The TRVs listed in Table 7-6 for selenium (ecological COPC for mammalian dietary exposures to chemicals in Fueling Piers Area surface soil) were adjusted in Step 3a of the BERA to reflect differences in body weights between the mammalian test species and the brown flower bat. Using the NOAEL as an example, this was accomplished by using the following scaling equation (Sample et al., 1996):

$$NOAEL_r = NOAEL_t(BW_t/BW_r)^{1/4}$$

where:

$NOAEL_r$	=	NOAEL for the receptor species (mg/kg-BW/day)
$NOAEL_t$	=	NOAEL for the test species (mg/kg-BW/day)
BW_t	=	Body weight of test species (kg)
BW_r	=	Body weight of receptor species (kg)

The adjusted TRVs for selenium are summarized below:

  - NOAEL: 0.382 mg/kg-BW/day
  - MATC: 0.574 mg/kg-BW/day
  - LOAEL: 0.468 mg/kg-BW/day

- For ecological COPCs lacking soil screening values (i.e., carbon disulfide in surface soil), the USEPA (2009d and 2009e) Ecological Structure Activity Relationships (ECOSAR) Class Program (MS-Windows Version 1.00a; http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm) was used to estimate their toxicity based on structural similarities to chemicals for which toxicity data are available (i.e., structure activity relationships [SARs]).

- For inorganic ecological COPCs (i.e., metals) in Fueling Piers Area surface soil, consideration was given to available background data. This was accomplished by statistically comparing SWMU-specific media concentrations to background concentrations in accordance with Navy guidance (NFESC, 2002). Statistical comparisons included descriptive summaries of each data set (e.g., maximum, arithmetic mean, and 95 percent UCL of the mean concentrations), statistical tests on the mean/median of the distributions (i.e., two sample t-test, Wilcoxon rank sum test, Gehan test, or Satterthwaite t-test), and statistical tests on the right tail of the distributions (i.e., quantile test and slippage test). The significance level (i.e., the probability criteria for rejecting the null hypothesis that the Fueling Piers Area and background data sets were sampled from the same population) was set at 0.05 for all statistical tests (NFESC, 2002). The background surface soil data used in Step 3a of the BERA for statistical comparisons to Fueling Piers Area surface soil is the basewide (non-airfield) background data set presented in the Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2010b). This document includes three unique data sets for basewide (non-airfield) background subsurface soil (i.e., data sets for soil classified as (1) clay; (2) fine sand/silt; and (3) weathered bedrock). Based on soil characteristics at the Fueling Piers Area, the background subsurface soil data set used in the statistical comparison was the data set for subsurface soil classified as “fine sand/silt”. However, due to the limited size of the Fueling Piers Area data set (n = 6), the statistical evaluation of the subsurface soil analytical data was limited to a descriptive comparison.

- Chemicals that were not identified as ecological COPCs because maximum detected concentrations (or maximum reporting limits in the case of non-detected chemicals) were less then media-specific screening values were not evaluated in Step 3a of the BERA since a conclusion of no unacceptable risk can be made with high confidence. Detected and non-detected chemicals with maximum dietary intakes less than NOAEL-based TRVs also were excluded from further evaluation in Step 3a of the BERA.

In addition to the adjustments and modifications listed above, consideration was given to the statistical evaluations discussed in Section 6.4 and included within Appendix B, which examined the relationship between TPH concentrations (i.e., DRO, GRO, and total TPH concentrations) and detected analyte concentrations using linear regressions (TPH has been selected as an indicator of a fuel release [Baker, 2011]). For a given ecological COPC, if concentrations are not positively correlated with DRO, GRO, and total TPH concentrations, that chemical will be dropped from further consideration in Step 3a since its presence cannot be attributed to a site-related release. However, if concentrations are positively correlated with DRO, GRO, and/or total TPH concentrations, the chemical may be site-related (i.e., associated with a fuel release). In this case, the chemical will be identified as an ecological COC if the refined risk evaluation does not support a conclusion of acceptable risk.

7.9.1 Refined Risk Calculation

Detected chemicals with maximum concentrations and/or maximum exposure doses greater than screening values, as well as detected chemicals lacking screening values were identified as ecological COPCs in Step 2 of the SERA. Non-detected chemicals with maximum MDLs/LODs and/or maximum exposure doses greater than screening values, as well as non-detected chemicals lacking screening values also were identified as ecological COPCs in Step 2 of the SERA. Only those detected and non-detected chemicals with maximum concentrations and/or maximum exposure doses greater than screening values, and those detected chemicals lacking screening values were addressed in Step 3a of the BERA. Although non-detected chemicals lacking screening values were eliminated from further evaluation, they remain ecological COPCs, but are not considered ecological COCs.

7.9.1.1 Step 3a Risk Evaluation for Surface Soil

Table 7-11 presented the results of the Step 2 screening level risk calculation for Fueling Piers Area surface soil. Arsenic, copper, mercury, selenium, vanadium, and zinc were identified as ecological COPCs in Step 2 of the SERA because maximum detected concentrations exceed soil screening values. Carbon disulfide also was detected and identified as an ecological COPC based on the lack of a soil screening value. The spatial extent of detected ecological COPC concentrations greater than soil screening values is depicted on Figure 7-11. The refined screening level risk calculation for Fueling Piers Area surface soil is presented in Table 7-19. As discussed in Section 7.9, risk estimates for surface soil were re-calculated using 95 percent UCL of the mean concentrations for those ecological COPCs having a minimum of eight detected values (i.e., arsenic, copper, mercury, vanadium, and zinc). The refined risk evaluation for Fueling Piers Area surface soil is presented and discussed within the paragraphs that follow.

As discussed in the preceding paragraph, carbon disulfide was detected and identified as an ecological COPC for surface soil based on the lack of an invertebrate or plant-based soil screening value. This VOC was detected in two of fourteen (2/14) surface soil samples (5.9 µg/kg in 74SB754-00 and 5.5J µg/kg in 74SB755-00). Studies investigating the effects of carbon disulfide on terrestrial plants and invertebrates were not identified from the literature. However, the USEPA (2009a and 2009b) ECOSAR program (Version 1.00a) predicts a 14-day earthworm LC_{50} of 489 mg/L for carbon disulfide in solution. As discussed in Section 7.9, ECOSAR is a program that is used to estimate the toxicity of chemicals lacking data based on their structural similarity to chemicals for which toxicity data are available (i.e., SARs). Although solution exposures cannot be used to predict effects from soil exposures, the LC_{50} value estimated using SARs analysis illustrates the low toxicity of carbon disulfide to earthworms. Detected carbon disulfide concentrations in surface soil are also less than the minimum soil screening value developed for other VOCs (11 ug/kg [vinyl chloride screening value]; see Table 7-4]). Based on the low magnitude of detections, the comparison of detected concentrations to screening values developed for other VOCs, and the predicted toxicity in solution to earthworms using SARs analysis (14-day LC_{50} of 489 mg/L), carbon disulfide is not identified as an ecological COC for surface soil, and no additional evaluation is recommended.

Arsenic, copper, mercury, selenium, vanadium, and zinc were identified as ecological COPCs in Step 2 of the SERA because maximum detected concentrations exceed soil screening values (see Table 7-11). To further evaluate the potential significant of risks presented by those metals having a minimum of eight detected values (arsenic, copper, mercury, vanadium, and zinc), risk estimates were re-calculated using 95 percent UCL of the mean concentrations (see Table 7-19). It is acknowledged that terrestrial plants are immobile and many terrestrial invertebrates are relatively immobile; therefore, individual are likely to be impacted by locations of maximum concentrations. However, as discussed in Section 7.9, evaluation of the 95 percent UCL of the mean exposure case is more indicative of the level of impact that might be expected at the population level. In addition to the re-calculation of risk estimates using 95 percent UCL of the mean concentrations, the Fueling Piers Area surface soil data were statistically compared to the basewide background surface soil data contained and presented within the Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Chemicals (Baker, 2010b) in accordance with Navy guidance (NFESC, 2002). The risk evaluation also took into consideration the statistical evaluations discussed in Section 6.4 and included within Appendix B, which examined the relationship between metal concentrations and TPH concentrations (i.e., DRO, GRO, and total TPH concentrations) using linear regressions. For a given ecological COPC, if concentrations are not positively correlated with DRO, GRO, or total TPH concentrations, its presence in Fueling Piers Area surface soil cannot be attributed to a site-related release.

Arsenic was detected in fourteen of fourteen (14/14) surface soil samples at concentrations ranging from 1.6 mg/kg (74SB753-00) to 21 mg/kg (74SB756-00). Only the maximum detected concentration exceeds the soil screening value of 18 mg/kg (USEPA, 2005c; see Figure 7-11). The Step 2 screening level risk estimate (HQ = 1.17; see Table 7-11), derived using the maximum detected concentration, indicates that this metal may be presenting unacceptable risk to terrestrial plant and invertebrates. However, the refined risk estimate (HQ = 0.41; see Table 7-19), derived using the 95 percent UCL of the mean concentration (7.45 mg/kg), indicates that arsenic is not presenting unacceptable risk to terrestrial plant and invertebrate populations. The descriptive statistics presented in Table 7-20 for the Fueling Piers Area and background surface soil data sets indicate that arsenic concentrations are elevated above background concentrations. Specifically, maximum, arithmetic mean, and 95 percent UCL of the mean arsenic concentrations in Fueling Piers Area surface soil (21 mg/kg, 5.09 mg/kg, and 7.45 mg/kg, respectively) exceed maximum, mean, and 95 percent UCL of the mean background concentrations (2.5J mg/kg, 1.18 mg/kg, and 1.50 mg/kg, respectively). The distributional statistics performed on the surface soil data sets (Gehan test, quantile test, and slippage test) also concluded that arsenic concentrations in Fueling Piers Area surface soil are elevated above background concentrations (see Table 7-20). Although the descriptive and distributional statistics presented in Table 7-20 indicated that arsenic concentrations in Fueling Piers Area surface soil are elevated above background levels, this metal is not identified as an ecological COPC. This decision is based on the low magnitude of the maximum detected concentration above the soil screening value (HQ = 1.17), as well as the refined risk estimate (HQ = 0.41), which indicates acceptable risk to terrestrial plant and invertebrate populations. The linear regressions discussed in Section 6.4 and included within Appendix B also show that arsenic concentrations in Fueling Piers Area surface soil are not positively correlated with DRO, GRO, and/or total TPH concentrations, indicating that this metal is not site-related (i.e., not associated with a fuel release).

Mercury was detected in eleven of fourteen (11/14) surface soil samples at concentrations ranging from 0.0085J mg/kg (74SB759-00) to 0.21 mg/kg (74SB756-00). Identical to arsenic, only the maximum detected concentration exceeds the soil screening value of 0.1 mg/kg (Efroymson et al., 1997a; see Figure 7-11). The Step 2 screening level risk estimate (HQ = 2.10; see Table 7-11), derived using the maximum detected concentration, indicates that this metal may be presenting unacceptable risk to terrestrial plants and invertebrates. However, the refined risk estimate (HQ = 0.56; see Table 7-19), derived using the 95 percent UCL of the mean concentration (0.06 mg/kg), indicates that mercury is not presenting unacceptable risk to terrestrial plant and invertebrate populations. The descriptive statistics presented in Table 7-20 for the Fueling Piers Area and background surface soil data sets indicate that mercury concentrations in Fueling Piers Area surface soil are not elevated above background concentrations. Specifically, the maximum mercury concentration in Fueling Piers Area surface soil (0.21 mg/kg) is only slightly elevated above the maximum background concentration (0.12J mg/kg), while arithmetic mean and 95 percent UCL of the mean concentrations (0.03 mg/kg and 0.06 mg/kg, respectively) are less than or equal to arithmetic mean and 95 percent UCL of the mean background concentrations (0.05 mg/kg and 0.06 mg/kg, respectively). The distributional statistics performed on the surface soil data sets (Gehan test, quantile test, and slippage test) also concluded that mercury concentrations in Fueling Piers Area surface soil are not elevated above background concentrations (see Table 7-20). Based on low magnitude of the maximum detected concentration above the soil screening value (HQ = 2.10), the refined risk estimate (HQ = 0.56), which indicates acceptable risk to terrestrial plant and invertebrate populations, and the descriptive and distributional statistics presented in Table 7-20, mercury is not identified as an ecological COC for surface soil, and no additional evaluation is recommended. It is noted that the linear regressions presented in Section 6.4 and included within Appendix B show that mercury concentrations in Fueling Piers Area surface soil are not positively correlated with DRO, GRO, and/or total TPH concentrations, indicating that this metal is not site-related (i.e., not associated with a fuel release).

Vanadium was detected in fourteen of fourteen (14/14) surface soil samples at concentrations ranging from 13 mg/kg (74SB760-00) to 64J mg/kg (74SB753-00). Twelve of the detected concentrations exceed the soil screening value of 20 mg/kg (USEPA, 2005b; see Figure 7-11). The Step 2 screening level risk estimate (HQ = 3.20; see Table 7-11), derived using the maximum detected concentration, indicates that this metal may be presenting unacceptable risk to terrestrial plants and invertebrates. The refined risk estimate (HQ = 2.22; see Table 7-19), derived using the

95 percent UCL of the mean concentration (44.4 mg/kg), also indicates that vanadium is presenting unacceptable risk to terrestrial plant and invertebrate populations. However, the descriptive statistics presented in Table 7-20 for the Fueling Piers Area and background surface soil data sets indicate that vanadium concentrations in Fueling Piers Area surface soil are not elevated above background concentrations. Specifically, maximum, arithmetic mean, and 95 percent UCL of the mean vanadium concentrations in Fueling Piers Area surface soil (64J mg/kg, 36.1 mg/kg, and 44.4 mg/kg, respectively) are less than maximum, arithmetic mean, and 95 percent UCL of the mean background concentrations (230 mg/kg, 142 mg/kg, and 259 mg/kg, respectively). The distributional statistics performed on the surface soil data sets (Satterthwait's t-test, quantile test, and slippage test) also concluded that vanadium concentrations in Fueling Piers Area surface soil are not elevated above background concentrations (see Table 7-20). Based on the descriptive and distributional statistics presented in Table 7-20, vanadium is not identified as an ecological COC for surface soil, and no additional evaluation is recommended.

Selenium was detected in seven of fourteen (7/14) surface soil samples at concentrations ranging from 0.26J mg/kg (74SB231-00) to 1.8 mg/kg (74SB753-00). Six of the detections exceed the soil screening value of 0.52 mg/kg (USEPA, 2007c; see Figure 7-11). The Step 2 screening level risk estimate (HQ = 3.46; see Table 7-11), derived using the maximum detected concentration, indicates that this metal may be presenting unacceptable risk to terrestrial plant and invertebrates. A refined risk estimate using the 95% UCL of the mean concentration could not be calculated due to the low number of detected results within the Fueling Piers Area surface soil data set (seven, see second bullet item in Section 7.9). The descriptive statistics presented in Table 7-20 indicate that maximum and arithmetic mean concentrations in Fueling Piers Area surface soil (1.8 mg/kg and 0.76 mg/kg, respectively) are only slightly elevated above maximum and arithmetic mean background concentrations (1.2J mg/kg and 0.51 mg/kg, respectively). Distribution statistics were not performed on the Fueling Piers Area and background surface soil data sets due to the low number of detected results in the background data set. Regardless, based on the low magnitude of the maximum detected concentration above the soil screening value (HQ = 3.46) and the maximum background concentration, selenium is not identified as an ecological COC for surface soil, and no additional evaluation is recommended.

Copper and zinc were detected in each surface soil sample. Copper concentrations ranged from 9.3 mg/kg (74SB759-00) to 550 mg/kg (73SB758-00), while zinc concentrations ranged from 12 mg/kg (74SB759-00) to 920 mg/kg (74SB750-00). Only the maximum copper concentration exceeds the soil screening value of 70 mg/kg (USEPA 2007d; see Figure 7-11). However, three zinc detections (920 mg/kg in 74SB750-00, 250 mg/kg in 74SB756-00, and 230 mg/kg in 74SB758-00) exceed the soil screening value of 120 mg/kg (USEPA, 2007e); see Figure 7-11). The Step 2 screening level risk estimates for copper and zinc (HQs = 7.86 and 7.67, respectively; Table 7-11), derived using maximum detected concentrations, indicate that these two metals may be presenting unacceptable risk to terrestrial plants and invertebrates. The refined risk estimates (HQ = 3.27 for copper and 3.44 for zinc; see Table 7-19), derived using 95 percent UCL of the mean concentrations (229 mg/kg for copper and 413 mg/kg for zinc), also indicates that copper and zinc are presenting unacceptable risk to terrestrial plant and invertebrate populations. Maximum and 95 percent UCL of the mean copper and zinc concentrations in Fueling Piers Area surface soil are elevated above maximum, 95 percent UCL of the mean, and upper limit of the mean background concentrations (see Table 7-20). However, the distributional statistics performed on the copper and zinc data sets (Gehan test, quantile test, and slippage test for copper; two sample t-test and slippage test for zinc) contradict the descriptive statistics. Statistical tests evaluating the mean/median of the distributions and, in the case of copper, both tests evaluating the right tail of the distributions (i.e., quantile test and slippage test) concluded that concentrations in Fueling Piers Area surface soil are not statistically elevated above background concentrations.

Box plots of log transformed Fueling Piers Area ('Group G1") and background ("Group G2") copper and zinc concentrations are included within Appendix G. As evidenced by the copper box plots, copper concentrations in Fueling Piers Area surface soil are generally lower than background concentrations. However, an outlier is present within the Fueling Piers Area data set at the upper end of the range (550 mg/kg in 73SB758-00). Because non-parametric ranking tests, such as the Gehan test, only use the relative rank of concentrations, the magnitude of the outlier is likely being masked, resulting in a conclusion of no statistical difference. The zinc box plots show that zinc concentrations in Fueling Piers Area surface soil are comparable to background concentrations. As discussed above, the statistical test evaluating the mean of the distributions (i.e., two sample t-test) did not indicate that zinc concentration in Fueling Piers Area are statistically elevated above background concentrations (see Table 7-20). However, this conclusion is contradicted by a statistical test evaluating the right-tail of the distributions (i.e., slippage test), which indicates that that zinc concentrations in Fueling Piers Area surface soil are elevated above background concentrations. This result can be attributed to three detected zinc concentrations in Fueling Piers Area surface soil (920 mg/kg in 74SB250-00, 250 mg/kg in 74SB756-00, and 230 mg/kg in 74SB758-00), which exceed the maximum background concentration (120E mg/kg).

Although the refined risk estimates indicate that copper and zinc may be presenting unacceptable risk to terrestrial plant and invertebrate populations (HQs = 3.27 and 3.44, respectively) and the descriptive statistics presented in Table 7-20 indicate that concentrations in Fueling Piers Area surface soil are elevated above background levels, these two metals are not identified as ecological COCs. This decision is based on the linear regressions discussed in Section 6.4 and included within Appendix B, which demonstrate that copper and zinc in Fueling Piers Area surface soil are not positively correlated with DRO, GRO, or total TPH concentrations, indicating that these two metals are not site-related (i.e., not associated with a fuel release).

In summary, no chemicals were identified as ecological COCs for Fueling Piers Area surface soil. Although carbon disulfide, arsenic, copper, mercury, selenium, vanadium, and zinc were detected and identified as ecological COPCs in Step 2 of the SERA, they are not considered ecological COCs based on the information presented within the preceding paragraphs, and no additional evaluation is recommended. No additional evaluation also is recommended for the non-detected chemicals identified as ecological COPCs in Step 2 of the SERA due to the lack of soil screening values.

7.9.1.2 Step 3a Risk Evaluation for Subsurface Soil

Table 7-12 presented the results of the Step 2 screening level risk calculation for the Fueling Piers Area subsurface soil. No detected chemicals were identified as ecological COPCs in Step 2 of the SERA (see Section 7.6.2.3). Although not detected, selenium was identified as an ecological COPC because the maximum MDL/LOD exceeds the soil screening value. As evidenced by Table 7-21, the maximum non-detected result for selenium (1.1 mg/kg) is only slightly elevated above the maximum detected basewide background concentration (1J mg/kg). However, this maximum MDL/LOD is less than the ULM background concentration (1.19 mg/kg). Based on these comparisons, selenium is not likely to be present in Fueling Piers Area subsurface soil at concentrations that would present ecological risks above background levels. For this reason, selenium is not identified as an ecological COC for Fueling Piers area subsurface soil, and no additional evaluation is recommended.

In summary, no chemicals were identified as ecological COCs for Fueling Piers Area subsurface soil. Although selenium was identified as an ecological COPC in Step 2 of the SERA because the maximum MDL/LOD exceeds the soil screening value, this metal is not identified as an ecological COC based on the descriptive statistics presented in Table 7-21, and no additional evaluation is recommended. No additional evaluation also is recommended for the non-detected chemicals identified as ecological COPCs in Step 2 of the SERA due to the lack of soil screening values.

7.9.1.3 Step 3a Risk Evaluation for Avian and Mammalian Dietary Exposures

Tables 7-13 and 7-14 presented the results of the Step 2 screening level risk calculation for avian and mammalian dietary exposures to chemicals in Fueling Piers Area surface soil and subsurface soil, respectively. HQ values for the refined risk calculations are summarized in Tables 7-22 (surface soil) and 7-23 (subsurface soil). The results of the refined risk evaluation is presented and discussed within the subsections that follow.

7.9.1.3.1 Avian and Mammalian Dietary Exposures: Surface Soil

Section 7.6.3.2.1 presented the results of the Step 2 screening level risk calculation for avian (American robin, mourning dove, and red-tailed hawk) and mammalian (brown flower bat) dietary exposures to chemicals in Fueling Piers Area surface soil. Screening level risk estimates also were provided in Table 7-13. Ten detected metals (cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, vanadium, and zinc) were identified as ecological COPCs in Step 2 of the SERA because maximum exposure doses exceed NOAEL-based TRVs for the American robin and/or mourning dove (maximum HQs exceed 1.0). One detected metal (beryllium) also was identified as an ecological COPC based on the lack of an avian TRV. In the case of the brown flower bat, selenium was identified as an ecological COPC in Step 2 of the SERA because the maximum exposure dose exceeds the NOAEL-based mammalian TRV.

Refined risk estimates for avian and mammalian dietary exposures to ecological COPCs in Fueling Piers Area surface soil (i.e., NOAEL-, MATC-, and LOAEL-based HQ values) are presented in Table 7-22 and discussed within the paragraphs that follow. 95 percent UCL of the mean surface soil concentrations were used in the refined dietary exposure calculations for those metals detected in at least eight samples (cadmium, chromium, copper, lead, mercury, nickel, vanadium, and zinc). Refinements to the dietary exposure calculations also included the use of mean body weights and mean food ingestion rates (see Section 7.9)

Beryllium was detected in eleven of fourteen (11/14) surface soil samples at concentrations ranging from 0.059J mg/kg (74SB756-00) to 0.25 mg/kg (74SB753-00). This metal was identified as an ecological COPC in Step 2 of the SERA for avian food web exposures based on the lack of a TRV. As evidenced by the descriptive statistics presented in Table 7-20, maximum, arithmetic mean, and 95 percent UCL of the mean beryllium concentrations in Fueling Piers Area surface soil (0.25 mg/kg, 0.09 mg/kg, and 0.12 mg/kg, respectively) are less than maximum, arithmetic mean, and 95 percent UCL of the mean background concentrations (0.58 mg/kg, 0.28 mg/kg, and 0.35 mg/kg, respectively). The distributional statistics performed on the Fueling Piers Area and background data sets (i.e., Gehan test, quantile test, and slippage test; see Table 7-20) also indicate that beryllium concentrations in Fueling Piers Area surface soil are not elevated above background concentrations. Based on the descriptive and distributional statistics presented in Table 7-20, beryllium is not identified as an ecological COC for avian food web exposures to chemicals in Fueling Piers Area surface soil, and no additional evaluation is recommended.

Cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, vanadium, and zinc were identified as ecological COPCs in Step 2 of the SERA because maximum exposure doses exceed NOAEL-based TRVs for the American robin and/or mourning dove. The maximum exposure dose for selenium also exceeds the NAOEL-based TRV for the brown flower bat. Refined dietary exposure doses for cadmium, chromium, lead, mercury, nickel, selenium, and silver are less than NOAEL-, MATC-, and LOAEL-based TRVs for the American robin and mourning dove, indicating acceptable risk to avian herbivore and omnivore populations. The refined dietary exposure dose for selenium is also less than the NAOEL-, MATC-, and LOAEL-based TRVs established for the brown flower bat (see Table 7-22), indicating acceptable risk to herbivorous bat populations. In the case of chromium, mercury, and nickel, the descriptive and distributional statistics presented in Table 7-20 also show that concentrations of these metals in Fueling Piers Area surface soil are not elevated above background concentrations. Based on the refined HQs presented in Table 7-22 and the descriptive and distributional statistics presented in Table 7-20, cadmium, chromium, lead, mercury, nickel, selenium, and silver are not identified as ecological COCs for avian or mammalian dietary exposures to chemicals in Fueling Piers Area surface soil, and no additional evaluation is recommended.

Refined dietary exposure doses for copper, vanadium, and zinc exceed NOAEL-based TRVs for the American robin (HQs = 1.29, 2.08, and 1.11, respectively). In the case of vanadium, the refined exposure dose also exceeds MATC- and LOAEL-based TRVs for the American robin and the NOAEL-based TRV for the mourning dove (see Table 7-22). As discussed in Section 7.9.1.1, the descriptive and distributional statistics presented in Table 7-20 show that vanadium concentrations in Fueling Piers Area surface soil are not elevated above background levels. The linear regressions discussed in Section 6.4 and included within Appendix B also show that copper and zinc concentrations in Fueling Piers Area surface soil are not positively correlated with DRO, GRO, or total TPH concentrations, indicating that these two metals are not site-related (i.e., not associated with a fuel release). For these reasons, as well as the low magnitude of refined dietary exposure doses above NOAEL-based TRVs, copper, vanadium, and zinc are not identified a ecological COCs for avian dietary exposures to chemicals in surface soil, and no additional evaluation is recommended.

In summary, no chemicals were identified as ecological COCs for avian or mammalian dietary exposures to chemicals in Fueling Piers Area surface soil. Although beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, vanadium, and zinc were detected and identified as ecological COPC in Step 2 of the SERA, they are not identified as ecological COCs based on the information presented within the preceding paragraphs, and no additional evaluation is recommended. No additional evaluation also is recommended for the non-detected chemicals identified as ecological COPCs in Step 2 of the SERA due to the lack of avian and/or mammalian TRVs.

7.9.1.3.2 Avian and Mammalian Dietary Exposures: Subsurface Soil

Section 7.6.2.3.2 presented the results of the Step 2 screening level risk calculation for avian (American robin, mourning dove, and red-tailed hawk) and mammalian (brown flower bat) dietary exposures to chemicals in Fueling Piers Area subsurface soil. Screening level risk estimates also were provided in Table 7-14. Seven detected metals (cadmium, chromium, copper, lead, mercury, vanadium, and zinc) were identified as ecological COPCs in Step 2 of the SERA because maximum exposure doses exceed NOAEL-based TRVs for the American robin and/or mourning dove (maximum HQs exceed 1.0). One detected metal (beryllium) was also identified as an ecological COPC based on the lack of an avian TRV. In the case of the brown flower bat, no detected or non-detected chemicals with established TRVs were identified as ecological

COPCs for mammalian dietary exposures to chemicals in Fueling Piers area subsurface soil (maximum HQs less than 1.0).

Refined risk estimates for avian dietary exposures to ecological COPCs in Fueling Piers Area subsurface soil (i.e., NOAEL-, MATC-, and LOAEL-based HQ values) are presented in Table 7-21 and discussed within the paragraphs that follow. Based on the small size of the subsurface soil data set for each ecological COPC (n = 6), dietary doses were not recalculated using 95 percent UCL of the mean chemical concentrations (see Section 7.9). As such, the specific refinements to the dietary exposure calculations were limited to the use of mean body weight, mean food ingestion rates, and BAFs based on, or modeled from, central tendency estimates.

Beryllium was detected in two of six (2/6) subsurface soil samples (0.054J mg/kg in 74SB751-01 and 0.072J mg/kg in 74SB753-01). Identical to surface soil, this metal was identified as an ecological COPC in Step 2 of the SERA for avian dietary exposures to chemicals in subsurface soil based on the lack of a TRV. The descriptive statistics presented in Table 7-21 show that both beryllium detections in Fueling Piers Area subsurface soil are less than the maximum and ULM background concentration. These data indicate that beryllium is not likely to be present at concentrations that would present ecological risks above background levels. For this reason, beryllium is not identified as an ecological COC for avian dietary exposures to chemicals in subsurface soil, and no additional evaluation is recommended.

Cadmium, chromium, copper, lead, mercury, vanadium, and zinc were identified as ecological COPCs in Step 2 of the SERA because maximum exposure doses exceed NOAEL-based TRVs for the American robin. Refined dietary exposure doses for chromium, copper, mercury, vanadium, and zinc are less than NOAEL-, MATC-, and LOAEL-based TRVs for the American robin, indicating acceptable risk to avian omnivore populations. In the case of chromium, copper, mercury, and vanadium, the descriptive statistics presented in Table 7-21 also show that concentrations of these metals in Fueling Piers Area subsurface soil are not elevated above background concentrations. Specifically, maximum detected concentrations in Fueling Piers Area subsurface soil for these four metals are less than maximum and ULM background concentrations. Although the maximum zinc concentration in Fueling Piers Area subsurface soil (110 mg/kg) exceeds the maximum and ULM background concentration (98.5J mg/kg and 92 mg/kg, respectively), the magnitude is low. Based on the refined HQs presented in Table 7-23 and the descriptive statistics presented in Table 7-20, chromium, copper, mercury, vanadium, and zinc are not identified as ecological COCs for avian dietary exposures to chemicals in Fueling Piers Area subsurface soil, and no additional evaluation is recommended.

Refined dietary exposure doses for cadmium and lead exceed NOAEL-based TRVs for the American robin (HQs = 1.42 and 1.13, respectively). However, refined exposure doses are less than MATC- and LOAEL-based TRVs. The descriptive statistics presented in Table 7-21 show that the cadmium and lead concentrations in Fueling Piers Area subsurface soil are elevated above background concentrations. For both metals, maximum concentrations (2.8 mg/kg for cadmium and 110 mg/kg for lead) exceed maximum and ULM background concentrations. However, the pair-wise linear regressions discussed in Section 6.4 and included within Appendix B show that cadmium and lead concentrations in Fueling Piers Area subsurface soil are not positively correlated with DRO, GRO, or total TPH concentrations, indicating that these two metals are not site-related (i.e., not associated with a fuel release). For this reason, as well as the low magnitude of the refined dietary exposure doses above NOAEL-based TRVs, cadmium and lead are not identified a ecological COCs for avian dietary exposures to chemicals in subsurface soil, and no additional evaluation is recommended.

In summary, no chemicals were identified as ecological COCs for avian or mammalian dietary exposures to chemicals in Fueling Piers Area subsurface soil. Although beryllium, cadmium, chromium, copper, lead, mercury, vanadium, and zinc were detected and identified as ecological COPC in Step 2 of the SERA, they are not identified as ecological COCs based on the information presented within the preceding paragraphs, and no additional evaluation is recommended. No additional evaluation also is recommended for the non-detected chemicals identified as ecological COPCs in Step 2 of the SERA due to the lack of avian and/or mammalian TRVs.

7.9.2 Step 3a Decision Point and Recommendations

Table 7-24 presents a summary of the ecological COPCs identified in Step 2 of the SERA, as well as the ecological COCs identified in Step 3a of the BERA. A summary of the Step 2 screening level risk calculation, as well as Step 3a of the BERA is also provided in the paragraphs that follow. As evidenced by Table 7-24, no chemicals were identified as ecological COCs. Therefore, no further evaluation of ecological risks is recommended for Fueling Piers Area surface and subsurface soil.

7.9.2.1 <u>Surface Soil</u>

Based on the refined media-specific risk evaluation presented in Section 7.9.1.1, no chemicals are identified as ecological COCs for Fueling Piers Area surface soil (see Table 7-24). Although carbon disulfide, arsenic, copper, mercury, selenium, vanadium, and zinc were identified as ecological COPCs in Step 2 of the SERA, they are not identified as ecological COCs based on (1) the predicted toxicity to earthworms using SARs analysis (in the case of carbon disulfide); (2) the low magnitude of maximum detected concentrations above soil screening values (see Table 7-11); (3) the refined risk estimates summarized in Table 7-19; (4) the descriptive and distributional statistics presented in Table 7-20; and/or (5) the lack of an association with a fuel release (see Section 6.4 and Appendix B).

7.9.2.2 <u>Subsurface Soil</u>

Based on the refined media-specific risk evaluation presented in Section 7.9.1.2, no chemicals are identified as ecological COCs for Fueling Piers Area subsurface soil (see Table 7-24). Although selenium was identified as an ecological COPC in Step 2 of the SERA, this metal is not identified as ecological COC based on the descriptive statistics presented in Table 7-21.

7.9.2.3 <u>Avian and Mammalian Dietary Exposures: Surface Soil</u>

Based on the refined risk evaluation presented in Section 7.9.1.3.1, no chemicals were identified as ecological COCs for avian herbivore, omnivore, and carnivore or mammalian herbivore dietary exposures to chemicals in Fueling Piers Area surface soil (see Table 7-24). Although beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, vanadium, and zinc were identified as ecological COPCs in Step 2 of the SERA, they are not identified as ecological COCs based on (1) the refined risk estimates presented in Table 7-22; (4) the descriptive and distributional statistics presented in Table 7-20; and/or (3) the lack of an association with a fuel release (see Section 6.4 and Appendix B).

7.9.2.4 Avian and Mammalian Dietary Exposures: Subsurface Soil

Based on the refined risk evaluation presented in Section 7.9.1.3.2, no chemicals were identified as ecological COCs for avian herbivore, omnivore, and carnivore or mammalian herbivore dietary exposures to chemicals in Fueling Piers Area subsurface soil (see Table 7-24). Although beryllium, cadmium, chromium, copper, lead, mercury, vanadium, and zinc were identified as ecological COPCs in Step 2 of the SERA, they are not identified as ecological COCs based on (1) the refined risk estimates presented in Table 7-23; (4) the descriptive statistics presented in Table 7-21; and/or (3) the lack of an association with a fuel release (see Section 6.4 and Appendix B).

7.10 References

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8.0 HUMAN HEALTH RISK ASSESSMENT AND DEVELOPMENT OF CAOs

8.1 Introduction

This section presents the HHRA for the Fueling Piers Area of SWMU 74, located at NAPR, Ceiba, Puerto Rico. The baseline HHRA was conducted in accordance with the Risk Assessment Guidance for Superfund (RAGS), Part A, Human Health Evaluation Manual (USEPA, 1989), and the most recent updates, such as RAGS Part D (USEPA, 2001), Part E (USEPA, 2004), and Part F (USEPA, 2009). The HHRA considers the most likely routes of potential human exposure for both current and future risk scenarios at the Fueling Piers Area. Should the results of the HHRA conclude that potential exposure to environmental media at the Fueling Piers Area is considered to pose unacceptable levels of risk and hazard to human receptors, medium- and chemical-specific CAOs will be calculated for comparison to the site data to determine if and where potential cleanup may occur.

8.2 Land Use and Potentially Exposed Receptors

To focus on developing practicable and cost-effective corrective measures alternatives and to streamline the environmental cleanup process, USEPA guidance ("Land Use in the CERCLA Remedy Selection Process," [USEPA, 1995]) and United States Department of Defense (Longuemare, 1997) direct that CAOs should reflect the reasonably anticipated land use.

SWMU 74 consists of fuel pipelines, valve pits, and hydrants and transverses across a large area of the central and eastern portions of NAPR (see Figure 2-2). The Fueling Piers Area of SWMU 74 (formerly referred to as ECP Site 20) consists of the underground pipeline along Forrestal Drive and associated spurs that lead to the Deep Water Fueling Pier (Pier No. 1) and the Berthing Pier (Pier No. 3). A single valve pit (VP-56), located near the intersection of Palau Street with Forrestal Drive (see Figure 2-6) is also included within the Fueling Piers Area.

The current primary mission of NAPR is to protect the physical assets remaining, comply with environmental regulations, and sustain the value of the property until final disposal of the property. It is assumed that long-term plans for the facility would be similar to those that had been in place prior to closure with land use also generally the same. As such, future property use of this site is expected to remain industrial.

Considering the expected future property use of the Fueling Piers Area of SWMU74 and the potential human receptors/exposure pathways listed in Attachment II of the RCRA §7003 Administrative Order on Consent for NAPR (USEPA, 2007), the following human receptors are considered potentially exposed to site environmental media. For the continued industrial/commercial land use scenario at this site, the industrial worker is used to characterize potential future exposure to contaminated soil. The assumption of USEPA's default industrial/commercial exposure scenario accounts for long term exposure (workers are assumed to be at the site eight hours per work day for 25 years) and is used to reflect future land use. At NAPR, it is considered that soil up to 10 feet bgs could be exposed during construction activities. (Note that for the Fueling Piers Area, analytical results from subsurface soil samples collected from the 9 to 11 feet bgs interval were included in the total soil data set because 10 feet bgs is included in this interval [refer to Appendix H]). Therefore, potential exposures to soil (0 to 11 feet bgs) were evaluated for industrial workers. The construction worker is also used to characterize potential future exposure to contaminated soil. Construction workers that may perform excavation and construction at the site could be exposed to soil (0 to 11 feet) at the Fueling Piers Area. It is conservatively assumed that for potential current and future exposures, adult and youth trespassers or an on-site worker may access the site. These receptors could be exposed to contaminated soil.

Exposure to groundwater via ingestion, dermal contact, or inhalation (volatiles in groundwater emitted through soil into buildings, into a trench, or while showering) at the Fueling Piers Area was considered a potentially complete but insignificant exposure pathway because groundwater was determined to be impacted by a release from SWMU 7/8 (which is being addressed under SWMU 7/8) and not site-related activities specific to the Fueling Piers Area during the 2008 Phase I CMS investigation (Baker, 2010a) (refer to Section 8.3.2.2 for further explanation). Therefore, exposure to groundwater, either directly or indirectly, was not evaluated in this HHRA.

Future residential land use is conservatively assumed for the Fueling Piers Area, although it is not included in the RCRA §7003 Administrative Order on Consent (USEPA, 2007) as a likely scenario given expected future land use. The site is the location of underground pipeline along Forrestal Drive and the Deep Water Fueling and Berthing Piers and is not conducive in its current setting to residential use. However, this scenario is used to evaluate unrestricted land use and provide the most conservatively protective risk estimation. Potential exposures to soil were conservatively assumed for future residents.

8.3 <u>Human Health Risk Assessment</u>

This section presents the results of the HHRA prepared for this CMS. The baseline HHRA considers the most likely routes of potential human exposure for both current and future risk scenarios. The baseline HHRA is comprised of seven sections. Section 8.3.1 presents the Selection of Chemicals of Potential Concern, which evaluates the site investigation data and identifies COPCs across the site with regard to potential health effects. Sections 8.3.2 and 8.3.3 present the Exposure Assessment and Toxicity Assessment, respectively. The Risk Characterization, including a discussion of potential human health effects, is presented in Section 8.3.4. Section 8.3.5 presents a comparison with background levels. Section 8.3.6 outlines the potential sources of uncertainty encountered in the process of performing a risk assessment, and their potential effects on the estimation of human health risks. Section 8.3.7 presents the summary and conclusions of the HHRA. Additionally, Section 8.4 presents the development of CAOs, as applicable, and Section 8.5 presents the references.

8.3.1 Selection of Chemicals of Potential Concern

8.3.1.1 <u>Data Evaluation</u>

The data used in the revised HHRA are presented in full in Appendix H. A statistical analysis, including the minimum, maximum, mean, standard deviation, and 95% UCL, was run for applicable data sets (i.e., surface soil [0 to 1 foot bgs], total soil [0 to 11 feet bgs], groundwater, surface water, and sediment COPCs). The statistical summary of data used in the HHRA is located in Appendix I. Data utilized in the HHRA is discussed in the paragraphs below. For duplicate samples, the higher of the two concentrations (environmental versus duplicate) was used, not both. The following paragraphs describe the data used in the HHRA for the Fueling Piers Area.

Sampling activities at the Fueling Piers Area have been conducted under two separate investigations: 2008 Phase I CMS field investigation and 2011 Phase II CMS field investigation. The Phase I CMS field investigation was conducted April 2008 and involved the collection of five surface soil samples (0.0 to 1.0-foot depth interval), sixty-nine subsurface soil samples (collected from the 1.0 to 3.0-foot, 3.0 to 5.0-foot, 5.0 to 7.0-foot, 7.0 to 9.0-foot, and 9.0 to 11.0-foot depth intervals), and six groundwater samples from forty-two boring locations. Boring and well locations are shown on Figure 2-6. Each soil and groundwater sample was analyzed for Appendix IX VOCs, PAHs, and metals (total and dissolved fraction for groundwater), as well as TPH DRO and TPH GRO. A description of the 2008 Phase I CMS field investigation and associated analytical results were previously presented in Section 9.0 of the Revised Final Phase I of the Corrective Measures Study Investigation for SWMU 74 – Fuel Pipelines and Hydrant Pits (Baker, 2010a). As discussed in the Revised Final Phase I CMS Report (Baker, 2010a), fuel-related impacts were detected at two surface soil sample locations (74SB221 and 74SB231) and fifteen subsurface soil sample locations (74SB215, 74SB216, 74SB218, 74SB221 through 74SB224, 74SB256, 74SB258, 74SB260, 74SB261, 74SB263 through 74SB265, and 74SB267). However, contamination at 74SB215, 74SB216, 74SB218, 74SB221 through 74SB224, 74SB256, 74SB258, 74SB260, 74SB261, 74SB263 through 74SB265, and 74SB267 is most likely the result of known releases from SWMU 7/8.

The Phase II CMS field investigation for the Fueling Piers Area (see Section 4.0 of this report) was conducted from April 18 through April 29, 2011 and involved the collection of thirteen surface soil samples (0.0 to 1.0-foot depth interval) and six subsurface soil samples (1.0 to 3.0-foot depth interval) from thirteen boring locations. Sampling activities were restricted to locations in the vicinity of 74SB231 (boring location installed during the 2008 Phase I CMS field investigation where potential fuel-related impacts were identified). In addition to soil, one groundwater sample was collected from an existing monitoring well (74SB246). Each surface and subsurface soil sample was analyzed for Appendix IX VOCs, PAHs, and metals, while the single groundwater sample was analyzed for Appendix IX PAHs. Analytical results are presented in Appendix B and discussed within Section 6.0.

Analytical data for soil collected from the 0.0 to 1.0-foot depth interval at 74SB231 during the 2008 Phase I CMS field investigation, as well as analytical data for soil collected from the 0.0 to 1.0-foot depth interval during the 2011 Phase II CMS field investigation were quantitatively evaluated as surface soil in the HHRA. Analytical data for soil collected from the 7.0 to 9.0- and 9.0 to 11.0-foot depth intervals at 74SB231 and 74SB232 during the 2008 Phase I CMS field investigation, as well as soil collected from the 1.0 to 3.0-foot depth interval during the Phase II CMS field investigation were combined with the surface soil data described above and quantitatively evaluated as total soil (0 to 11.0-foot soil column) in the HHRA. Analytical data for soil collected during the 2008 Phase I CMS field investigation at locations with no fuel-related impacts, as well as analytical data for soil collected at locations with fuel-related contamination attributable to SWMU 7/8 also were omitted from evaluation in the HHRA. Finally, the available groundwater data for the Fueling Piers Area were omitted from evaluation in the HHRA since there is no indication that groundwater has been impacted by a fuel-related release (Baker, 2010a). The surface and subsurface soil analytical data quantitatively evaluated in the HHRA are included as Appendix H, while sample locations are depicted on Figure 4-2. It is noted that the analytical laboratory reported non-detected results to the MDL for soil samples collected during the 2008 Phase I CMS field investigation. However, for the 2011 Phase II CMS field investigation, the analytical laboratory reported non-detected results to the LOD.

8.3.1.2 COPC Selection

COPCs are those chemicals having the greatest potential to cause adverse human health effects should receptors come in contact with site media. For each environmental medium, COPCs were selected in accordance with USEPA's RAGS, Volume I, Human Health Evaluation Manual (Part

A), Interim Final, (USEPA, 1989). Although some metals occur above the risk-based screening values, but below background concentrations, no metals were eliminated from the risk evaluation based on their occurrence at background levels. The final site recommendations were based on results of the HHRA and comparisons with the background levels as appropriate for the metals.

8.3.1.2.1 COPC Selection Criteria

The COPCs were selected by comparing the maximum concentrations detected in environmental samples to risk-based screening levels. Chemicals exceeding screening levels were retained as COPCs for further evaluation; chemicals detected at concentrations below these criteria were not evaluated unless other circumstances (frequency of exposure detected in other media, same chemical class [i.e., PAHs] or documented usage) warrant the re-inclusion and further evaluation of chemicals selected as COPCs. The risk-based screening levels used in selecting chemicals as COPCs in the HHRA for the Fueling Piers Area were the USEPA RSLs (USEPA, 2011a), which are described in greater detail below.

In conjunction with concentration comparisons to the USEPA RSLs, a comparison to concentrations detected in field and laboratory blanks was conducted by a third-party data validator, to ensure that only site-related chemicals are evaluated in the quantitative estimation of human health effects. Metals were also compared to corresponding background screening values. A description of actual background screening concentrations used can be found later in this section. Note that metals are not eliminated from the risk evaluation during the COPC selection process based on their occurrence at background levels. The comparison of metals against background screening values is presented with the COPC selection for practicality. This comparison is then used to refine the risk assessment so that that the portion of the total site risk that is attributable to background concentrations can be seen and used in risk management decisions.

USEPA RSLs – The RSLs were developed by the USEPA to support the risk assessment screening process, while improving consistency across Regions and incorporating updated guidance in a timely manner. The RSL Table was developed with the Department of Energy's Oak Ridge National Laboratory under an Interagency Agreement as an update of the individual screening tables that had previously been maintained by Regions III, IV, and IX. As recommended by the USEPA, these RSLs are to replace all other screening values.

The RSL Table contains risk-based screening levels derived from standardized equations (representing ingestion, dermal contact, and inhalation exposure pathways), calculated using the latest toxicity values, default exposure assumptions, and physical and chemical properties. The RSLs contained in the RSL Table are generic; they are calculated without site-specific information. RSLs should be viewed as Agency guidelines, not legally enforceable standards. The RSLs for potentially carcinogenic chemicals are based on a target Incremental Lifetime Cancer Risk (ILCR) of $1x10^{-06}$. The RSLs for noncarcinogens are based on a target HQ of 1.0. However, in order to account for cumulative risk from multiple chemicals in a medium, the noncarcinogenic RSLs were divided by a factor of ten, yielding a target HQ of 0.1. For potential carcinogens, the toxicity criteria applicable to the derivation of RSL values are oral Cancer Slope Factors (CSFs) and inhalation unit risk (IUR) factors; for noncarcinogens, they are chronic oral reference doses (RfDs) and inhalation reference concentrations (RfCs). These toxicity criteria are subject to change as more updated information and results from the most recent toxicological/epidemiological studies become available. The RSL table is updated periodically to reflect such changes. The June 2011 version of the RSL table (USEPA, 2011a) was used in this HHRA.

In this HHRA, chemicals detected in surface soil and total soil are compared to residential soil RSLs. It should be noted that although residential screening criteria were conservatively used in this HHRA, residential land use is not likely to occur at the Fueling Piers Area.

Background or Naturally Occurring Levels - Generally, a comparison to naturally occurring levels applies only to metals, because the majority of organic chemicals are not naturally occurring. Background samples are collected from areas that are not influenced by site contamination. The background data used for comparison purposes in this HHRA are taken from the Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2010b) for NAPR. The criterion used for screening is the ULM, which is calculated as the mean plus two times the standard deviation of the mean.

Sample concentrations for metals in site-specific surface soil and total soil were compared to the ULM of the corresponding NAPR base-wide surface soil background data set. There is currently no established background data set for NAPR base-wide total soil. However, for the purposes of comparison to background, the established background data sets for NAPR base-wide surface soil and fine silt and sand subsurface soil were combined. Total soil ULM values were calculated following the methodology outlined in the Revised Final II Summary Report (Baker, 2010b) for comparison to site-specific total soil analytical results. As previously discussed, no metals were eliminated from the risk evaluation based on their occurrence at background levels.

8.3.1.2.2 Use of Surrogate Chemicals for Missing Screening Values

If a screening value for a constituent was not available from the RSL tables, the constituent was evaluated using the screening values for a surrogate chemical, if appropriate and available. Soil screening values for acenaphthylene, benzo(g,h,i)perylene, phenanthrene, total chromium, and vanadium were not available from the RSL table. Acenaphthene was selected as a surrogate for acenaphthylene based on structural similarity. Pyrene was selected as a surrogate chemical for benzo(g,h,i)perylene and phenanthrene during the COPC selection process because of its structural similarity. "Vanadium and Compounds" was selected from the RSL Table (USEPA, 2011a) as a surrogate for vanadium.

Trivalent chromium was selected as a surrogate chemical for total chromium since there is no history of hexavalent chromium production operations at the Fueling Piers Area. It should be noted that chromium will be present predominantly in the trivalent chromium oxidation state in most soils. While hexavalent chromium contamination is generally associated with industrial activity, it can occur naturally. Oxidation of trivalent chromium to hexavalent chromium can occur in the soil environment. The relation between trivalent chromium and hexavalent chromium strongly depends on pH (the process is enhanced at pH values greater than 6) and oxidative properties of the location, but in most cases, the trivalent chromium is the dominating species (Kotaś and Stasicka, 2000). Most trivalent chromium in soil is immobilized due to adsorption and complexation with soil materials. As such, due to the lack of availability of mobile trivalent chromium, a large portion of chromium in soil will not be oxidized to hexavalent chromium even with favorable oxidation and pH conditions (Agency for Toxic Substances and Disease Registry [ATSDR], 2008).

8.3.1.2.3 Selection of COPCs

The following paragraphs present the rationale for selection of COPCs. Tables 8-1 and 8-2 present the selection of COPCs. Constituents retained as COPCs are indicated by the shaded cells in the tables. These tables also include exposure concentrations for COPCs, which are discussed further in Section 8.3.2, Exposure Assessment. Information is presented in these tables only for those constituents detected at least once in the medium of interest. The geographic distribution of the COPCs is shown on Figures 8-1 and 8-2. Sample locations, analytical results, and corresponding figures for surface soil and subsurface soil and are presented in Section 4.0 and appendices of this report.

For the soil exposure pathway evaluation for the Fueling Piers Area, COPCs were selected from both surface soil (0 to 1 foot bgs) and total soil (0 to 11 feet bgs). As previously discussed, analytical results from subsurface soil samples collected from the 9 to 11 feet bgs interval were included in the total soil data set used in the HHRA because 10 feet bgs is included in this interval (refer to Appendix H). The most conservative exposure concentration for each COPC was used in the risk calculations to produce a conservative risk estimate (refer to Section 8.3.2.4 for further explanation).

Surface Soil

The data and COPC selection summary for surface soil samples collected at the Fueling Piers Area are presented in Table 8-1. The spatial extent of surface soil COPC concentrations greater than residential soil RSLs is depicted on Figure 8-1. Note that only those detected concentrations exceeding corresponding residential soil RSLs are shown on the figure (i.e., those COPCs retained based on lack of screening/toxicity criteria or chemical similarity are not included).

There were no VOCs detected in the surface soil at concentrations above corresponding residential soil RSLs. Therefore, VOCs were not retained as surface soil COPCs.

The carcinogenic PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were detected in the surface soil at maximum concentrations above corresponding residential soil RSLs and were retained as COPCs for surface soil. Benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were detected at concentrations below corresponding residential soil RSLs. However, these carcinogenic PAHs were re-included as COPCs for surface soil because of the potential additive toxic effects of carcinogenic PAHs.

TPH DRO and GRO were detected at concentrations exceeding their respective screening criteria and were retained as COPCs for surface soil.

Arsenic, cobalt, copper, thallium, and vanadium were detected in surface soil at concentrations exceeding corresponding residential soil RSLs and were retained as surface soil COPCs. The following observations were made concerning the concentrations of metals selected as surface soil COPCs relative to background screening concentrations established for NAPR. Eleven of fourteen concentrations of arsenic exceeded the background screening concentration, while only the maximum concentration of copper exceeded the background screening concentration. All site-specific concentrations of thallium exceeded background because thallium was not detected in NAPR base-wide background surface soil samples. All detected concentrations of cobalt and vanadium were less than corresponding background screening values.

Total Soil

The existing Fueling Piers Area surface soil (0-1 foot bgs) and subsurface soil (1-11 feet bgs) data sets were combined to create a total soil column (0-11 feet bgs) data set. For the purposes of background comparison of total soil in this HHRA, the surface soil and fine silt and sand subsurface soil data sets from the approved Revised Final II Summary Report for Environmental

Background Concentrations of Inorganic Compounds (Baker, 2010b) were combined. Total soil ULM values were calculated to which the site-specific total soil analytical results were compared.

The data and COPC selection summary for total soil samples collected at the Fueling Piers Area are presented in Table 8-2. The spatial extent of total soil COPC concentrations greater than residential soil RSLs is depicted on Figure 8-2. Note that only those detected concentrations exceeding corresponding residential soil RSLs are shown on the figure (i.e., those COPCs retained based on lack of screening/toxicity criteria or chemical similarity are not included).

There were no VOCs detected in the total soil at concentrations above corresponding residential soil RSLs. Therefore, VOCs were not retained as total soil COPCs.

The carcinogenic PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were detected in the total soil at maximum concentrations above corresponding residential soil RSLs and were retained as COPCs for total soil. Benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were detected at concentrations below corresponding residential soil RSLs. However, these carcinogenic PAHs were re-included as COPCs for total soil because of the potential additive toxic effects of carcinogenic PAHs.

TPH DRO and GRO were detected at concentrations exceeding their respective screening criteria and were retained as COPCs for total soil.

Arsenic, cobalt, copper, thallium, and vanadium were detected in total soil at concentrations exceeding corresponding residential soil RSLs and were retained as total soil COPCs. The following observations were made concerning the concentrations of metals selected as total soil COPCs relative to background screening concentrations established for NAPR. Nineteen out of twenty-four concentrations of arsenic exceeded the background screening concentration, while only the maximum concentration of copper exceeded the background screening concentration. All detected concentrations of cobalt, thallium, and vanadium were less than corresponding background screening values.

8.3.1.2.3 Summary of COPCs

- *Surface Soil*: Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, TPH DRO and GRO, arsenic, cobalt, copper, thallium, and vanadium.

- *Total Soil*: Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, TPH DRO and GRO, arsenic, cobalt, copper, thallium, and vanadium.

8.3.2 Exposure Assessment

An exposure assessment was performed to evaluate the potential exposure of the identified human receptors to the site media based on current and anticipated future land use for the Fueling Piers Area. The exposure assessment includes potential exposure pathways for human receptors, potential routes of exposure, exposure factor assumptions, and estimated exposure concentrations. In order to establish a complete exposure pathway, the following four elements were considered (USEPA, 1989):

- A source and potential mechanism of chemical release
- An environmental retention or transport medium
- A point of potential human contact with the contaminated medium; and
- A human exposure route (e.g., ingestion) at the contact point

The exposure scenarios discussed in this report represent USEPA's Reasonable Maximum Exposure (RME). Relevant equations for assessing intakes and exposure parameters were obtained from RAGS Part A (USEPA, 1989), Exposure Factors Handbook (USEPA, 1997a), RAGS Part E Supplemental Guidance for Dermal Risk Assessment (USEPA, 2004), RAGS Part F Supplemental Guidance for Inhalation Risk Assessment (USEPA, 2009), Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 2002a), and Standard Default Exposure Factors, Interim Final (USEPA, 1991). Exposure parameters used in this HHRA are provided in Table 8-3.

8.3.2.1 Potential Human Receptors and Exposure Pathways

NSRR underwent operational closure on March 31, 2004. On April 1, 2004, NSRR was re-designated as NAPR. The current primary mission of NAPR is to protect the physical assets remaining, comply with environmental regulations, and sustain the value of the property until final disposal of the property. It is assumed that long-term plans for the facility would be similar to those that had been in place prior to closure with land use also generally the same. Based on information available regarding the physical features, site setting, site historical activities, and current and expected land uses, seven potential human receptors have been selected for evaluation. These include:

- Current/Future On-site Adult Trespasser
- Current/Future On-site Youth (6-16 years) Trespasser
- Current/Future On-site Adult Worker
- Future Adult Resident
- Future Young Child (1-6 years) Resident
- Future Industrial/Commercial Adult Worker
- Future Construction Worker

At present, there is no activity at the Fueling Piers Area. As discussed in Section 8.2, for the continued industrial/commercial land use scenario at this site, the industrial/commercial worker and construction worker were evaluated to characterize potential future exposure to contaminated soil. Exposure to groundwater via ingestion, dermal contact, or inhalation (volatiles in groundwater emitted through soil into buildings, into a trench, or while showering) at the Fueling Piers Area was considered a potentially complete but insignificant exposure pathway because groundwater was determined to be impacted by a release from SWMU 7/8 (which is being addressed under SWMU 7/8) and not site-related activities specific to the Fueling Piers Area during the 2008 Phase I CMS investigation (Baker, 2010a). Therefore, exposure to groundwater, either directly or indirectly, was not evaluated in this HHRA. The future industrial/commercial worker is included in the RCRA § 7003 Administrative Order on Consent (USEPA, 2007) as a potential human receptor under expected usage conditions (i.e., expected future land usage being similar to the land usage patterns currently in place). In anticipation of excavation of soil during redevelopment of the site, it is considered possible that subsurface soil could be brought to the surface and exposure to this medium could occur in the future. At NAPR, it is considered that soil up to 10 feet bgs could be exposed during construction activities. Note that analytical results from subsurface soil samples collected from the 9 to 11 feet bgs interval were included in the total soil data set used in the HHRA because 10 feet bgs is included in this interval (refer to Appendix H). Therefore, potential exposures to surface soil (0 to 1 foot bgs) and total soil (0 to 11 feet bgs) (hereafter referred to as soil) were evaluated for industrial workers. Potential exposure to soil at the Fueling Piers Area was evaluated for construction workers that may perform excavation and construction at the site. Potential exposures to soil were evaluated for adult on-site workers that may perform maintenance or groundskeeping activities now or in the future. Additionally, potential exposures to soil were evaluated for adult and/or youth trespassers that may gain access to the site now or in the future and could be exposed to these environmental media. Construction workers, industrial/commercial workers, on-site workers, and trespasser receptors are listed in the RCRA §7003 Administrative Order on Consent (USEPA, 2007).

Future residential land use is conservatively assumed for the Fueling Piers Area. Future residential adult and young child receptors are evaluated in this HHRA, although residential receptors are not included as potential human receptors in the RCRA §7003 Administrative Order on Consent (USEPA, 2007). Additionally, the industrial setting of the Fueling Piers Area of SWMU 74 precludes its use as a residential site. A residential land use scenario is incorporated to evaluate unrestricted land use and provide the most conservatively protective risk estimation. Potential exposures to soil were conservatively evaluated for future residents.

As previously noted, metals detected in site media were retained for risk estimation, although they could reflect background conditions.

Specifically, the following potential human exposure receptors and exposure pathways were retained for quantitative evaluation in this HHRA.

Current/Future On-Site Adult and Youth (Ages 6-16 Years) Trespassers

- Ingestion of Soil
- Dermal Contact with Soil
- Inhalation of Fugitive Dusts/Volatiles Emanating from Soil

Current/Future On-Site Adult On-Site Workers

- Ingestion of Soil
- Dermal Contact with Soil
- Inhalation of Fugitive Dusts/Volatiles Emanating from Soil

Future Adult and Young Child (Ages 1-6 Years) Residents

- Ingestion of Soil
- Dermal Contact with Soil
- Inhalation of Fugitive Dusts/Volatiles Emanating from Soil

Future Adult Industrial/Commercial Workers

- Ingestion of Soil
- Dermal Contact with Soil
- Inhalation of Fugitive Dusts/Volatiles Emanating from Soil

Future Construction Workers

- Ingestion of Soil
- Dermal Contact with Soil
- Inhalation of Fugitive Dusts/Volatiles from Soil

8.3.2.2 Conceptual Site Model

Development of a conceptual site model of potential exposure is critical in evaluating exposures for the human receptors. The conceptual site model considers all reasonable current and future potential exposures and media of concern under a no-action scenario. Current and potential future exposure scenarios for the Fueling Piers Area are summarized in the conceptual site model in Figure 8-3 of this HHRA. Current receptor exposure scenarios may consist of trespassers and on-site workers. Future receptor exposure scenarios at this site may consist of trespassers, on-site workers, residents, adult industrial/commercial workers, and construction workers.

Potential chemical release mechanisms from historical source areas include transport of chemicals associated with pipelines and associated valve pits for the release of fuel-related compounds to soil. Contaminated surface soil also represents a potential source for the release of chemicals to subsurface soil and down gradient surface soil. Finally, subsurface soil represents a potential source for the release of chemicals to groundwater. Potential transport pathways include to paved surfaces with storm water to down gradient surface soil leaching to underlying groundwater and advective transport in the direction of groundwater flow.

Based on the findings of the Revised Final Phase I CMS Report, leaching of chemicals from surface soil and/or subsurface soil to groundwater represents a potentially complete, but insignificant transport pathway for the following reasons: (1) VOCs, PAHs, and total recoverable metals were not detected in groundwater collected at the Fueling Piers Area during the 2008 Phase I CMS field investigation above RSLs (with the exception of one low, estimated concentration of benzo[a]pyrene) and/or ULM background concentrations (Baker, 2010a); (2) no total TPH detections were reported above the established screening value in groundwater collected from wells located at the Fueling Piers Area (Baker 2010a); and (3) no total TPH detections were reported above the established screening value in subsurface soil collected at soil boring location 73SB231 during the 2008 Phase I CMS field investigation (boring location where potential fuel-related impacts were identified in surface soil) (Baker, 2010a).

8.3.2.3 Quantification of Exposure

Exposure to chemicals is quantified using 1) data from the site (i.e., concentrations of chemicals) and 2) determining human exposure to the environmental media. The chemical concentrations used in the estimation of chronic daily intakes (CDIs) and dermally absorbed doses (DADs) for each medium are considered representative of the types of potential exposures encountered by each receptor throughout the time of exposure. A discussion of site data and human exposure at the Fueling Piers Area is presented in the following sections.

8.3.2.4 Data Analysis

USEPA recommends using the average concentration to represent “a reasonable estimate of the concentration likely to be contacted over time” (USEPA, 1989). This concentration, commonly termed the exposure point concentration (EPC), is a conservative estimate of the average chemical concentration in an environmental medium at hazardous waste sites. The EPC is determined for each individual exposure unit within a site. An exposure unit is the area throughout which a receptor moves and encounters an environmental medium for the duration of the exposure. Unless there is site-specific evidence to the contrary, an individual receptor is assumed to be equally exposed to media within all portions of the exposure unit over the time frame of the risk assessment (USEPA, 2002b).

USEPA's most recent guidance, Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (USEPA, 2002b), provides tools to calculate upper confidence limits to be used as EPCs in risk assessments. The USEPA 2002 guidance recommends the use of the software package, ProUCL (USEPA, 2010a and 2010b), to calculate UCLs for use in risk assessments. ProUCL Version 4.1 (current at the time the calculations were performed) was used in this HHRA to calculate 95% UCLs.

The ProUCL software has been developed by USEPA to compute an appropriate 95% UCL of the unknown population mean. All upper confidence limit computation methods contained in the USEPA guidance documents are available in ProUCL, Version 4.1. ProUCL 4.1 contains statistical methods to address various environmental issues for both full data sets without nondetects and for data sets with nondetects (also known as left-censored data sets). Note that the 95% UCLs were calculated in the "with NDs" mode, as applicable.

The 95% UCL on the mean concentration was used as the EPC for each COPC identified for a receptor group where the number of detected concentrations was four or more and where eight or more samples are available in the dataset. For the soil exposure pathway evaluation for the Fueling Piers Area, COPCs were selected from both surface soil (0 to 1 foot bgs) and total soil (0 to 11 feet bgs). EPCs were subsequently calculated for surface soil and total soil COPCs, and the higher of the two EPCs for each COPC was used in the risk calculations to produce a conservative risk estimate. For COPCs having less than four detected concentrations or less than eight samples in the dataset, the maximum detected concentration was used as the EPC for that data grouping. However, there were no instances in which a maximum COPC concentration was used as an EPC in this HHRA.

Measured concentrations were used in the HHRA for most EPCs. However, modeled concentrations were used as EPCs when evaluating inhalation exposures to particulates in air. Ambient air EPCs (resulting from particulate emissions from soil) were modeled based on the measured soil concentrations. A site-specific particulate emission factor (PEF) was calculated for use in intake calculations for construction workers. Climate Zone 9 (based on Miami, FL) and a 3 acre aerial extent of site contamination were used in the site-specific PEF calculation.

The computational output from the ProUCL calculations performed for each COPC is presented in Appendix I. The equations for estimating intakes due to direct exposures to site-related chemicals for the various identified pathways are presented in Appendix J. The calculation of the site-specific PEF is included in Appendix K (Risk Calculation Spreadsheets).

It should be noted that estimated concentrations also were used to calculate the 95% UCL, such as "J" qualified (estimated) data. Reported concentrations qualified with an "R" (rejected) were not used in the statistical evaluation. For further discussion of data qualifications specific to this investigation, a laboratory data validation summary can be found in Section 6.5.2 of this report.

8.3.2.5 Exposure Input Parameters

Table 8-3 presents the exposure parameters used in the estimation of potential CDIs/DADs for COPCs retained for each receptor identified below. When USEPA exposure parameters are not available, best professional judgment and site-specific information are used to derive a conservative and defensible value. The following paragraphs present the rationale for the RME assumptions for each receptor group evaluated in the HHRA. RME is defined as the highest exposure that is reasonably expected to occur at a site.

Current/Future Adult and Youth Trespassers

This scenario assumes that current adult and youth (6 - 16 years) trespassers could come into contact with soil at the Fueling Piers Area. Therefore, these receptors were evaluated for potential exposure to soil (using the most conservative EPCs of the surface soil and total soil COPCs), including ingestion, dermal contact, and inhalation of volatiles and/or fugitive dust. A summary of the exposure parameters is discussed in the following paragraphs and presented on Table 8-3.

A 70 kilogram (kg) adult and a 45 kg youth (USEPA, 1997a) were assumed to have exposure durations (EDs) of 24 years (USEPA, 1991) and 11 years (professional judgment, represents youths from 6 to 16 years of age), respectively. Exposure time (ET) was estimated to be 2 hours per day (USEPA, 1997a) in relationship to inhalation exposure. An ingestion rate (IR) of 100 milligrams per day (mg/day) for soil was assumed for both the youth and the adult (USEPA, 1991), with a conservative assumption of 100 percent fraction ingested from the source (professional judgment). The exposure frequency (EF) was assumed to be 52 events/year (professional judgment), based on anticipated exposures of one day/week/year. Averaging times (ATs) of 8,760 days for adults and 4,015 days for youths for noncarcinogens, and 25,550 days for carcinogens were also used (USEPA, 1989).

The USEPA recommended weighted soil to skin adherence factor (AF) of 0.07 milligrams per square centimeter (mg/cm^2) for the residential adult (USEPA, 2004) was used for the adult trespasser for soil. This is based on the 50^{th} percentile weighted AF for gardeners, which is the activity determined to represent a reasonable, high-end contact activity. The USEPA recommended weighted 0.2 mg/cm^2 AF for the young child was conservatively used for the youth trespasser for soil and is based on the 95^{th} percentile weighted AF for children playing at a day care center or in wet soil (USEPA, 2004). Skin surface areas of 3,200 square centimeters (cm^2) for the youth (25% of the total body surface area of 12,900 cm^2 for youths ages 7-17) (USEPA, 1997a) and 5,700 cm^2 for the adult (USEPA, 2004) were assumed for the soil scenario.

Dermal absorption (ABS) values have been empirically determined for very few chemicals. USEPA (2004) provides recommended values for a limited number of chemicals and recommends treating dermal exposure to other compounds qualitatively in the uncertainty section or quantitatively using default values on a site-specific basis. RAGS Part E (USEPA, 2004) offers ABS values for a few organic and inorganic constituents, and these have been used in this HHRA. As cited in Exhibit 3-4 of RAGS Part E, the ABS for arsenic is set at 0.03 and for cadmium at 0.001 (USEPA, 2004). In the absence of USEPA Region II-specific guidance on dermal ABS for metals, ABS from all metals in soil except for arsenic and cadmium have been assumed to be 0.01 (Virginia Department of Environmental Quality [VDEQ], 2011) based on the following rationale. RAGS Part E states that for metals, the speciation of the compound is critical to the dermal absorption and there are too little data to extrapolate a reasonable default value (USEPA, 2004). However, the guidance does allow for quantitative evaluation using default

ABS values as an interim measure as long as uncertainties are presented and discussed. Therefore, in order to maintain a conservative approach and to account for dermal contact exposure pathway, an ABS value greater than zero (0) was assumed in this HHRA.

Current/Future Adult On-Site Workers

This scenario assumes that current/future adult on-site workers could come into contact with soil at the Fueling Piers Area. This receptor would be involved in landscaping/maintenance activities on the property grounds and not exposed to groundwater. Therefore, this receptor was evaluated for potential exposure to soil (using the most conservative EPCs of the surface soil and total soil COPCs) via ingestion, dermal contact, and inhalation of fugitive dust and/or volatiles in soil. A summary of the exposure parameters is discussed in the following paragraphs and presented on Table 8-3.

The IR for a 70 kg adult on-site worker exposed to soil was assumed to be 100 mg/day (USEPA, 2002a) and the fraction ingested was assumed to be 100 percent (professional judgment). An EF of 250 days per year (USEPA, 2004) for soil was used in conjunction with an ED of 25 years (USEPA, 2004). An ET of 8 hours/day (professional judgment) assuming a typical 8 hour work day was used to evaluate inhalation of fugitive dusts from soil. An averaging time of 70 years or 25,550 days was used for exposure to potentially carcinogenic compounds while an averaging time of 9,125 days was used for noncarcinogens.

There is a potential for on-site workers to absorb COPCs by dermal contact. A skin surface area of 3,300 cm^2 for an adult (USEPA, 2004) assumed to wear a short-sleeved shirt, long pants, and shoes, was used to evaluate dermal contact with soil. The USEPA recommended weighted AF of 0.2 mg/cm^2 (USEPA, 2004) was used for the on-site worker for soil. Dermal absorption values were applied as previously discussed.

Future Adult and Young Child Residents

This scenario assumes that future adult and young child (1-6 years) residents could come into contact with soil at the Fueling Piers Area. Therefore, these receptors were evaluated for potential exposure to soil (using the most conservative EPCs of the surface soil and total soil COPCs) via ingestion and dermal contact, as well as inhalation of fugitive dust and/or volatiles in soil. A summary of the exposure parameters is discussed in the following paragraphs and presented on Table 8-3.

Future adult and young child residents could contact soil during outdoor recreational activities in the area immediately surrounding their homes. A 70 kg adult and a 15 kg child (USEPA, 1997a) were assumed for exposure durations of 24 years and 6 years (USEPA, 1991), respectively. The exposure time was conservatively assumed to be 24 hours per day (professional judgment) for soil exposures. The IR for soil was assumed to be 200 mg/day for the young child and 100 mg/day for the adult (USEPA, 1991), with a 100 percent fraction ingested from source, over 350 days/year (USEPA, 2004) for soil. Averaging times of 8,760 days for adults and 2,190 days for children for non-carcinogens, and 25,550 days for carcinogens were also used (USEPA, 1989).

The USEPA recommended weighted AFs of 0.07 mg/cm^2 for the adult and 0.2 mg/cm^2 for the young child were used for soil (USEPA, 2004). Dermal absorption values were applied as previously discussed. Skin surface areas of 2,800 cm^2 for the young child and 5,700 cm^2 for the adult (USEPA, 2004) were assumed for the soil.

Future Adult Industrial/Commercial Workers

This scenario assumes that future adult industrial/commercial workers could come into contact with soil at the Fueling Piers Area. Therefore, this receptor was evaluated for potential exposure to soil (using the most conservative EPCs of the surface soil and total soil COPCs) via ingestion, dermal contact, and inhalation of volatiles and/or fugitive dust. A summary of the exposure parameters is discussed in the following paragraphs and presented on Table 8-3.

The IR for a 70 kg adult industrial/commercial worker exposed to soil was assumed to be 100 mg/day (USEPA, 2002a), and the fraction ingested was assumed to be 100 percent (professional judgment). An EF of 250 days per year (USEPA, 2004) for soil was used in conjunction with an ED of 25 years (USEPA, 2004). An ET of 8 hours/day (professional judgment) assuming a typical 8 hour work day was also used. An AT of 70 years or 25,550 days was used for exposure to potentially carcinogenic compounds while an averaging time of 9,125 days was used for noncarcinogenic exposures.

There is a potential for industrial/commercial workers to absorb COPCs by dermal contact. A skin surface area of 3,300 cm^2 for an adult (USEPA, 2004) assumed to wear a short-sleeved shirt, long pants, and shoes, was used to evaluate dermal contact with soil. An AF of 0.2 mg/cm^2 was used for soil and is based on the 50^{th} percentile weighted AF for utility workers, which is the activity determined by USEPA to represent a reasonable, high-end contact activity (USEPA, 2004). Dermal absorption values were applied as previously discussed.

Future Adult Construction Workers

Potential exposures to soil COPCs may occur to construction workers while performing soil excavation and construction activities at the Fueling Piers Area. Soil exposure pathways evaluated include ingestion, dermal contact, and inhalation of volatiles and/or fugitive dust (using the most conservative EPCs of the surface soil and total soil COPCs). A summary of the exposure parameters is discussed in the following paragraphs and presented on Table 8-3.

Exposure to soil was assumed to occur for 8 hours per day (professional judgment assuming a typical 8 hour work day), 250 days per year (USEPA, 2004), for a construction period of 1 year (professional judgment conservatively assuming duration of a construction project). The USEPA default value for the soil IR of 330 mg/day (USEPA, 2002a) and a 100 percent fraction ingested from source (professional judgment) were also assumed for a 70 kg construction worker (USEPA, 1997a). A skin surface area of 3,300 cm^2 for an adult (USEPA, 2004) assumed to wear a short-sleeved shirt, long pants, and shoes, was used to evaluate dermal contact with soil. A soil to skin adherence factor of 0.3 mg/cm^2 (USEPA, 2002a) was used for soil, and dermal absorption values were applied as previously discussed. The averaging time of 365 days for noncarcinogens and 25,550 days for carcinogens, respectively, were also used (USEPA, 1989). A site-specific PEF of 3.3×10^{06} was calculated for the construction worker scenario (refer to Appendix K).

8.3.3 Toxicity Assessment

An important component of the HHRA process is the relationship between the dose of a compound (amount to which an individual or population is potentially exposed) and the potential for adverse health effects resulting from exposure to that dose. Dose-response relationships provide a means by which potential public health impacts may be evaluated. Standard RfDs and/or CSFs have been developed for many of the COPCs. This section provides a brief description of these parameters.

8.3.3.1 Reference Doses

The RfDs are developed for chronic and/or subchronic human exposure to chemicals, and are based solely on the noncarcinogenic effects of chemical substances. These values are defined as an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of adverse effects during a lifetime. The RfD is expressed as dose per unit body weight per unit time (mg/kg/day). For the inhalation route, an RfC was utilized. The RfC is expressed as milligrams per cubic meter (mg/m^3).

Quantitative indices of toxicity are presented in Table 8-4 for the identified COPCs.

8.3.3.2 Carcinogenic Slope Factors

CSFs are used to estimate an upper bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen (USEPA, 1989). This factor is reported in units of proportion (of a population) affected per mg/kg/day and is derived through an assumed low-dosage, linear multistage model and an extrapolation from high to low dose-responses determined from animal studies. The slope factor represents the upper 95th percent confidence limit on the increased cancer risk from a lifetime exposure to an agent. CSFs can also be derived from USEPA promulgated unit risk values for air and/or water. CSFs derived from unit risks cannot, however, be applied to environmental media other than the medium considered in the unit risk estimate. For the inhalation route, an IUR was utilized. The IUR is expressed as the inverse of micrograms per cubic meter ($(\mu g/m^3)^{-1}$).

Slope factors are also accompanied by weight-of-evidence classifications, which designate the strength of the evidence that the COPC is a potential human carcinogen.

Quantitative indices of toxicity and USEPA weight-of-evidence classifications are presented in Table 8-4 for the identified COPCs.

The hierarchy (USEPA, 2003) for choosing these toxicity values was:

- Tier 1 – Integrated Risk Information System (IRIS) (USEPA, 2011b)
- Tier 2 – USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) (database of values developed on a chemical-specific basis when requested by USEPA's Superfund program)
- Tier 3 – Other Toxicity Values (includes additional USEPA and non-USEPA sources of toxicity information)

IRIS is the preferred source of human health toxicity values. IRIS generally contains RfDs, RfCs, CSFs, drinking water unit risk values, and IUR values that have gone through a peer review and USEPA consensus review process. IRIS normally represents the official Agency scientific position regarding the toxicity of the chemicals based on the data available at the time of the review.

The second tier is USEPA's PPRTVs. Generally, PPRTVs are derived for one of two reasons. First, the Superfund Health Risk Technical Support Center (STSC) reviews the toxicity values in the Health Effects Assessment Summary Table (HEAST) (USEPA, 1997b), which is now a Tier 3 source. As the reviews are completed, those toxicity values will be removed from HEAST, and any new toxicity value developed in such a review becomes a PPRTV and placed in the PPRTV database. Second, Regional Superfund Offices may request a PPRTV for chemicals lacking a relevant IRIS value. The STSC uses the same methodologies for both situations.

The third tier includes other sources of information. These sources should provide toxicity information based on similar methods and procedures as those used for Tiers 1 and 2, contain values which are peer reviewed, are available to the public, and are transparent about the methods and processes used to develop the values. Tier 3 sources include, but are not limited to, the following:

- The California Environmental Protection Agency (Cal EPA) toxicity values;
- The ATSDR Minimal Risk Levels; and
- HEAST toxicity values.

8.3.3.3 Dermal Absorption Efficiency

The following discussion is presented to provide general information regarding the use of administered dose to estimate absorbed dose when assessing potential dermal exposures. Many of the RfDs and CSFs are derived from oral toxicological studies based on administered dose, and do not account for the amount of a substance that can penetrate exchange boundaries after contact (e.g., absorbed dose). As a result, there is very little information available regarding dermal toxicity criteria. Therefore, in order to account for a difference in toxicity between an administered dose and an absorbed dose, the RfDs and CSFs (that were based on an administered dose) were adjusted, as described by the USEPA (USEPA, 1989), using experimentally-derived oral absorption efficiencies. The adjustment for the oral RfD that would correspond to a dermally absorbed dose is represented by multiplying the RfD by an oral absorption efficiency. The adjustment for the oral CSF that would correspond to the dermally absorbed dose is represented by dividing the CSF by oral absorption efficiency. Recommended oral absorption efficiencies for those compounds/analytes with chemical-specific dermal absorption factors were obtained from RAGS Part E (USEPA, 2004) The oral absorption efficiencies were obtained from sources such as the National Center for Environmental Assessment (NCEA), IRIS, ATSDR toxicological profiles, toxicology publications, toxicology references, and USEPA Regional Offices. In some instances, published information is not available to determine the absorption efficiency. On these occasions, adjustments to the toxicity value are not conducted (e.g., an absorption efficiency of 100% was assumed) (USEPA, 2004).

8.3.3.4 Mutagenic Mode of Action Chemicals

For chemicals that USEPA has determined to be carcinogenic via a mutagenic mode of action (MMOA) (marked with an "M" in the RSL table [USEPA, 2010a]), special adjustments are applied in estimating cancer risks. The carcinogenic PAHs benzo(a)pyrene and dibenz(a,h)anthracene are listed in USEPA's Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (USEPA, 2005) as having a MMOA and were selected as COPCs in the Fueling Piers Area surface soil and total soil. USEPA's 2005 Supplemental Guidance recommends the application of generic age-dependent adjustment factors (ADAFs) to adjust cancer risk for receptors whose exposure includes early life. Additionally, it is recommended that the ADAFs be applied to other carcinogenic PAHs when assessing early life exposure for PAHs. As such, recommended default ADAFs are incorporated in the calculation of risk for the applicable receptors for all carcinogenic PAHs selected as COPCs in this HHRA. The following ADAFs are used: 10 for age 0 to 2 years, 3 for age 2 to 16 years, and no adjustment for ages 16 and up (USEPA, 2005). These adjustments are incorporated in the risk calculations presented in Appendix K.

8.3.4 Risk Characterization

The risk characterization combines the selected COPCs, the exposure assessment, and the toxicity assessment to produce a quantitative estimate of current and future potential human health risks associated with the Fueling Piers Area. Sections 8.3.4.1 and 8.3.4.2 discuss the USEPA methodologies used for quantifying and characterizing carcinogenic and noncarcinogenic human health risks. ILCRs and HIs are calculated to characterize potential human health effects. These terms are defined in the sections that follow. ILCRs and HIs are estimated for current and future receptors exposure scenarios that were identified in Section 8.3.2, and are discussed in Section 8.3.4.3.

8.3.4.1 Quantification and Characterization of Carcinogenic Risks

Quantitative risk calculations for potentially carcinogenic compounds estimate inferentially (versus probabilistically) the potential ILCR 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 ILCR of 1 x 10^{-06} indicates that an exposed individual has an increased probability of one in one million of developing cancer subsequent to exposure, over the course of their lifetime.

The potential lifetime ILCR for an individual was estimated from the following relationship:

$$ILCR = \sum_{i=1}^{n} (CDI_i or DAD_i) \times CSF_i$$

Where the CSF_i is expressed as $(mg/kg/day)^{-1}$ for compound i, and the CDI_i and DAD_i is expressed as mg/kg/day for compound i. Since the units of CSF are (mg chemical/kg body weight/day) $^{-1}$ and the units of intake or dose are milligram (mg) chemical/kg body weight/day, the ILCR value is dimensionless. 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.

As put forth in RAGS Part F (USEPA, 2009), for evaluation of the inhalation pathway, the potential lifetime ILCR for an individual was estimated from the following relationship:

$$ILCR = \sum_{i=1}^{n} EC_i \times IUR_i \times 10^3 \ \mu g / mg$$

IUR is expressed as $(\mu g/m^3)^{-1}$ for compound i, and the exposure concentration (EC) is expressed in mg/m^3 for compound i. The ILCR value here is also dimensionless such that the inhalation risks can be summed with the ingestion and dermal contact risks to yield a total risk over all potential pathways.

For quantitative estimation of risk, it is assumed that cancer risks from various exposure routes are additive. Estimated ILCR values will be compared to 1 x 10^{-06} to 1 x 10^{-04}, which represents the target risk range of ILCR values considered by the USEPA to represent an acceptable (i.e., de minimis) risk (USEPA, 1990).

8.3.4.2 Quantification and Characterization of Noncarcinogenic Risks

Noncarcinogenic compounds assume that a threshold toxicological effect exists. Therefore, the potential for noncarcinogenic effects are calculated by comparing (i.e., dividing) CDI_i and DAD_i levels with RfDs for each COPC.

Noncarcinogenic effects are estimated by calculating the HQ for individual chemicals and the HI for overall chemicals and pathways by the following equation:

$$HI = \sum_{i=1}^{n} HQ_i$$

$$where : HQ_i = \frac{(CDI_i orDAD_i)}{RfD_i} \quad \text{(ingestion/dermal contact)}$$

and

$$HQ_i = \frac{(EC_i)}{RfC_i} \quad \text{(inhalation)}$$

An HQ is the ratio of the daily intake or absorbed dose to the reference dose. CDI_i is the chronic daily intake (mg/kg/day) of chemical i; DAD_i is the dermally absorbed dose (mg/kg/day) of chemical i, and RfD_i is the reference dose (mg/kg/day) of the chemical i over a prolonged period of exposure. Since the units of RfD are mg/kg/day and the units of CDI/DAD are mg/kg/day, the HQ and HI are dimensionless. The RfC is expressed as mg/m^3 for compound i, and the EC is expressed in mg/m^3 for compound i. The HQ value here is also dimensionless such that the inhalation risks can be summed with the ingestion and dermal contact risks to yield a total risk over all potential pathways.

To account for the additivity of noncarcinogenic risk following exposure to numerous chemicals, the HI, which is the sum of all the HQs, will be calculated. A ratio of 1.0 is used for comparison to the HQ and HI (USEPA, 1990). Ratios less than 1.0 indicate that adverse noncarcinogenic health effects are unlikely. Ratios greater than 1.0 indicate that adverse noncarcinogenic health effects may occur at that exposure level. However, this does not mean that adverse effects will definitely occur, since the RfD incorporates safety and modifying factors to ensure that it is well below that dose for which adverse effects have been observed. This procedure assumes that the risks from exposure to multiple chemicals are additive, an assumption that is probably valid for compounds that have the same target organ or cause the same toxic effect.

8.3.4.3 Potential Human Health Effects

The estimated carcinogenic risks (i.e., ILCRs) and noncarcinogenic risks (i.e., HIs) provide a basis for site-specific risk management decisions. The conservative nature of the analysis and the uncertainty inherent in the risk assessment were considered when interpreting the results. The uncertainty associated with the risk estimations is discussed in Section 8.3.6. These results are presented in Tables 8-5 through 8-11. All calculation spreadsheets used for estimating potential carcinogenic and noncarcinogenic risks for receptors are presented in Appendix K. RAGS Part D tables are presented in Appendix L.

Current/Future Adult and Youth Trespassers

As shown in Tables 8-5 and 8-6, the total site ILCRs calculated for the adult and youth trespassers (1.1×10^{-06} and 8.5×10^{-07}) to soil at the Fueling Piers Area fell within and below USEPA's target risk range of 1×10^{-06} to 1×10^{-04}. Similarly, the total site HIs (0.02 for the adult trespasser and 0.03 for the youth trespasser) were less than USEPA's target hazard level of 1.0.

Current/Future On-Site Worker

As shown in Table 8-7, the total site ILCR for the current/future on-site worker was 6.0×10^{-06}, which is within the USEPA's target risk range of 1×10^{-06} to 1×10^{-04}. The current/future on-site worker was evaluated for exposures to soil at the Fueling Piers Area. Similarly, the total site HI (0.09) was less than USEPA's target hazard level of 1.0.

Future Adult and Young Child Residents

As shown in Tables 8-8 and 8-9, the total site ILCRs calculated for adult and young child residential exposures (7.2×10^{-06} and 1.5×10^{-05}, respectively) to soil at the Fueling Piers Area were within USEPA's target risk range of 1×10^{-06} to 1×10^{-04}. The total lifetime risk (2.2×10^{-05}) is also within the USEPA's target risk range.

The total site HI (0.12) for the future adult resident was less than USEPA's target hazard level of 1.0. The total site HI (1.05) for the future young child resident was slightly greater than USEPA's target hazard level of 1.0 primarily as a result of arsenic, cobalt, thallium, and vanadium in soil (approximately 35%, 29%, 17%, and 11% risk contributions, respectively, to the total site HI). However, the individual HQs for young child exposure to arsenic, cobalt, thallium, and vanadium were less than 1.0 (refer to Table 8-9). Additionally, the target organ analysis presented on Table 8-9 demonstrates that none of the target organ HIs exceed 1.0.

Future Industrial/Commercial Worker

As shown in Table 8-10, the total site ILCR for the future industrial/commercial worker was 6.0×10^{-06}, which is within the USEPA's target risk range of 1×10^{-06} to 1×10^{-04}. The future industrial/commercial worker was evaluated for exposures to soil at the Fueling Piers Area. Similarly, the total site HI (0.09) was less than USEPA's target hazard level of 1.0.

Future Construction Worker

As shown in Table 8-11, the total site carcinogenic risk for the future construction worker was 9.4 x 10^{-07}, which falls below the USEPA's target risk range of 1 x 10^{-06} to 1 x 10^{-04}. The construction worker was evaluated for exposures to soil. Similarly, the total site HI (0.56) was less than USEPA's target hazard level of 1.0.

8.3.5 Comparison to Background Levels

As part of the COPC selection process, the maximum detected concentrations of metals in surface soil and total soil sampled at the Fueling Piers Area were compared to NAPR-specific background concentrations (ULM for each inorganic) established in the Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2010b), for NAPR. As previously discussed, metals were not eliminated as COPCs based on comparison to background concentrations. Therefore, it is possible that risks resulting from potential exposures to metals could represent background conditions.

COPCs were selected from both surface soil (0 to 1 foot bgs) and total soil (0 to 11 feet bgs) for the soil exposure pathway evaluation for the Fueling Piers Area. EPCs were subsequently calculated for surface soil and total soil COPCs, and the higher of the two EPCs for each COPC was used in the risk calculations to produce a conservative risk estimate. Specifically, the EPCs for copper, thallium, and vanadium used in the risk calculations were from surface soil (since the 95% UCLs were greater than those in total soil). The EPC for arsenic used in the risk calculations was from total soil since the 95% UCL was greater than that calculated for arsenic in surface soil.

Eleven of fourteen concentrations of arsenic in surface soil and nineteen out of twenty-four arsenic concentrations in total soil exceeded the background screening concentration. The maximum concentration of copper exceeded the background screening concentration in both surface soil and total soil. All site-specific concentrations of thallium in surface soil exceeded background because thallium was not detected in NAPR base-wide background surface soil samples. All detected concentrations of cobalt and vanadium in both surface soil and total soil were less than corresponding background screening values. All detected concentrations of thallium in total soil were less than the total soil background screening value.

Although arsenic, copper, and thallium exceeded corresponding background screening values, site risks from these metals did not exceed USEPA's target risk criteria for the receptors evaluated in the HHRA. As such, comparison of site-related risks to background risks would be superfluous. All detected concentrations of cobalt and vanadium in both surface soil and total soil were less than corresponding background screening values. As such, site-related risks from cobalt and vanadium would be less than those from background. Further, site-related risks from cobalt and vanadium did not exceed USEPA's target risk criteria for the receptors evaluated in the HHRA.

8.3.6 Sources of Uncertainty

Uncertainties are encountered throughout the risk assessment process. This section discusses the sources of uncertainty inherent in the following elements of the HHRA performed for the Fueling Piers Area:

- Sampling and analysis

- Selection of COPCs
- Exposure assessment
- Toxicity assessment
- Risk characterization
- Comparison to background levels

Table 8-12 summarizes the potential effects of certain uncertainties on the estimation of human health risks. Uncertainties associated with this risk assessment are discussed in the following paragraphs.

8.3.6.1 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 the Fueling Piers Area, USEPA-approved sampling and analytical methods were employed. Samples were taken from locations specified in the approved Work Plan along with the necessary QA/QC samples. The data were validated and found to meet the data quality objectives and all validation criteria.

Analytical data are limited by the precision and accuracy of the methods of analysis, which are reflected by the relative percent difference 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.

Uncertainty exists also in the fact that contamination may or may not be fully delineated. And so, having a complete data set impacts the representativeness of exposure concentrations derived from the data.

8.3.6.2 Selection of COPCs

Surface soil and total soil COPCs were selected based on comparisons of the maximum detected concentration with USEPA RSLs for residential soil. The application of the residential RSL values to COPC selection provides a list of COPCs that are very conservative for NAPR and specifically, the Fueling Piers Area. Although future on-site residential land use was conservatively used for screening criteria, it is not considered reasonably anticipated at the Fueling Piers Area. It is assumed that long-term plans for the facility would be similar to those that had been in place prior to closure with land use also generally the same.

The RSLs were derived using conservative, USEPA-promulgated default values, and the most recent toxicological criteria available. RfDs and CSFs have been combined with "standard" exposure scenarios to calculate the RSLs. Actual exposure scenarios and parameters may differ from those used to calculate the RSL. All noncarcinogenic RSLs were divided by 10 to account for potential additive effects. This adjustment corresponds to assuming an HQ of 0.1, rather than 1.0. This adds additional conservatism to the COPC selection process.

COPC selection is based on the detected concentrations of analytes, not their detection limits. This criterion introduces some uncertainty when analytes in site-specific environmental media have maximum detection limits in excess of the RSLs. For the Fueling Piers Area, the following chemicals in surface soil and total soil had detection limits in excess of the RSLs: benzo(a)pyrene, dibenz(a,h)anthracene, and thallium. However, all carcinogenic PAHs and thallium were retained as COPCs in surface soil and total soil. In the case of some chemicals with extremely conservative risk-based RSLs (e.g., thallium), conventional analytical techniques cannot produce detection levels less than these values. These chemicals were quantitatively evaluated in the HHRA, thereby reducing the uncertainty added to the HHRA.

8.3.6.3 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 parameters have been generated by the scientific community and have been reviewed by the USEPA. The USEPA has published an Exposure Factors Handbook (USEPA, 1997a), which contains the best and latest values. These exposure parameters have been derived from a range of values generated by studies of limited numbers of individuals. It is assumed that all potential receptors remain on or near the site throughout the exposure periods and that their exposures to chemicals from the site are all uniform. In all instances, values used in this risk assessment, scientific judgments, and conservative assumptions agree with those of the USEPA.

The use of a RME approach, designed to avoid underestimating daily intakes, was employed throughout this risk assessment. The use of 95% UCL estimates of the arithmetic mean versus maximum values as the concentration term in estimating the CDI or DAD for exposure scenarios reduces the potential for underestimating exposure.

As discussed in Section 8.3.2.5, in the absence of USEPA Region II-specific guidance on dermal ABS for metals, an ABS of 0.01 was assumed for all metals in soil except for arsenic and cadmium. However, as acknowledged in RAGS Part E, there is a great deal of uncertainty associated with the evaluation of the dermal contact pathway for potential exposure to metals. RAGS Part E states that for metals, the speciation of the compound is critical to the dermal absorption and there are too little data to extrapolate a reasonable default value (USEPA, 2004). However, the guidance does allow for quantitative evaluation using default ABS values as an interim measure as long as uncertainties are presented and discussed. Therefore, in order to maintain a conservative approach and to account for dermal contact exposure pathway, an ABS value greater than zero (0) was assumed. Under this conservative assumption, risk estimates from dermal exposure to metals were likely an overestimate of the true risk, since the dermal exposure pathway is assumed by USEPA guidance to more reasonably contribute only a small percentage to the total HI.

8.3.6.4 Toxicity Assessment

In making quantitative estimates of the toxicity of 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 human exposures, 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 pharmacokinetics.

- 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.

All potential toxic endpoints for human receptors have been addressed to the extent allowed by the data evaluated from the most recent toxicological/epidemiological studies used to derive the cancer slope factors and reference doses. Therefore, any uncertainties associated with toxic endpoints are directly correlated to the information obtained from, and reliability of those studies.

TPH DRO and GRO were detected in soil and retained as COPCs. However, there are no toxicity criteria for TPH. Therefore, potential risk posed by TPH was not quantified in the HHRA. Some toxicity data and cancer assessments are available for whole, unweathered petroleum products. However, there are uncertainties associated with the use of this information because the composition of each type of petroleum product is variable depending on the crude oil from which it was refined, differences in the refining process, and differences in the formulation of the final product. Further this would apply only if one knows what petroleum product was released. In many cases, the released material is not known or more than one product may have been released and toxicity data for the whole petroleum products that are relatively heterogeneous are not necessarily applicable to the fractions to which exposures actually occur. Additionally, it is believed that the TPH present at NAPR represents a highly weathered fraction further indicating the inapplicability of using toxicity data for whole petroleum products to quantify risk. Given the other conservative aspects of the HHRA, the potential for underestimation of risks is considered low.

8.3.6.5 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. 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.

8.3.6.6 Comparison to Background Levels

As previously discussed, metals were not eliminated as COPCs based on comparison to background concentrations. Therefore, it is possible that risks presented from metals could represent background conditions.

Although arsenic, copper, and thallium exceeded corresponding background screening values, site risks from these metals did not exceed USEPA's target risk criteria for the receptors evaluated in the HHRA. As such, comparison of site-related risks to background risks would be superfluous. All detected concentrations of cobalt and vanadium in both surface soil and total soil were less than corresponding background screening values. As such, site-related risks from cobalt and vanadium would be less than those from background. Further, site-related risks from cobalt and vanadium did not exceed USEPA's target risk criteria for the receptors evaluated in the HHRA. However, it is likely that site-related risks from exposure to cobalt and vanadium are overestimated.

8.3.7 Summary and Conclusions of the HHRA

The risk assessment evaluated the exposure of potential receptor populations including adult and youth trespassers, adult on-site worker, adult and child residents, construction workers, and industrial/commercial workers.

The total site carcinogenic risks calculated for all media for the future residential receptors were within USEPA's target risk range of 1×10^{-06} to 1×10^{-04}. As previously discussed, the future residential land use scenario was used to evaluate unrestricted land use and provide the most conservatively protective risk estimation for the Fueling Piers Area, although it is highly unlikely that housing would be built on this site. While the total site HI for the future adult resident was less than USEPA's target hazard level of 1.0, noncarcinogenic risks were slightly greater than the USEPA's target limit for the future residential child. This exceedance was primarily due to arsenic, cobalt, thallium, and vanadium in soil. However, after refinement of the total site noncarcinogenic risk addressing the magnitude of individual HQs and their contribution to target organs, all individual HQs for arsenic, cobalt, thallium, and vanadium were less than 1.0 and none of the target organ HIs exceeded 1.0. Therefore, because target organ HI values were less than 1.0, cumulative adverse health effects are not likely for the future residential child receptor from exposure to soil at the Fueling Piers Area. Since the carcinogenic and noncarcinogenic risks calculated for the future residential receptors did not exceed USEPA's target risk criteria, no further actions in the form of corrective measures are recommended for site media based on risk to future residential receptors.

The estimated carcinogenic risks from all media were within or below USEPA's target risk range for the remaining receptors (i.e., current/future trespassers, current/future on-site workers, future construction workers, and future industrial/commercial workers). Similarly, the total site HIs (0.02 for the adult trespasser and 0.03 for the youth trespasser) were less than USEPA's target hazard level of 1.0. Since the carcinogenic and noncarcinogenic risks calculated for the trespasser and industrial receptors did not exceed USEPA's target risk criteria, no further actions are recommended for site media based on risk to trespassers, on-site workers, construction workers, and industrial/commercial workers.

8.4 Development of CAOs

The CMS process from a human health risk assessment perspective continues when potential exposure to a site is considered to pose unacceptable levels of risk and hazard and medium- and chemical-specific CAOs are calculated for comparison to the site data to determine if and where potential cleanup may occur.

CAOs are medium- and chemical-specific goals for protecting human health and the environment. The CAOs are used to focus the development of corrective measure alternatives on technologies that may achieve appropriate target levels, thereby limiting the number of alternatives analyzed.

CAOs can be general and descriptive (i.e., qualitative) or specific and numerical (i.e., quantitative). They are achieved by reducing exposure (e.g., installing a soil cover or limiting access) or by reducing contaminant levels (e.g., active remediation; USEPA, 1988). CAOs are used to evaluate which samples/areas within a site may require corrective measures, and which corrective measures alternative best protects human health and the environment.

8.4.1 Qualitative CAOs

There were no carcinogenic risks or noncarcinogenic health hazards calculated that exceeded USEPA's acceptable criteria for current/future adult and youth trespasser, current/future on-site worker, future adult and child residential, future construction worker, and future industrial/commercial worker receptors. Therefore, qualitative CAOs for soil for the protection of human health assuming continued industrial use were not developed for the Fueling Piers Area of SWMU 74. Additionally, the results of the approved Revised Final Phase I CMS Report (Baker, 2010a) indicated that groundwater was determined to be impacted by a release from SWMU 7/8 (which is being addressed under SWMU 7/8) and not site-related activities specific to the Fueling Piers Area. Therefore, qualitative CAOs for groundwater were not developed.

8.4.2 Quantitative CAOs

There were no carcinogenic risks or noncarcinogenic health hazards calculated that exceeded USEPA's acceptable criteria for current/future adult and youth trespasser, current/future on-site worker, future adult and child residential, future construction worker, and future industrial/commercial worker receptors. Therefore, quantitative CAOs for soil for the protection of human health assuming continued industrial use were not developed for SWMU 74 – Fueling Piers Area. Additionally, the results of the approved Revised Final Phase I CMS Report (Baker, 2010a) indicated that groundwater was determined to be impacted by a release from SWMU 7/8 (which is being addressed under SWMU 7/8) and not site-related activities specific to the Fueling Piers Area. Therefore, quantitative CAOs for groundwater were not developed.

8.5 References

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9.0 SUMMARY OF COCs AND CAOs

The risk assessment processes discussed in Sections 7.0 and 8.0 were followed to identify specific COCs and develop CAOs for soil that are protective of ecological and human receptors. As discussed in the Revised Final Phase I of the Corrective Measures Study Investigation for SWMU 74 (Baker, 2010), there were no exceedances of screening criteria in groundwater that were positively correlated to TPH indicating that the presence of these compounds is not the result of a release from SWMU 74. Consequently, this medium was not further evaluated as part of the risk assessments.

The results of Step 3a of the BERA for the Fueling Piers Area did not identify COCs or unacceptable risks to ecological receptors from exposure to fuel-related chemicals (i.e., chemicals positively correlated with DRO, GRO, or Total TPH) in surface or subsurface soil. Therefore, ecological CAOs were not developed.

The results of the HHRA for the Fueling Piers Area did not identify COCs or unacceptable risks to human receptors (based on current/future adult and youth trespasser, on-site adult worker, industrial/commercial adult worker, and future adult and young child residents and construction worker exposure scenarios) from exposure to fuel-related chemicals (i.e., chemicals positively correlated with DRO, GRO, or Total TPH) in surface and total soil. Therefore, human health qualitative or quantitative CAOs were not developed.

As discussed in Section 6.1 – Surface Soil, TPH exceeded the PREQB screening criteria of 100 mg/kg for soil at four sample locations. However, since TPH is not typically considered a RCRA regulated constituent and no human health or ecological risks were identified for these samples, a CAO for TPH was not established.

10.0 JUSTIFICATION AND RECOMMENDATION OF THE CORRECTIVE MEASURE

No unacceptable ecological risks or human health risks from exposure to fuel-related chemicals (i.e., chemicals positively correlated with DRO, GRO, or Total TPH) in site soil were identified for the Fueling Piers Area of SWMU 74. Site-related impacts to groundwater also were not identified. Although isolated areas of TPH-impacted surface soil were identified based on exceedances of the PREQB screening value (100 mg/kg), TPH is not typically considered a RCRA-regulated constituent, and the screening value is not strictly risk-based. Removing the isolated areas of TPH-impacted surface soil will not result in increased protectiveness to human health or the environment. Therefore, the selected remedy for the Fueling Piers Area is No Action, ultimately resulting in a Corrective Action Complete (CAC) without controls designation for this portion of SWMU 74.

Use of a presumptive remedy, such as No Action, bypasses several steps of the CMS process (USEPA, 1994) including the screening of corrective measures technologies, identification and formulation of corrective measures alternatives (Task I from Attachment IV of the §7003 Administrative Order [USEPA, 2007]), and evaluation of the corrective measures alternatives (Task II from Attachment IV of the §7003 Administrative Order). This results in a streamlined CMS that focuses on the description and evaluation of the selected remedy. Descriptions of the selected remedy and technical, human health, and environmental considerations are discussed in the following sections. The technical approach to implementing the selected remedy is discussed in more detail in Section 11.0.

10.1 Description of the Remedy

The selected remedy for the Fueling Piers Area is No Action. Since no unacceptable ecological or human health risks from exposure to fuel-related chemicals (i.e., chemicals positively correlated with DRO, GRO, or Total TPH) in site soil were identified for the Fueling Piers Area of SWMU 74 and no site-related impacts to groundwater were identified, no remedial or institutional actions are required to mitigate site risk. Administrative actions are required to designate this portion of SWMU 74 as CAC.

10.2 Justification of the Corrective Measure

Justification for selecting No Action is provided below and was based on technical, environmental, and human health considerations.

10.2.1 Technical Considerations

Based on the results of the risk assessments, No Action will be protective of human health and the environment. There are no safety concerns associated with implementing this remedy. In general, this corrective measure will be effective, reliable, and easily implemented.

10.2.2 Environmental Considerations

Based on results of the ERA, there were no unacceptable risks to ecological receptors upon potential exposure to fuel-related constituents detected in soil at the Fueling Piers Area. Therefore, no further evaluation or action from an ecological perspective is warranted.

10.2.3 Human Health Considerations

Based on results of the HHRA, there were no unacceptable risks to human receptors upon potential exposure to fuel-related constituents detected in soil at the Fueling Piers Area. Therefore, no further evaluation or action from a human health perspective is warranted.

10.3 References

USEPA. 2007. RCRA §7003 Administrative Order on Consent. In the Matter of: United States The Department of the Navy, Naval Activity Puerto Rico formerly Naval Station Roosevelt Roads, Puerto Rico. Environmental Protection Agency, EPA Docket No. RCRA-02-2007-7301. January 29, 2007.

USEPA. 1994. RCRA Corrective Action Plan. Office of Solid Waste and Emergency Response. OSWER Directive 9902.3-2A. May 1994.

11.0 TECHNICAL APROACH TO IMPLEMENTATION OF THE CORRECTIVE MEASURE

The selected remedy for the Fueling Piers Area of SWMU 74 (No Action) will be implemented through administrative actions and will ultimately result in a CAC designation for this portion of SWMU 74. No other remedial or institutional actions are required for this site.

The cost of implementing the No Action is anticipated to be minimal since the costs incurred will most likely be associated administrative actions. Minimal annual or five year review costs will be incurred.

TABLES

TABLE 4-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM - ENVIRONMENTAL SAMPLES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

					Fixed Based Laboratory Analysis					
Media	**Site ID**	**Sample ID**	**Sample Depth (ft bgs)**	**Sample Date**	App IX VOCs	App IX Low-Level PAHs	App IX Metals (Total)	TPH GRO	TPH DRO	**Comment**
Surface Soil	74SB748	74SB748-00	0.3-1.0	4/18/2011	X	X	X	X	X	
		74SB748-00D	0.3-1.0	4/18/2011	X	X	X	X	X	Duplicate
		74SB748-00 (MS/MSD)	0.3-1.0	4/18/2011	X	X	X	X	X	Matrix Spike/Matrix Spike Duplicate
	74SB749	74SB749-00	0.0-1.0	4/18/2011	X	X	X	X	X	
	74SB750	74SB750-00	0.0-1.0	4/18/2011	X	X	X	X	X	
	74SB751	74SB751-00	0.4-1.0	4/18/2011	X	X	X	X	X	
	74SB752	74SB752-00	0.4-1.0	4/18/2011	X	X	X	X	X	
	74SB753	74SB753-00	0.0-1.0	4/18/2011	X	X	X	X	X	
	74SB754	74SB754-00	0.0-1.0	4/19/2011	X	X	X	X	X	
	74SB755	74SB755-00	0.0-1.0	4/19/2011	X	X	X	X	X	
	74SB756	74SB756-00	0.0-1.0	4/29/2011	X	X	X	X	X	
	74SB757	74SB757-00	0.0-1.0	4/29/2011	X	X	X	X	X	
	74SB758	74SB758-00	0.0-1.0	4/29/2011	X	X	X	X	X	
	74SB759	74SB759-00	0.0-1.0	4/29/2011	X	X	X	X	X	
		74SB759-00D	0.0-1.0	4/29/2011	X	X	X	X	X	Duplicate
		74SB759-00 (MS/MSD)	0.0-1.0	4/29/2011	X	X	X	X	X	Matrix Spike/Matrix Spike Duplicate
	74SB760	74SB760-00	0.0-1.0	4/29/2011	X	X	X	X	X	
Subsurface Soil	74SB748	74SB748-01	1.0-3.0	4/18/2011	X	X	X	X	X	
		74SB748-01D	1.0-3.0	4/18/2011	X	X	X	X	X	Duplicate
		74SB748-01 (MS/MSD)	1.0-3.0	4/18/2011	X	X	X	X	X	Matrix Spike/Matrix Spike Duplicate
	74SB749	74SB749-01	1.0-2.3	4/18/2011	X	X	X	X	X	
	74SB750	74SB750-01	1.0-2.5	4/18/2011	X	X	X	X	X	
	74SB751	74SB751-01	1.0-3.0	4/18/2011	X	X	X	X	X	
	74SB752	74SB752-01	1.0-3.0	4/18/2011	X	X	X	X	X	
	74SB753	74SB753-01	1.0-3.0	4/18/2011	X	X	X	X	X	
Groundwater	74GW246	74GW246B	NA	4/19/2011		X				
		74GW246BD	NA	4/19/2011		X				Duplicate
		74GW246B (MS/MSD)	NA	4/19/2011		X				Matrix Spike/Matrix Spike Duplicate

Notes:
DRO - Diesel-Range Organics
ft bgs - feet below ground surface
GRO - Gasoline-Range Organics
NA - Not Applicable
PAHs - Polynuclear Aromatic Hydrocarbons
TPH - Total Petroleum Hydrocarbons
VOCs - Volatile Organic Compounds

TABLE 4-2

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM - QA/QC SAMPLES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

			Fixed Base Laboratory Analysis					
Sample Type	**Sample ID**	**Sample Date**	App IX VOCs	App IX Low-Level PAHs	App IX Metals (Total)	TPH GRO	TPH DRO	**Comment**
Trip Blanks	74TB114	4/18/2011	X			X		
	74TB115	4/19/2011	X			X		
	74TB117	4/29/2011	X			X		
Equipment Rinsate Blanks	74ER114	4/18/2011	X	X	X	X	X	Acetate Liner/Stainless Steel Spoon/Disposable Pan
	74ER115	4/19/2011		X				Stainless Steel Bladder Pump
	74ER116	4/19/2011	X	X	X	X	X	Stainless Steel Bucket Auger
	74ER117	4/29/2011	X	X	X	X	X	Stainless Steel Bucket Auger
Field Blanks	74FB01	4/18/2011	X	X	X	X	X	Laboratory-Grade Deionized Water

Notes:
DRO - Diesel-Range Organics
GRO - Gasoline-Range Organics
PAHs - Polynuclear Aromatic Hydrocarbons
TPH - Total Petroleum Hydrocarbons
VOCs - Volatile Organic Compounds

TABLE 4-3

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CRQLs
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Volatile Organics	Quantitation Limits		Method Description	Method Number	Preparation Methods	
	Water (μg/L)	Low Soil (μg/kg)			Water	Soil
1,1,1,2-Tetrachloroethane	0.33	2.4	GC/MS	8260B	5030B	5035
1,1,1-Trichloroethane	0.5	1	GC/MS	8260B	5030B	5035
1,1,2-Trichloroethane	0.25	1.3	GC/MS	8260B	5030B	5035
1,1-Dichloroethane	0.25	1.1	GC/MS	8260B	5030B	5035
1,1-Dichloroethene	0.25	1.5	GC/MS	8260B	5030B	5035
1,2,3-Trichloropropane	0.5	2.4	GC/MS	8260B	5030B	5035
1,2-Dibromo-3-chloropropane	1	4.4	GC/MS	8260B	5030B	5035
1,2-Dibromoethane	0.25	1.5	GC/MS	8260B	5030B	5035
1,2-Dichloroethane	0.25	1.1	GC/MS	8260B	5030B	5035
1,2-Dichloropropane	0.25	1	GC/MS	8260B	5030B	5035
2-Butanone	1	2.4	GC/MS	8260B	5030B	5035
2-Hexanone	1	3.3	GC/MS	8260B	5030B	5035
3-Chloro-1-propene	0.5	2.2	GC/MS	8260B	5030B	5035
4-Methyl-2-pentanone	1	4.2	GC/MS	8260B	5030B	5035
Acetone	5	11	GC/MS	8260B	5030B	5035
Acetonitrile	10	41	GC/MS	8260B	5030B	5035
Acrolein	7.4	24	GC/MS	8260B	5030B	5035
Acrylonitrile	7.2	34	GC/MS	8260B	5030B	5035
Benzene	0.25	1	GC/MS	8260B	5030B	5035
Bromodichloromethane	0.25	1	GC/MS	8260B	5030B	5035
Bromoform	0.5	1.5	GC/MS	8260B	5030B	5035
Bromomethane	0.8	1.5	GC/MS	8260B	5030B	5035
Carbon Disulfide	0.6	1.1	GC/MS	8260B	5030B	5035
Carbon Tetrachloride	0.5	1	GC/MS	8260B	5030B	5035
Chlorobenzene	0.25	1	GC/MS	8260B	5030B	5035
Chloroethane	1	2.7	GC/MS	8260B	5030B	5035
Chloroform	0.25	1.1	GC/MS	8260B	5030B	5035
Chloromethane	0.33	2	GC/MS	8260B	5030B	5035
Chloroprene	0.3	2.1	GC/MS	8260B	5030B	5035
cis-1,3-Dichloropropene	0.25	1	GC/MS	8260B	5030B	5035
Dibromochloromethane	0.25	1.7	GC/MS	8260B	5030B	5035
Dibromomethane	0.25	1.7	GC/MS	8260B	5030B	5035
Dichlorodifluoromethane	0.25	1	GC/MS	8260B	5030B	5035
Ethyl benzene	0.25	3.4	GC/MS	8260B	5030B	5035
Ethyl methacrylate	0.25	1.3	GC/MS	8260B	5030B	5035
Iodomethane	1	1.8	GC/MS	8260B	5030B	5035
Isobutanol	20	52	GC/MS	8260B	5030B	5035
Methacrylonitrile	5	23	GC/MS	8260B	5030B	5035
Methyl methacrylate	0.5	4.5	GC/MS	8260B	5030B	5035
Methylene Chloride	1	1	GC/MS	8260B	5030B	5035

TABLE 4-3

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CRQLs
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Volatile Organics (continued)	Quantitation Limits		Method Description	Method Number	Preparation Methods	
	Water (µg/L)	Low Soil (µg/kg)			Water	Soil
Pentachloroethane	1.2	6.3	GC/MS	8260B	5030B	5035
Propionitrile	5	26	GC/MS	8260B	5030B	5035
Stryene	0.25	1	GC/MS	8260B	5030B	5035
Tetrachloroethene	0.25	1.9	GC/MS	8260B	5030B	5035
Toluene	0.33	1	GC/MS	8260B	5030B	5035
trans-1,2-dichloroethene	0.25	1	GC/MS	8260B	5030B	5035
trans-1,3-Dichloropropene	0.25	1	GC/MS	8260B	5030B	5035
trans-1,4-Dichloro-2-butene	1	2.9	GC/MS	8260B	5030B	5035
Trichloroethene	0.25	1.3	GC/MS	8260B	5030B	5035
Trichlorofluoromethane	0.25	1.2	GC/MS	8260B	5030B	5035
Vinyl Acetate	0.5	2.5	GC/MS	8260B	5030B	5035
Vinyl Chloride	0.5	1.5	GC/MS	8260B	5030B	5035
Xylene	0.75	1.1	GC/MS	8260B	5030B	5035
Low Level Polynuclear Aromatic Hydrocarbons (PAHs)	**Quantitation Limits**		**Method Description**	**Method Number**	**Preparation Methods**	
	Water (µg/L)	**Low Soil (µg/kg)**			**Water**	**Soil**
2-Methylnaphthalene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Acenaphthene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Acenaphthylene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Anthracene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Benzo(a)anthracene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Benzo(a)pyrene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Benzo(b)fluoranthene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Benzo(g,h,i)perylene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Benzo(k)fluoranthene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Chrysene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Dibenzo(a,h)anthracene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Fluoranthene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Fluorene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Indeno(1,2,3-cd)pyrene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Naphthalene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Phenanthrene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Pyrene	0.1	3.3	GC/MS	8270C_LL_PAH	3520C	3546
Metals	**Quantitation Limits**		**Method Description**	**Method Number**	**Preparation Methods**	
	Water (µg/L)	**Low Soil (mg/kg)**			**Water**	**Soil**
Antimony	2	1	ICP/MS	6020A	3010A	3050B
Arsenic	1.3	0.25	ICP/MS	6020A	3010A	3050B
Barium	1.4	0.25	ICP/MS	6020A	3010A	3050B
Beryllium	0.25	0.05	ICP/MS	6020A	3010A	3050B

TABLE 4-3

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CRQLs
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Metals (continued)	Quantitation Limits		Method Description	Method Number	Preparation Methods	
	Water (µg/L)	Low Soil (mg/kg)			Water	Soil
Cadmium	0.2	0.05	ICP/MS	6020A	3010A	3050B
Chromium	2.5	0.5	ICP/MS	6020A	3010A	3050B
Cobalt	0.3	0.03	ICP/MS	6020A	3010A	3050B
Copper	1.1	0.5	ICP/MS	6020A	3010A	3050B
Lead	0.5	0.2	ICP/MS	6020A	3010A	3050B
Mercury	0.1	0.0088	Cold Vapor AA	7470A/7471A	7470A	7471A
Nickel	2	1	ICP/MS	6020A	3010A	3050B
Selenium	1.1	1	ICP/MS	6020A	3010A	3050B
Silver	0.25	0.1	ICP/MS	6020A	3010A	3050B
Thallium	0.25	0.05	ICP/MS	6020A	3010A	3050B
Tin	1.4	5.1	ICP/MS	6020A	3010A	3050B
Vanadium	3.2	0.55	ICP/MS	6020A	3010A	3050B
Zinc	8.4	3	ICP/MS	6020A	3010A	3050A
Total Petroleum Hydrocarbons	**Quantitation Limits**		**Method Description**	**Method Number**	**Preparation Methods**	
	Water (µg/L)	**Low Soil (µg/kg)**			**Water**	**Soil**
Diesel Range Organics (DRO)	0.05	2.1	GC	8015B	3520C	3546
Gasoline Range Organics (GRO)	0.025	0.05	GC	8015B	5030B	5035

Notes:

AA - Atomic Adsorption
CRQLs - Contract Required Quantitation Limits
GC - Gas Chromatography
ICP - Inductively Coupled Plasma
MS - Mass Spectrometry
µg/L - micrograms per liter
µg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram

TABLE 4-4

SUMMARY OF SOIL BORING SPECIFICATIONS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Soil Boring Designation	Date	Coordinates		Ground Elevation (ft datum)	Borehole Depth (ft bgs)	Bottom Elevation (ft datum)
		Easting	Northing			
74SB748	4/18/2011	939657.38	798971.43	109.56	4.0	105.56
74SB749	4/18/2011	939607.96	798975.12	110.05	4.0	106.05
74SB750	4/18/2011	939585.15	798958.78	110.23	4.0	106.23
74SB751	4/18/2011	939585.13	798922.68	109.98	4.0	105.98
74SB752	4/18/2011	939594.15	798898.10	110.01	4.0	106.01
74SB753	4/18/2011	939658.22	798907.35	110.21	4.0	106.21
74SB754	4/19/2011	939693.76	798993.00	108.98	1.3	107.68
74SB755	4/19/2011	939627.95	799043.00	108.82	1.2	107.62
74SB756	4/29/2011	939679.13	798866.95	109.59	1.0	108.59
74SB757	4/29/2011	939606.26	799086.30	109.87	1.0	108.87
74SB758	4/29/2011	939606.26	799086.30	110.09	1.0	109.09
74SB759	4/29/2011	939606.26	799086.30	108.25	1.0	107.25
74SB760	4/29/2011	939667.14	799062.33	108.73	1.0	107.73

Notes:
ft bgs - feet below ground surface
The Phase II field investigation was implemented April 18, 2011.
The datum plan used is the Mean Low Water plus 100.00 feet as established by the U.S. Navy Survey Section (November 1941).

TABLE 6-1

SUMMARY OF DETECTED LABORATORY RESULTS - TPH IN SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	PREQB Screening Criteria	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID		74SB748-00	74SB748-00D	74SB749-00	74SB750-00	74SB751-00	74SB752-00	74SB753-00
Date		4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)		0.3-1.0	0.3-1.0	0.0-1.0	0.0-1.0	0.4-1.0	0.4-1.0	0.0-1.0
TPH DRO and GRO (mg/kg)								
Diesel Range Organics	100	290	410	150	47	44	78	400
Gasoline Range Organics	100	2500 J	170 J	35 J	26 J	26 J	12 J	16 J
TPH Total	100	2790 J	580 J	185 J	73 J	70 J	90 J	416 J

Notes/Qualifiers:
J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Not detected at the Limit of Detection
UJ - Reported quantitation limit is qualified as estimated
DRO - Diesel-Range Organics
ft bgs - feet below ground surface
GRO - Gasoline-Range Organics
mg/kg - milligrams per kilogram
PREQB - Puerto Rico Environmental Quality Board
TPH - Total Petroleum Hydrocarbons
Shaded Result exceeds PREQB screening criteria

TABLE 6-1

SUMMARY OF DETECTED LABORATORY RESULTS - TPH IN SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	PREQB Screening Criteria	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB759	74SB760
Sample ID		74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB759-00D	74SB760-00
Date		4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)		0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
TPH DRO and GRO (mg/kg)									
Diesel Range Organics	100	56	110	36	24	25	32 J	19 J	71
Gasoline Range Organics	100	0.12 J	0.26 J	0.31 U	0.31 U	0.3 U	0.27 UJ	0.32 UJ	0.3 U
TPH Total	100	56.12 J	110.26 J	36	24	25	32 J	19 J	71

Notes/Qualifiers:
J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Not detected at the Limit of Detection
UJ - Reported quantitation limit is qualified as estimated
DRO - Diesel-Range Organics
ft bgs - feet below ground surface
GRO - Gasoline-Range Organics
mg/kg - milligrams per kilogram
PREQB - Puerto Rico Environmental Quality Board
TPH - Total Petroleum Hydrocarbons
Shaded - Result exceeds PREQB screening criteria

TABLE 6-2

SUMMARY OF DETECTED LABORATORY RESULTS - OGANICS IN SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753	74SB754
Sample ID	74SB748-00	74SB748-00D	74SB749-00	74SB750-00	74SB751-00	74SB752-00	74SB753-00	74SB754-00
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/19/2011
Depth Range (ft bgs)	0.3-1.0	0.3-1.0	0.0-1.0	0.0-1.0	0.4-1.0	0.4-1.0	0.0-1.0	0.0-1.0
Volatile Organics (µg/kg)								
Carbon disulfide	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.9
LLPAHs (µg/kg)								
2-Methylnaphthalene	71 U	71 U	72 U	69 U	74 U	72 U	69 U	71 U
Acenaphthene	71 U	71 U	72 U	69 U	74 U	72 U	69 U	71 U
Acenaphthylene	71 U	71 U	72 U	69 U	74 U	72 U	69 U	71 U
Anthracene	71 U	71 U	51 J	69 U	74 U	72 U	69 U	71 U
Benzo[a]anthracene	71 U	71 U	190	140	78	72 U	69 U	71 U
Benzo[a]pyrene	71 U	71 U	170	200	90	25 J	120	44 J
Benzo[b]fluoranthene	71 U	71 U	190	230	74 U	72 U	69 U	73
Benzo[g,h,i]perylene	43 J	71 U	170	92	52 J	72 U	69 U	36 J
Benzo[k]fluoranthene	71 U	71 U	160	170	130	72 U	69 U	71 U
Chrysene	71 U	39 J	210	160	100	72 U	74	71 U
Dibenz(a,h)anthracene	71 U	71 U	57 J	45 J	74 U	72 U	69 U	71 U
Fluoranthene	71 U	71 U	330	120	110	72 U	69 U	71 U
Fluorene	71 U	71 U	72 U	69 U	74 U	72 U	69 U	71 U
Indeno[1,2,3-cd]pyrene	71 U	71 U	110	84	38 J	72 U	69 U	71 U
Phenanthrene	71 U	71 U	100	69 U	35 J	26 J	26 J	71 U
Pyrene	71 U	71 U	320	160	140	72 U	52 J	71 U
LLPAH Totals (µg/kg)								
Low molecular weight PAHs	568	568	841	603	589	530	509	568
High molecular weight PAHs	611	607	1577	1281	776	601	660	579

Notes/Qualifiers:
J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Not detected at the Limit of Detection
ft bgs - feet below ground surface
LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons
µg/kg - micrograms per kilogram

TABLE 6-2

SUMMARY OF DETECTED LABORATORY RESULTS - OGANICS IN SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB755	74SB756	74SB757	74SB758	74SB759	74SB759	74SB760
Sample ID	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB759-00D	74SB760-00
Date	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Volatile Organics (µg/kg)							
Carbon disulfide	5.5 J	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
LLPAHs (µg/kg)							
2-Methylnaphthalene	75 U	4.2 J	7.4 U	7.2 U	7.2 U	7.1 U	7.2 U
Acenaphthene	75 U	7.2 U	7.4 U	7.2 U	3.8 J	7.1 U	9.4
Acenaphthylene	75 U	11	7.4 U	7.2 U	17	14	17
Anthracene	75 U	25	4 J	4.5 J	26	12	52
Benzo[a]anthracene	75 U	63	13	37	160 J	50 J	140
Benzo[a]pyrene	59 J	110	20	50	180 J	68 J	140
Benzo[b]fluoranthene	68 J	200	36	89	270 J	120 J	240
Benzo[g,h,i]perylene	76	53	7.4 U	24	52	23	66
Benzo[k]fluoranthene	56 J	180	33	73	230 J	94 J	210
Chrysene	46 J	110	31	50	200 J	96 J	250
Dibenz(a,h)anthracene	75 U	20	7.4 U	7.2 U	7.2 U	7.1 U	22
Fluoranthene	43 J	97	32	50	300 J	170 J	400
Fluorene	75 U	7.2 U	7.4 U	7.2 U	3.6 J	7.1 U	7.6
Indeno[1,2,3-cd]pyrene	44 J	26	5 J	12	26	14	36
Phenanthrene	75 U	40	6.2 J	8.6	78 J	32 J	180
Pyrene	51 J	110	33	58	350 J	190 J	430
LLPAH Totals (µg/kg)							
Low molecular weight PAHs	568	198.8	79.2	99.1	442.8	256.4	680.4
High molecular weight PAHs	550	872	185.8	400.2	1475.2	662.1	1534

Notes/Qualifiers:
J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Not detected at the Limit of Detection
ft bgs - feet below ground surface
LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons
µg/kg - micrograms per kilogram

TABLE 6-3

SUMMARY OF DETECTED LABORATORY RESULTS - METALS IN SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPLINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	NAPR Basewide Background	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753	74SB754
Sample ID		74SB748-00	74SB748-00D	74SB749-00	74SB750-00	74SB751-00	74SB752-00	74SB753-00	74SB754-00
Date		4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/19/2011
Depth Range (ft bgs)		0.3-1.0	0.3-1.0	0.0-1.0	0.0-1.0	0.4-1.0	0.4-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)									
Antimony	3.17	2 U	1.9 U	2.9	2 U	2.1 U	2 U	2 U	2 U
Arsenic	2.65	2	1.5	4.3	4.2	4.7	1.7	1.6	3.5
Barium	199	150 J	190 J	29 J	44 J	55 J	150 J	110 J	65 J
Beryllium	0.59	0.17	0.14	0.064 J	0.078 J	0.093 J	0.14	0.25	0.079 J
Cadmium	1.02	0.062 J	0.046 J	1.3	0.18	0.086 J	0.047 J	0.12	0.73
Chromium	49.8	7.3	3.9	20	13	15	4.2	9.5	11
Cobalt	46.2	6.3	5.7	2.6	3	9.3	6.5	7.3	4.8
Copper	168	12	9.9	45	16	49	17	22	22
Lead	22.0	4.6	3.5	120	32	7.6	3.5	8.8	25 R
Mercury	0.109	0.021 U	0.02 U	0.022	0.02	0.014 J	0.0092 J	0.016 J	0.0093 J
Nickel	20.7	4.8 J	2.7 J	4.3	3.2	8	3.7	6.9	4
Selenium	1.48	1	1	0.97 U	0.98 U	0.77 J	1.5	1.8	0.87 J
Silver	NE	0.2 U	0.19 U	0.84	0.2 U	0.21 U	0.2 U	0.2 U	0.2 U
Thallium	NE	0.2 U	0.19 U	0.054 J	0.068 J	0.21 U	0.2 U	0.2 U	0.16 J
Vanadium	259	46 J	37 J	21 J	22 J	60 J	40 J	64 J	34
Zinc	115	34	32	110	920	36	37	49	40

Notes/Qualifiers:
J - Estimated: The analyte was positively identified; the quantitation is an estimation
R - Rejected data; data is not usable
U - Not detected at the Limit of Detection
ft bgs - feet below ground surface
mg/kg - milligrams per kilogram
NAPR - Naval Activity Puerto Rico
NE - Not Established
Shaded Result exceeds NAPR Basewide Background

TABLE 6-3

SUMMARY OF DETECTED LABORATORY RESULTS - METALS IN SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPLINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID		74SB755	74SB756	74SB757	74SB758	74SB759	74SB759	74SB760
Sample ID	NAPR	74SB755-00	4SB756-0	4SB757-0	4SB758-0	74SB759-00	74SB759-00D	74SB760-00
Date	Basewide	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	Background	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)								
Antimony	3.17	2.2 U	1.8 J	2.1 U	2.1 U	2.1 U	2.1 U	2 U
Arsenic	2.65	2.9	21	3.7	5.1	5.2	4.3	6.8
Barium	199	54 J	38 J	44 J	17 J	15 J	13 J	20 J
Beryllium	0.59	0.095 J	0.059 J	0.099 J	0.06 J	0.11 U	0.1 U	0.099 U
Cadmium	1.02	1.8	0.7	0.11	0.51	0.11	0.079 J	0.18
Chromium	49.8	18	27	19	11	9.4	8.5	7.8
Cobalt	46.2	10	10 J	6.5 J	2.9 J	1.9 J	1.8 J	1.7 J
Copper	168	48	59	39	550	9.3	7.1	15
Lead	22.0	50 R	58	35	71	6.7	5.4	7.3
Mercury	0.109	0.012 J	0.21	0.021 U	0.015 J	0.02 U	0.0085 J	0.02 U
Nickel	20.7	8.5	27	9.1	3.9	4.2	2.6	2.2
Selenium	1.48	0.83 J	0.97 U	1.1 U	1.1 U	1.1 U	1 U	0.99 U
Silver	NE	0.16 J	0.1 J	0.21 U	0.83	0.21 U	0.21 U	0.2 U
Thallium	NE	0.21 J	0.061 J	0.21 U	0.21 U	0.21 U	0.21 U	0.2 U
Vanadium	259	62	29	48	31	15	18	13
Zinc	115	100	250	33	230	12	10	28

Notes/Qualifiers:
J - Estimated: The analyte was positively identified; the quantitation is an estimation
R - Rejected data; data is not usable
U - Not detected at the Limit of Detection
ft bgs - feet below ground surface
mg/kg - milligrams per kilogram
NAPR - Naval Activity Puerto Rico
NE - Not Established
Shaded Result exceeds NAPR Basewide Background

TABLE 6-4

SUMMARY OF DETECTED LABORATORY RESULTS - TPH IN SUBSURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	PREQB Screening Criteria	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID		74SB748-01	74SB748-01D	74SB749-01	74SB750-01	74SB751-01	74SB752-01	74SB753-01
Date		4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)		1.0-3.0	1.0-3.0	1.0-2.3	1.0-2.5	1.0-3.0	1.0-3.0	1.0-3.0
TPH DRO and GRO (mg/kg)								
Diesel Range Organics	100	3.7 U	3.6 U	37	15	32	20	31
Gasoline Range Organics	100	26 J	28 J	31 J	14 J	11 J	23 J	19 J
TPH Total	100	26 J	28 J	68 J	29 J	43 J	43 J	50 J

Notes/Qualifiers:
J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Not detected at the Limit of Detection
DRO - Diesel-Range Organics
ft bgs - feet below ground surface
GRO - Gasoline-Range Organics
mg/kg - milligrams per kilogram
PREQB - Puerto Rico Environmental Quality Board
TPH - Total Petroleum Hydrocarbons
Shaded Result exceeds PREQB screening criteria

TABLE 6-5

SUMMARY OF DETECTED LABORATORY RESULTS - ORGANICS IN SUBSURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID	74SB748-01	74SB748-01D	74SB749-01	74SB750-01	74SB751-01	74SB752-01	74SB753-01
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	1.0-3.0	1.0-3.0	1.0-2.3	1.0-2.5	1.0-3.0	1.0-3.0	1.0-3.0
Volatile Organics (µg/kg)							
None detected							
LLPAHs (µg/kg)							
Anthracene	7.5 U	7.4 U	72 U	6.1 J	74 U	7.3 U	72 U
Benzo[a]anthracene	7.5 U	7.4 U	72 U	23	72 J	7.3 U	72 U
Benzo[a]pyrene	7.5 U	7.4 U	66 J	45	63 J	7.3 U	25 J
Benzo[b]fluoranthene	7.5 U	7.4 U	110	45	74 U	4.7 J	72 U
Benzo[g,h,i]perylene	7.5 U	7.4 U	62 J	30	74 U	7.3 U	72 U
Benzo[k]fluoranthene	7.5 U	7.4 U	41 J	36	83	2.3 J	72 U
Chrysene	7.5 U	7.4 U	42 J	24	62 J	7.3 U	72 U
Dibenz(a,h)anthracene	7.5 U	7.4 U	72 U	10	74 U	7.3 U	72 U
Fluoranthene	7.5 U	7.4 U	72 U	10	110	7.3 U	72 U
Indeno[1,2,3-cd]pyrene	7.5 U	7.4 U	46 J	27	74 U	7.3 U	72 U
Phenanthrene	7.5 U	7.4 U	72 U	7.1 U	32 J	7.3 U	72 U
Pyrene	7.5 U	7.4 U	72 U	15	110	7.3 U	72 U
LLPAH Totals (µg/kg)							
Low molecular weight PAHs	60	59.2	576	58.7	586	58.4	576
High molecular weight PAHs	67.5	66.6	583	255	686	58.1	601

Notes/Qualifiers:
J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Not detected at the Limit of Detection
ft bgs - feet below ground surface
LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons
µg/kg - micrograms per kilogram

TABLE 6-6

SUMMARY OF DETECTED LABORATORY RESULTS - METALS IN SUBSURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPLINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	NAPR Basewide Background	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID		74SB748-01	74SB748-01D	74SB749-01	74SB750-01	74SB751-01	74SB752-01	74SB753-01
Date		4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)		1.0-3.0	1.0-3.0	1.0-2.3	1.0-2.5	1.0-3.0	1.0-3.0	1.0-3.0
Metals (mg/kg)								
Antimony	7.44	2.1 U	2.2 U	2.9	2.1 U	2.1 U	2.1 U	2.1 U
Arsenic	6.66	3.5	2.6	3.4	3.3	4.1	2	3.6
Barium	207	11 J	9.7 J	21 J	34 J	56 J	9.7 J	35 J
Beryllium	0.933	0.11 U	0.11 U	0.11 U	0.11 U	0.054 J	0.11 U	0.072 J
Cadmium	0.57	0.11 U	0.11 U	2.8	0.029 J	0.044 J	0.11 U	0.11 U
Chromium	47.9	3.5	2.4	13	4.7	10	11	5.1
Cobalt	63.1	0.37	0.22	1.7	0.97	2	0.57	2.2
Copper	120	1.9	1.5	53	4.5	7.7	2.2	28
Lead	6.2	0.32 J	0.28 J	110	3.8	3.7	0.97	6.4
Mercury	0.067	0.021 U	0.021 U	0.027	0.0098 J	0.016 J	0.011 J	0.012 J
Nickel	26.5	1.2	0.82 J	4.2	1.7	2.6	1.9	2.9
Silver	NE	0.21 U	0.22 U	0.4	0.21 U	0.21 U	0.21 U	0.21 U
Thallium	NE	0.057 J	0.22 U	0.22 U	0.21 U	0.21 U	0.21 U	0.21 U
Vanadium	256	5.1 J	3.3 J	14 J	11 J	20 J	5.5 J	20 J
Zinc	92	1.9 J	4.3 U	110	39	16	2.4 J	11

Notes/Qualifiers:
J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Not detected at the Limit of Detection
ft bgs - feet below ground surface
mg/kg - milligrams per kilogram
NAPR - Naval Activity Puerto Rico
NE - Not Established
Shaded Result exceeds NAPR Basewide Background

TABLE 6-7

SUMMARY OF LINEAR REGRESSION RESULTS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Frequency of	TPH Gasoline-Range Organics			TPH Diesel-Range Organics			Total TPH			
	Detection	Linear Regression		Correlation	Linear Regression		Correlation	Linear Regression		Correlation	
Constituent	**(FOD)**	**Slope**	**R^2**	**(Yes/No)**	**Slope**	**R^2**	**(Yes/No)**	**Slope**	**R^2**	**(Yes/No)**	**Comments**
Volatile Organics											
Carbon disulfide	11%										Not evaluated; FOD < 50%
LLPAHs											
2-Methylnaphthalene	5%										Not evaluated; FOD < 50%
Acenaphthene	9%										Not evaluated; FOD < 50%
Acenaphthylene	18%										Not evaluated; FOD < 50%
Anthracene	36%										Not evaluated; FOD < 50%
Benzo[a]anthracene	50%	0.0001	0.0000	No	0.0780	0.0361	No	0.0034	0.0017	No	
Benzo[a]pyrene	77%	-0.0015	0.0002	No	0.1060	0.0500	No	0.0032	0.0011	No	
Benzo[b]fluoranthene	59%	-0.0136	0.0087	No	-0.0266	0.0017	No	-0.0120	0.0084	No	
Benzo[g,h,i]perylene	59%	-0.0033	0.0022	No	0.1047	0.1157	No	0.0017	0.0008	No	
Benzo[k]fluoranthene	64%	-0.0084	0.0047	No	0.0015	0.0000	No	-0.0066	0.0036	No	
Chrysene	68%	-0.0061	0.0023	No	0.0134	0.0006	No	-0.0043	0.0014	No	
Dibenz(a,h)anthracene	23%										Not evaluated; FOD < 50%
Fluoranthene	55%	-0.0155	0.0059	No	0.0184	0.0004	No	-0.0117	0.0042	No	
Fluorene	9%										Not evaluated; FOD < 50%
Indeno[1,2,3-cd]pyrene	55%	0.0120	0.0432	No	0.1277	0.2508	Yes	0.0150	0.0838	No	
Phenanthrene	50%	0.0093	0.0141	No	0.0721	0.0432	No	0.0106	0.0224	No	
Pyrene	59%	-0.0193	0.0079	No	-0.0311	0.0011	No	-0.0168	0.0074	No	
Metals											
Antimony	11%										Not evaluated; concentrations < background
Arsenic	100%	-0.0012	0.0249	No	-0.0090	0.0794	No	-0.0013	0.0399	No	
Barium	100%										Not evaluated; concentrations < background
Beryllium	54%										Not evaluated; concentrations < background
Cadmium	71%	-0.0001	0.0091	No	-0.0001	0.0001	No	-0.0001	0.0076	No	
Chromium, total	100%										Not evaluated; concentrations < background
Cobalt	100%										Not evaluated; concentrations < background
Copper	89%	-0.0120	0.0031	No	-0.0592	0.0041	No	-0.0122	0.0040	No	
Lead	85%	-0.0064	0.0088	No	0.0032	0.0001	No	-0.0050	0.0066	No	
Mercury	64%	0.0000	0.0000	No	0.0000	0.0000	No	0.0000	0.0000	No	
Nickel	100%	0.0001	0.0001	No	0.0042	0.0086	No	0.0003	0.0009	No	
Selenium	29%										Not evaluated; FOD < 50%
Silver	25%										Not evaluated; concentrations < background
Thallium	21%										Not evaluated; concentrations < background
Vanadium	100%										Not evaluated; concentrations < background
Zinc	93%	-0.0167	0.0020	No	-0.0304	0.0004	No	-0.0146	0.0019	No	

Notes:
LLPAHs - Low Level Polynuclear Aromatic Hydrocarbons
TPH - Total Petroleum Hydrocarbons

TABLE 6-8

SUMMARY OF DETECTED LABORATORY RESULTS - QA/QC SAMPLES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Equipment Rinsate Blanks				**Field Blank**	**Trip Blanks**		
Sample ID	74ER114	74ER115	74ER116	74ER117	74FB01	74TB114	74TB115	74TB117
Date	4/18/2011	4/19/2011	4/19/2011	4/29/2011	4/18/2011	4/18/2011	4/19/2011	4/29/2011
Volatile Organics (µg/L)								
Acetone	25 U	NA	25 U	41	25 U	25 U	25 U	25 U
Chloroform	1 U	NA	1 U	0.72 J	1 U	1 U	1 U	1 U
Methylene Chloride	5 U	NA	5 U	74	5 U	5 U	5 U	5 U
Toluene	1 U	NA	1 U	0.52 J	1 U	1 U	1 U	1 U
LLPAHs (µg/L)								
Naphthalene	0.19 U	0.19 U	0.19 U	0.3	0.19 U	NA	NA	NA
Total Metals (µg/L)								
Barium	11	NA	5 U	5 U	9.1	NA	NA	NA
Copper	1.6 J	NA	5 U	5 U	5 U	NA	NA	NA
TPH DRO and GRO (µg/L)								
Diesel Range Organics	0.024 J	NA	0.12	0.036 J	0.034 J	NA	NA	NA
Gasoline Range Organics	0.05 U	NA	0.05 U	0.013 J	0.05 U	50 U	0.05 U	0.05 U
TPH Total	0.024 J	NA	0.12	0.049 J	0.034 J	50 U	0.05 U	0.05 U

Notes/Qualifiers:
U - Not detected at the Limit of Detection
J - Estimated: The analyte was positively identified; the quantitation is an estimation
DRO - Diesel-Range Organics
GRO - Gasoline-Range Organics
LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons
µg/L - micrograms per liter
TPH - Total Petroleum Hydrocarbons

TABLE 6-9

PERCENT COMPLETENESS BY METHOD AND MATRIX
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Matrix	Parameter Class	Analytical Method	Total Unique Results	Fully Rejected Results	Difference	Percent Complete
Surface Soil	VOCs	8260B	795	0	795	100%
	LLPAHs	8270C	255	0	255	100%
	Metals	6020A/ 7470A/7471A	255	2	253	99.2%
	TPH	8015B	30	0	30	100%
Subsurface Soil	VOCs	8260B	371	0	371	100%
	LLPAHs	8270C	119	0	119	100%
	Metals	6020A/ 7470A/7471A	119	0	119	100%
	TPH	8015B	14	0	14	100%
Groundwater	LLPAHs	8270C	34	0	34	100%
Total			1992	2	1990	**99.9%**

Notes:
LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons
TPH - Total Petroleum Hydrocarbons
VOCs - Volatile Organic Compounds

TABLE 7-1
LIST OF BIRDS REPORTED FROM OR HAVING THE POTENTIAL TO OCCUR AT NAVAL ACTIVITY PUERTO RICO
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Common Name (1)		
Pied-billed grebe	Red-billed tropicbird	Brown pelican
Brown booby	Magnificent frigatebird	Great blue heron
Louisiana heron	Snowy egret	Great egret
Striated heron	Little blue heron	Cattle egret
Least bittern	Yellow-crowned night heron	Black-crowned night heron
White-cheeked pintail	Blue-winged teal	American widgeon
Red-tailed hawk	Osprey	Merlin
Clapper rail	American coot	Caribbean coot
Common gallinule	Piping plover (3)(4)	Semipalmated plover
Black-bellied plover	Wilson's plover	Killdeer
Ruddy turnstone	Black-necked stilt	Whimbrel
Spotted sandpiper	Semipalmated sandpiper	Short-billed dowitcher
Greater yellowlegs	Lesser yellowlegs	Willet
Stilt sandpiper	Pectoral sandpiper	Laughing gull
Royal tern	Sandwich tern	Bridled tern
Least tern	Brown noddy	White-winged dove
Zenaida dove	White-crowned pigeon	Mourning dove
Red-necked pigeon	Common ground dove	Bridled quail dove
Ruddy quail dove	Caribbean parakeet	Smooth-billed ani
Yellow-billed cuckoo	Mangrove cuckoo	Short-eared owl
Chuck-will's-widow	Common nighthawk	Antillean crested hummingbird
Green-throated carib	Antillean mango	Belted kingfisher

TABLE 7-1
LIST OF BIRDS REPORTED FROM OR HAVING THE POTENTIAL TO OCCUR AT NAVAL ACTIVITY PUERTO RICO
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Common Name [1]		
Gray kingbird	Loggerhead kingbird	Stolid flycatcher
Caribbean elaenia	Purple martin	Cave swallow
Barn swallow	Northern mockingbird	Pearly-eyed thrasher
Red-legged thrush	Black-whiskered vireo	American redstart
Parula warbler	Prairie warbler	Yellow warbler
Magnolia warbler	Cape May warbler	Black-throated blue warbler
Adelaide's warbler	Palm warbler	Black and white warbler
Ovenbird	Northern water thrush	Bananaquit
Striped-headed tanager	Shiny cowbird	Black-cowled oriole
Greater Antillean grackle	Yellow-shouldered blackbird [2]	Hooded manakin
Yellow-faced grassquit	Black-faced grassquit	Least sandpiper
Western sandpiper	Puerto Rican woodpecker	Rock dove
Puerto Rican emerald	Puerto Rican flycatcher	Pin-tailed whydah
Spice finch	Ruddy duck	Peregrine falcon
Marbled godwit	Puerto Rican lizard cuckoo	Prothonotary warbler
Green-winged teal	Orange-cheeked waxbill	Roseate tern [3][4]
Least grebe	West Indian whistling duck	Puerto Rican screech owl
Puerto Rican tody	Green heron	

Notes:

(1) List of birds taken from Geo-Marine, Inc. (1998).
(2) Federally-designated endangered species.
(3) Federally-designated threatened species.
(4) Species has the potential to occur at Naval Activity Puerto Rico.

TABLE 7-2
PRELIMINARY ASSESSMENT ENDPOINTS, RISK QUESTIONS, AND MEASUREMENT ENDPOINTS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Assessment Endpoints	Risk Questions	Measurement Endpoints
Terrestrial Habitat:		
Survival, growth, and reproduction of terrestrial soil invertebrate communities.	Are site-related chemical concentrations in surface and subsurface soil sufficient to adversely affect terrestrial soil invertebrate communities?	Comparison of maximum chemical concentrations in surface and subsurface soil with soil screening values.
Survival, growth, and reproduction of terrestrial plant communities.	Are site-related chemical concentrations in surface and subsurface soil sufficient to adversely affect terrestrial plant communities?	Comparison of maximum chemical concentrations in surface and subsurface soil with soil screening values.
Survival, growth, and reproduction of flying mammalian herbivores (i.e., bats).	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to flying mammal species (i.e., bats) that may consume terrestrial plants from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface and subsurface soil.
Survival, growth, and reproduction of terrestrial avian herbivores.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume terrestrial plants from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface and subsurface soil.
Survival, growth, and reproduction of terrestrial avian omnivores.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume terrestrial plants and soil invertebrates from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface and subsurface soil.
Survival, growth, and reproduction of terrestrial avian carnivores.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian species that may consume small mammals from the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum chemical concentrations in surface and subsurface soil.

TABLE 7-2
PRELIMINARY ASSESSMENT ENDPOINTS, RISK QUESTIONS, AND MEASUREMENT ENDPOINTS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Assessment Endpoints	Risk Questions	Measurement Endpoints
Terrestrial Habitat (continued): Survival, growth, and reproduction of terrestrial reptile communities.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial reptiles?	Qualitative examination of exposures and risks to ecological receptors occupying similar trophic levels.
Survival, growth, and reproduction of terrestrial amphibian communities.	Are site-related chemical concentrations in surface and subsurface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial amphibians?	Qualitative examination of exposures and risks to ecological receptors occupying similar trophic levels.

TABLE 7-3
LOG K_{ow} AND K_{oc} VALUES FOR ORGANIC CHEMICALS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Log K_{ow} Range	Recommended Log K_{ow}	Reference	K_{oc} [1] (L/Kg)	Bioaccumulative Chemical [2]
Volatile Organics:					
1,1,1,2-Tetrachloroethane	2.63 to 3.03	2.63	USEPA 1995	385	Yes
1,1,1-Trichloroethane	2.47 to 2.51	2.48	USEPA 1995	274	No
1,1,2,2-Tetrachloroethane	2.31 to 2.64	2.39	USEPA 1995	224	No
1,1,2-Trichloroethane	2.03 to 2.07	2.05	USEPA 1995	104	No
1,1-Dichloroethane	1.78 to 1.85	1.79	USEPA 1995	57.5	No
1,1-Dichloroethene	2.13 to 2.37	2.13	USEPA 1995	124	No
1,2,3-Trichloropropane	1.98 to 2.63	2.25	USEPA 1995	163	No
1,2-Dibromo-3-chloropropane	2.26 to 2.41	2.34	USEPA 1995	200	No
1,2-Dichloroethane	1.4 to 1.48	1.47	USEPA 1995	27.9	No
1,2-Dichloropropane	1.94 to 1.99	1.97	USEPA 1995	86.5	No
2-Butanone (MEK)	0.28 to 0.69	0.28	USEPA 1995	1.89	No
2-Chloro-1,3-butadiene	2.03 to 2.13	2.08	USEPA 1995	124.00	No
2-Hexanone	Not Reported	1.38	USEPA 2011	22.7	No
3-Chloro-1-propene	Not Reported	1.93	USEPA 2011	79.0	No
4-Methyl-2-pentanone (MIBK)	Not Reported	1.31	USEPA 2011	19.4	No
Acetone	-0.21 to -0.24	-0.24	USEPA 1995	0.58	No
Acetonitrile	-0.34 to -0.39	-0.34	USEPA 1995	0.46	No
Acrolein	-0.01 to 0.90	-0.01	USEPA 1995	0.98	No
Acrylonitrile	-0.92 to 1.20	0.25	USEPA 1995	1.76	No
Benzene	1.83 to 2.50	2.13	USEPA 1995	124	No
Bromoform	2.30 to 2.38	2.35	USEPA 1995	204	No
Bromomethane	Not Reported	1.19	USEPA 2011	14.8	No
Carbon disulfide	1.84 to 2.16	2.00	USEPA 1995	92.5	No
Carbon tetrachloride	2.03 to 3.10	2.73	USEPA 1995	483	Yes
Chlorobenzene	2.56 to 3.79	2.86	USEPA 1995	648	Yes
Clorodibromomethane	2.13 to 2.24	2.17	USEPA 1995	136	No
Chloroethane	Not Reported	1.43	USEPA 2011	25.5	No
Chloroform	1.81 to 3.04	1.92	USEPA 1995	77.2	Yes
Chloromethane	Not Reported	0.91	USEPA 2011	7.85	No
cis-1,3-Dichloropropene	Not Reported	2.03	USEPA 2011	99.0	No
Dibromomethane	Not Reported	1.70	USEPA 2011	46.9	No
Dichlorobromomethane	1.88 to 2.14	2.10	USEPA 1995	116	No
Dichlorodifluoromethane	2.0 to 2.37	2.16	USEPA 1995	133	No
Ethylbenzene	3.07 to 3.57	3.14	USEPA 1995	1,222	Yes
Ethylene dibromide	Not Reported	1.96	USEPA 2011	84.5	No
Ethyl methacrylate	1.59 to 1.65	1.59	USEPA 2011	36.6	No
Iodomethane	Not Reported	1.51	USEPA 2011	30.5	No
Isobutyl alcohol	0.65 to 0.76	0.75	USEPA 1995	5.46	No
Methacrylonitrile	0.54 to 0.70	0.68	USEPA 2011	4.66	No
Methylene chloride	1.22 to 1.40	1.25	USEPA 1995	16.9	No
Methyl methacrylate	1.11 to 1.38	1.38	USEPA 1995	22.7	No
Pentachloroethane	Not Reported	3.22	USEPA 2011	1,464	Yes
Propionitrile	Not Reported	0.16	USEPA 2011	1.44	No
Styrene	2.76 to 3.16	2.94	USEPA 1995	777	Yes
Tetrachloroethene	2.53 to 2.98	2.67	USEPA 1995	422	No

TABLE 7-3
LOG K_{ow} AND K_{oc} VALUES FOR ORGANIC CHEMICALS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Log K_{ow} Range	Recommended Log K_{ow}	Reference	K_{oc} [1] (L/Kg)	Bioaccumulative Chemical [2]
Volatile Organics:					
Toluene	2.21 to 3.13	2.75	USEPA 1995	505	Yes
trans-1,2-Dichloroethene	1.77 to 2.10	2.07	USEPA 1995	108	No
trans-1,3-Dichloropropene	Not Reported	2.03	USEPA 2011	99.0	No
trans-1,4-Dichloro-2-butene	Not Reported	2.60	USEPA 2011	360	No
Trichloroethene	2.42 to 3.14	2.71	USEPA 1995	462	Yes
Trichlorofluoromethane	2.44 to 2.58	2.53	USEPA 1995	307	No
Vinyl acetate	0.21 to 0.83	0.73	USEPA 1995	5.22	No
Vinyl chloride	1.23 to 1.52	1.50	USEPA 1995	29.8	No
Xylenes (total) [3]	2.77 to 3.54	3.13	USEPA 1995	1,194	Yes
PAHs:					
2-Methylnaphthalene	Not Reported	3.86	USEPA 2011	6,232	Yes
Acenaphthene	3.77 to 4.49	3.92	USEPA 1995	7,139	Yes
Acenaphthylene	Not Reported	3.94	USEPA 2011	7,470	Yes
Anthracene	3.45 to 4.80	4.55	USEPA 1995	29,712	Yes
Benzo(a)anthracene	4.00 to 5.79	5.70	USEPA 1995	401,218	Yes
Benzo(a)pyrene	5.98 to 6.42	6.11	USEPA 1995	1,014,869	Yes
Benzo(b)fluoranthene	5.79 to 6.40	6.20	USEPA 1995	1,244,171	Yes
Benzo(g,h,i)perylene	6.63 to 7.05	6.70	USEPA 1995	3,858,158	Yes
Benzo(k)fluoranthene	6.12 to 6.27	6.20	USEPA 1995	1,244,171	Yes
Chrysene	5.41 to 5.79	5.70	USEPA 1995	401,218	Yes
Dibenzo(a,h)anthracene	6.50 to 6.88	6.69	USEPA 1995	3,771,812	Yes
Fluoranthene	4.31 to 5.39	5.12	USEPA 1995	107,954	Yes
Fluorene	4.04 to 4.40	4.21	USEPA 1995	13,763	Yes
Indeno(1,2,3-cd)pyrene	6.58 to 6.72	6.65	USEPA 1995	3,445,323	Yes
Naphthalene	3.01 to 4.70	3.36	USEPA 1995	2,010	Yes
Phenanthrene	4.28 to 4.57	4.55	USEPA 1995	29,712	Yes
Pyrene	4.76 to 5.52	5.11	USEPA 1995	105,538	Yes

Notes:

K_{ow} = Octanol-Water Partition Coefficient
K_{oc} = Organic Carbon Partition Coefficient
L/kg = liter per kilogram
PAH = Polynuclear Aromatic Hydrocarbon
USEPA = United States Environmental Protection Agency

(1) K_{oc} values were estimated from the following equation: Log K_{oc} = 0.00028 + (0.983)(Log K_{ow}) (USEPA 1993 and 1996).

(2) An organic chemical is considered a bioaccumulative chemical if its Log K_{ow} value is greater than or equal to 3.0. When a range of Log K_{ow} values was reported, the upper value within the range was conservatively used to identify bioaccumulative chemicals.

(3) The K_{ow} values shown are for o-xylene

TABLE 7-3

LOG K_{ow} AND K_{oc} VALUES FOR ORGANIC CHEMICALS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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USEPA. 1995. Internal Report on Summary of Measured, Calculated and Recommended Log K_{ow} Values. Environmental Research Laboratory, Athens, GA. April 10, 1995.

USEPA. 1993. Technical Basis for Deriving Sediment Quality Criteria for Nonionic Organic Contaminants for the Protection of Benthic Organisms by Using Equilibrium Partitioning. Office of Water, Washington, D.C. EPA-822-R-93-011.

TABLE 7-4
SOIL SCREENING VALUES FOR PLANTS AND INVERTEBRATES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Soil Screening Value	Reference	Comment
Volatile Organics (µg/kg):			
1,1,1,2-Tetrachloroethane	100	CCME 2007	Canadian soil quality guideline based on agricultural land uses
1,1,1-Trichloroethane	100	CCME 2007	Canadian soil quality guideline based on agricultural land uses
1,1,2,2-Tetrachloroethane	100	CCME 2007	Canadian soil quality guideline based on agricultural land uses
1,1,2-Trichloroethane	100	CCME 2007	Canadian soil quality guideline based on agricultural land uses
1,1-Dichloroethane	100	CCME 2007	Canadian soil quality guideline based on agricultural land uses
1,1-Dichloroethene	100	CCME 2007	Canadian soil quality guideline based on agricultural land uses
1,2,3-Trichloropropane	NA	---	---
1,2-Dibromo-3-chloropropane	NA	---	---
1,2-Dichloroethane	402 (1)	MHSPE 2000	---
1,2-Dichloropropane	700,000	Efroymson et al. 1997a	Toxicological threshold for earthworms
2-Butanone (MEK)	NA	---	---
2-Chloro-1,3-butadiene	NA	---	---
2-Hexanone	NA	---	---
3-Chloro-1-propene	NA	---	---
4-Methyl-2-pentanone (MIBK)	NA	---	---
Acetone	NA	---	---
Acetonitrile	NA	---	---
Acrolein	NA	---	---
Acrylonitrile	1,000,000	Efroymson et al. 1997a	Toxicological threshold for soil microorganisms and microbial processes
Benzene	101 (1)	MHSPE 2000	---
Bromoform	NA	---	---
Bromomethane	NA	---	---
Carbon disulfide	NA	---	---
Carbon tetrachloride	1,000,000	Efroymson et al. 1997a	Toxicological threshold for soil microorganisms and microbial processes
Chlorobenzene	40,000	Efroymson et al. 1997a	Toxicological threshold for earthworms
Chlorodibromomethane	NA	---	---
Chloroethane	NA	---	---
Chloroform	1,002 (1)	MHSPE 2000	---
Chloromethane	NA	---	---
cis-1,3-Dichloropropene	100	CCME 2007	Canadian soil quality guideline based on agricultural land uses
Dibromomethane	NA	---	---
Dichlorobromomethane	NA	---	---

TABLE 7-4
SOIL SCREENING VALUES FOR PLANTS AND INVERTEBRATES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Soil Screening Value	Reference	Comment
Volatile Organics (µg/kg):			
Dichlorodifluoromethane	NA	---	---
Ethylbenzene	5,003 (1)	MHSPE 2000	---
Ethylene dibromide	300	CCME 2007	Canadian soil quality guideline based on agricultural land uses
Ethyl methacrylate	NA	---	---
Iodomethane	NA	---	---
Isobutyl alcohol	NA	---	---
Methacrylonitrile	NA	---	---
Methylene chloride	1,040 (1)	MHSPE 2000	---
Methyl methacrylate	NA	---	---
Pentachloroethane	NA	---	---
Propionitrile	NA	---	---
Styrene	10,030 (1)	MHSPE 2000	---
Tetrachloroethene	400 (1)	MHSPE 2000	---
Toluene	13,001 (1)	MHSPE 2000	---
trans-1,2-Dichloroethene	100	CCME 2007	Canadian soil quality guideline based on agricultural land uses
trans-1,3-Dichloropropene	100	CCME 2007	Canadian soil quality guideline based on agricultural land uses
trans-1,4-Dichloro-2-butene	1,000,000	Efroymson et al. 1997a	Toxicological threshold for soil microorganisms and microbial processes
Trichloroethene	6,010 (1)	MHSPE 2000	---
Trichlorofluoromethane	NA	---	---
Vinyl acetate	NA	---	---
Vinyl chloride	11.0 (1)	MHSPE 2000	---
Xylenes (total)	1,000	USEPA 2003	Region 5 ecological screening level based on exposure to plants
PAHs (µg/kg):			
Low molecular weight PAHs (2)	29,000	USEPA 2007a	Ecological soil screening level for soil invertebrates
High molecular weight PAHs (3)	18,000	USEPA 2007a	Ecological soil screening level for soil invertebrates
Metals (mg/kg):			
Antimony	78.0	USEPA 2005a	Ecological soil screening level for soil invertebrates
Arsenic	18.0	USEPA 2005b	Ecological soil screening level for plants
Barium	330	USEPA 2005c	Ecological soil screening level for soil invertebrates
Beryllium	40.0	USEPA 2005d	Ecological soil screening level for soil invertebrates

TABLE 7-4
SOIL SCREENING VALUES FOR PLANTS AND INVERTEBRATES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Soil Screening Value	Reference	Comment
Metals (mg/kg):			
Cadmium	32.0	USEPA 2005e	Ecological soil screening level for plants
Chromium, total	57.0	USEPA 2008	Reproduction-based MATC for *Eisenia andrei* (earthworm)
Cobalt	13.0	USEPA 2005f	Ecological soil screening level for plants
Copper	70.0	USEPA 2007b	Ecological soil screening level for plants
Lead	120	USEPA 2005g	Ecological soil screening level for plants
Mercury	0.10	Efroymson et al. 1997a	Toxicological threshold for earthworms
Nickel	38.0	USEPA 2007c	Ecological soil screening level for plants
Selenium	0.52	USEPA 2007d	Ecological soil screening level for plants
Silver	560	USEPA 2006	Ecological soil screening level for plants
Thallium	1.00	Efroymson et al. 1997b	Toxicological threshold for plants
Tin	50.0	Efroymson et al. 1997b	Toxicological threshold for plants
Vanadium	20.0	USEPA 2005h	Growth-based LOAEC for *Brassica oleracea* (broccoli) with a safety factor of 5 [(4)]
Zinc	120	USEPA 2007e	Ecological soil screening level for soil invertebrates

Notes:

NA = Not Available
MHSPE = Ministry of Housing, Spatial Planning and Environment
CCME = Canadian Council of Ministers of the Environment
USEPA = United States Environmental Protection Agency
MATC = Maximum Acceptable Toxicant Concentration
LOAEC = Lowest Observed Adverse Effect Concentration
PAH = Polynuclear Aromatic Hydrocarbon
µg/kg = microgram per kilogram
mg/kg = milligram per kilogram

(1) The screening value shown is an average of the target and intervention soil standards for soil remediation. The value is based on a default organic carbon content of 0.02 (2 percent), which represents a minimum value (adjustment range is 2 to 30 percent).

(2) Low molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of fewer than four rings. The low molecular weight PAH compounds analyzed for in SWMU 74 (fueling piers area) soil were 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene.

(3) High molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of four or more rings. The high molecular weight PAH compounds analyzed for in SWMU 74 (fueling piers area) soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene.

(4) The safety factor applied to the growth-based LOAEC is the value recommended by Wentsel et al. (1996) for converting a chronic LOAEL to a chronic NOAEL.

TABLE 7-4
SOIL SCREENING VALUES FOR PLANTS AND INVERTEBRATES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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USEAP. 2007d. Ecological Soil Screening Levels for Selenium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-72.

USEPA. 2007e. Ecological Soil Screening Levels for Zinc (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-73.

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USEPA. 2005a. Ecological Soil Screening Levels for Antimony (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-61.

USEPA. 2005b. Ecological Soil Screening Levels for Arsenic (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-62.

USEPA. 2005c. Ecological Soil Screening Levels for Barium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-63.

TABLE 7-4
SOIL SCREENING VALUES FOR PLANTS AND INVERTEBRATES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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USEPA. 2005f. Ecological Soil Screening Levels for Cobalt (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-67

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TABLE 7-5
TOXICITY REFERENCE VALUES FOR BIRDS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	Test Material	NOAEL (mg/kg/d)	MATC [1] (mg/kg/d)	LOAEL (mg/kg/d)	Source Document [2]	Comments
Volatile Organics:											
1,1,1,2-Tetrachloroethane	---	---	---	---	---	---	NA	NA	NA	---	---
Carbon tetrachloride	---	---	---	---	---	---	NA	NA	NA	---	---
Chlorobenzene	---	---	---	---	---	---	NA	NA	NA	---	---
Chloroform	---	---	---	---	---	---	NA	NA	NA	---	---
Ethylbenzene	---	---	---	---	---	---	NA	NA	NA	---	---
Pentachloroethane	---	---	---	---	---	---	NA	NA	NA	---	---
Styrene	---	---	---	---	---	---	NA	NA	NA	---	---
Toluene	---	---	---	---	---	---	NA	NA	NA	---	---
Trichloroethene	---	---	---	---	---	---	NA	NA	NA	---	---
Xylenes (total)	Quail	0.191	Unknown	Oral in diet	Mortality	---	40.5 [3]	90.7	203 [4]	Hill and Camardese 1986	---
PAHs:											
2-Methylnaphthalene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Acenaphthene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Acenaphthylene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Anthracene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Benzo(a)anthracene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Benzo(a)pyrene	White leghorn chicken	1.50	35 days	Oral in diet	Reproduction	Not Applicable	39.5	88.4	198 [5]	Rigdon and Neal 1963	---
Benzo(b)fluoranthene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Benzo(g,h,i)perylene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Benzo(k)fluoranthene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Chrysene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Dibenz(a,h)anthracene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Fluoranthene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Fluorene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Indeno(1,2,3-cd)pyrene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Naphthalene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Phenanthrene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Pyrene	---	---	---	---	---	---	39.5	88.4	198	---	Values for benzo(a)pyrene used as surrogates
Metals:											
Antimony	Northern bobwhite	0.19	6 weeks	Oral	Unknown	Unknown	4,740	14,989	47,400	Opresko et al. 1993	---
Arsenic	Chicken	1.6	19 days	Oral in diet	Growth	Arsenic oxide	2.24 [6]	3.18	4.51 [7]	USEPA 2005a [13]	---
Barium	One-day old chicks	0.121	4 weeks	Oral in diet	Mortality	Barium hydroxide	20.8	29.5	41.7	Sample et al. 1996 [13]	---
Beryllium	---	---	---	---	---	---	NA	NA	NA	---	---
Cadmium	Multiple species	Various	Various	Oral in diet/water	Reproduction/growth	Cadmium, cadmium sulfate, and cadmium chloride	1.47 [8]	3.06	6.36 [9]	USEPA 2005b	---
Chromium (total)	Multiple species	Various	Various	Oral in diet	Reproduction/growth	Sodium and potassium dichromate	2.66 [8][10]	6.44	15.6 [9]	USEPA 2008	---
Cobalt	Multiple species	Various	Various	Oral in diet	Growth	Cobalt, cobalt chloride, and cobalt	7.61 [8]	11.8	18.3 [9]	USEPA 2005c	---
Copper	Chicken	1.52	84 days	Oral in diet	Reproduction	Copper	4.05 [11]	7.00	12.1	USEPA 2007a [13]	---
Lead	Chicken	1.81	4 weeks	Oral in diet	Reproduction	Lead acetate	1.63 [11]	2.31	3.26	USEPA 2005d [13]	---
Mercury	Mallard duck	1.00	3 generations	Oral in diet	Reproduction	Methyl mercury dicyandiamide	0.026	0.045	0.078	USEPA 1997a [13]	---
Nickel	Multiple species	Various	Various	Oral in diet	Reproduction/growth	Nickel acetate, chloride, and sulfate	6.71 [8]	11.2	18.6 [9]	USEPA 2007b	---
Selenium	Chicken	0.328	2 weeks	Oral in diet	Mortality	Sodium selenite	0.29 [11]	0.410	0.579	USEPA 2007c [13]	---
Silver	Turkey	0.662	5 weeks	Oral in diet	Growth	Silver acetate	2.02 [12]	6.39	20.2	USEPA 2006	---
Thallium	European starling	Unknown	acute	Oral	Survival	Unknown	0.35 [3]	0.78	1.75 [4]	USEPA 1999 [13]	---
Tin	Japanese quail	0.15	6 weeks	Oral in diet	Reproduction	bis(Tributyltin)-oxide	6.80	11	16.9	Sample et al. 1996 [13]	---
Vanadium	Chicken	1.042	5 weeks	Oral in diet	Growth	Sodium metavanadate	0.344 [11]	0.486	0.688	USEPA 2005e[13]	---
Zinc	Multiple species	Various	Various	Oral in diet	Reproduction/growth	Zinc carbonate, oxide, and sulfate	66.1 [8]	106	171 [9]	USEPA 2007d	---

TABLE 7-5
TOXICITY REFERENCE VALUES FOR BIRDS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes:

PAH = Polynuclear Aromatic Hydrocarbon
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level
MATC = Maximum Acceptable Toxicant Concentration
USEPA = United States Environmental Protection Agency
mg/kg/d = milligram per kilogram-body weight per day
NA = Not Available
kg = kilogram

(1) MATC values were derived by calculating the geometric mean of the NOAEL and LOAEL values (values were calculated by Michael Baker Jr. Inc.).
(2) Source documents for NOAEL and LOAEL values represent primary data sources (as reported by original authors) unless otherwise noted.
(3) The chronic NOAEL value was estimated by applying a safety factor of 100 to a LD_{50} value (Wentsel et al., 1996 and USEPA, 1997b).
(4) A chronic LOAEL value was not available from the study used as the source of the chronic NOAEL value. Therefore, the chronic LOAEL value was estimated by applying a safety factor of 5 to the chronic NOAEL value (Wentsel et al., 1996).
(5) A chronic NOAEL value was not available from the study used as the source of the chronic LOAEL value. Therefore, the chronic NOAEL value shown was estimated by applying a safety factor of 5 to the chronic LOAEL value (Wentsel et al., 1996).
(6) The NOAEL value represents the lowest value of all reproduction, growth, and survival-based NOAEL values listed in the cited ecological soil screening levels document that meet the required data evaluation score. The value was used by the USEPA to derive the avian ecological soil screening level. It is noted that a geometric mean of NOAEL values for growth and reproduction could not be calculated by the USEPA because insufficient NOAEL values meeting the minimum required data evaluation score were identified from the literature.
(7) A LOAEL value was not available from the study chosen by the USEPA as the source of the NOAEL value selected as the ecological soil screening level. Therefore, the LOAEL value represents a geometric mean of all reproduction- and growth-based LOAEL values listed within the cited ecological soil screening level document that meet the minimum required data evaluation score (value was calculated by Michael Baker Jr. Inc.).
(8) The NOAEL value represents the geometric mean of all reproduction and growth-based NOAEL values listed within the cited ecological soil screening level document that meet the minimum required data evaluation score. Because this value is lower than the lowest bounded LOAEL for reproduction, growth, or survival, it was selected by the USEPA as the toxicity reference value for avian ecological soil screening level development.
(9) The NOAEL value selected by the USEPA as the ecological soil screening level represents a geometric mean of all reproduction and growth-based NOAEL values that meet the minimum required data evaluation score. Therefore, the LOAEL value shown represents a geometric mean of all reproduction and growth-based LOAEL values listed within the cited ecological soil screening level document that meet the minimum required data evaluation score (value was calculated by Michael Baker Jr. Inc.).
(10) The NOAEL value shown is for trivalent chromium.
(11) The NOAEL value shown represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival listed within the cited ecological soil screening levels that meet the minimum required data evaluation score. The value was used by the USEPA as the toxicity reference value for avian ecological soil screening value development. It is noted that a geometric mean of available NOAEL values for growth and reproduction was not used as the toxicity reference value by the USEPA for ecological soil screening value development since the geometric mean is higher than the lowest bounded LOAEL for reproduction, growth, and survival.
(12) The NOAEL is equal to the lowest value of all reproduction- and growth-based LOAELs listed in the cited ecological soil screening levels document that meet the minimum required data evaluation score divided by ten. The value was used by the USEPA to derive the avian ecological soil screening level. It is noted that a geometric mean of NOAEL values for growth and reproduction could not be calculated by the USEPA based on the lack of NOAEL values for reproduction and growth.
(13) The data reference represents a secondary data source.

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Table References (continued):

USEPA. 2007a. Ecological Soil Screening Levels for Copper (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-77.

USEPA. 2007b. Ecological Soil Screening Levels for Nickel (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-76.

USEPA. 2007c. Ecological Soil Screening Levels for Selenium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-72.

Table References (continued);

USEPA. 2007d. Ecological Soil Screening Levels for Zinc (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-73.

USEPA. 2006. Ecological Soil Screening Levels for Silver (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWEER Directive 9285.7-61

USEPA. 2005a. Ecological Soil Screening Levels for Arsenic (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-62.

USEPA. 2005b. Ecological Soil Screening Levels for Cadmium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-65.

USEPA. 2005c. Ecological Soil Screening Levels for Cobalt (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-67

USEPA. 2005d. Ecological Soil Screening Levels for Lead (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-70.

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TABLE 7-6
TOXICITY REFERENCE VALUES FOR MAMMALS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	Test Material	NOAEL (mg/kg/d)	MATC [1] (mg/kg/d)	LOAEL (mg/kg/d)	Source Document [2]
Volatile Organics:										
1,1,1,2-Tetrachloroethane	---	---	---	---	---	---	NA	NA	NA	---
Carbon tetrachloride	Rat	0.35	2 years	Oral in diet	Reproduction	Not Applicable	16	35.8	80 [3]	Sample et al. 1996 [14]
Chlorobenzene	Dog	12.7	13 weeks	Oral	Liver toxicity	Not Applicable	27.25	38.5	54.5	USEPA 2011 [14]
Chloroform	Rat	0.35	13 weeks	Oral (intubation)	Liver toxicity	Not Applicable	15 [4]	33.5	75 [3]	Sample et al. 1996 [14]
Ethylbenzene	Rat	0.35	182 days	Oral (gavage)	Liver/kidney toxicity	Not Applicable	136	236	408	USEPA 2011 [14]
Pentachloroethane	---	---	---	---	---	---	NA	NA	NA	---
Styrene	Rat	0.35	90 days	Oral in water	Reproduction	Not Applicable	35	78.3	175 [3]	Beliles et al. 1985
Toluene	Mouse	0.03	Days 6-12 of gestation	Oral (gavage)	Reproduction	Not Applicable	52 [4]	116	260	Sample et al. 1996 [14]
Trichloroethene	Mouse	0.03	6 weeks	Oral (gavage)	hepatotoxicity	Not Applicable	5.0 [5]	3.5	2.5 [3]	Sample et al. 1996 [14]
Xylenes (total)	Mouse	0.03	Days 6-15 of gestation	Oral (gavage)	Reproduction	Not Applicable	2.06	2.31	2.58	Sample et al. 1996 [14]
PAHs:										
2-Methylnaphthalene	Norway rat	0.247	6 weeks	Oral in diet	Growth (body weight)	1-Naphthaleneacetic acid	65.6 [6]	147	328	USEPA 2007a [14]
Acenaphthene	Norway rat	0.247	6 weeks	Oral in diet	Growth (body weight)	1-Naphthaleneacetic acid	65.6 [6]	147	328	USEPA 2007a [14]
Acenaphthylene	Norway rat	0.247	6 weeks	Oral in diet	Growth (body weight)	1-Naphthaleneacetic acid	65.6 [6]	147	328	USEPA 2007a [14]
Anthracene	Norway rat	0.247	6 weeks	Oral in diet	Growth (body weight)	1-Naphthaleneacetic acid	65.6 [6]	147	328	USEPA 2007a [14]
Benzo(a)anthracene	House mouse	0.038	65 weeks	Oral in diet	Mortality	Benzo(a)pyrene	0.615 [6]	1.36	3.01	USEPA 2007a [14]
Benzo(a)pyrene	House mouse	0.038	65 weeks	Oral in diet	Mortality	Benzo(a)pyrene	0.615 [6]	1.36	3.01	USEPA 2007a [14]
Benzo(b)fluoranthene	House mouse	0.038	65 weeks	Oral in diet	Mortality	Benzo(a)pyrene	0.615 [6]	1.36	3.01	USEPA 2007a [14]
Benzo(g,h,i)perylene	House mouse	0.038	65 weeks	Oral in diet	Mortality	Benzo(a)pyrene	0.615 [6]	1.36	3.01	USEPA 2007a [14]
Benzo(k)fluoranthene	House mouse	0.038	65 weeks	Oral in diet	Mortality	Benzo(a)pyrene	0.615 [6]	1.36	3.01	USEPA 2007a [14]
Chrysene	House mouse	0.038	65 weeks	Oral in diet	Mortality	Benzo(a)pyrene	0.615 [6]	1.36	3.01	USEPA 2007a [14]
Dibenz(a,h)anthracene	House mouse	0.038	65 weeks	Oral in diet	Mortality	Benzo(a)pyrene	0.615 [6]	1.36	3.01	USEPA 2007a [14]
Fluoranthene	Norway rat	0.247	6 weeks	Oral in diet	Growth (body weight)	1-Naphthaleneacetic acid	65.6 [6]	147	328	USEPA 2007a [14]
Fluorene	Norway rat	0.247	6 weeks	Oral in diet	Growth (body weight)	1-Naphthaleneacetic acid	65.6 [6]	147	328	USEPA 2007a [14]
Indeno(1,2,3-cd)pyrene	House mouse	0.038	65 weeks	Oral in diet	Mortality	Benzo(a)pyrene	0.615 [6]	1.36	3.01	USEPA 2007a [14]
Naphthalene	Norway rat	0.247	6 weeks	Oral in diet	Growth (body weight)	1-Naphthaleneacetic acid	65.6 [6]	147	328	USEPA 2007a [14]
Phenanthrene	Norway rat	0.247	6 weeks	Oral in diet	Growth (body weight)	1-Naphthaleneacetic acid	65.6 [6]	147	328	USEPA 2007a [14]
Pyrene	House mouse	0.038	65 weeks	Oral in diet	Mortality	Benzo(a)pyrene	0.615 [6]	1.36	3.01	USEPA 2007a [14]
Metals:										
Antimony	Norway rat	0.33	31 days	Oral in water	Reproduction (progeny weight)	Antimony trichloride	0.059 [6]	0.19	0.59	USEPA 2005a [14]
Arsenic	Dog	10.1	8 weeks	Oral in diet	Growth (body weight)	Sodium arsenite	1.04 [6]	1.31	1.66	USEPA 2005b [14]
Barium	House mouse/Norway rat	Various	Various	Oral in diet/water or gavage	Reproduction/Growth	Barium acetate, barium chloride, and barium chloride dihydrate	51.8 [7]	65.5	82.7 [8]	USEPA 2005c
Beryllium	Norway rat	0.486	4 years	Oral in diet	Mortality (life span)	Beryllium sulfate	0.532 [9]	0.549	0.567 [10]	USEPA 2005d [14]
Cadmium	Norway rat	0.43	57 days	Oral in water	Growth (body weight)	Cadmium acetate	0.77 [6]	2.43	7.7	USEPA 2005e [14]
Chromium (total)	Various	Various	Various	Oral in diet/water	Reproduction/growth	Various	2.4 [11][12]	11.85	58.53 [8]	USEPA 2005f
Cobalt	Various	Various	Various	Oral in diet/water or gavage	Reproduction/growth	Various	7.33 [7]	11.77	18.9 [8]	USEPA 2005g

TABLE 7-6
TOXICITY REFERENCE VALUES FOR MAMMALS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	Test Material	NOAEL (mg/kg/d)	MATC [(1)] (mg/kg/d)	LOAEL (mg/kg/d)	Source Document [(2)]
Metals:										
Copper	Pig	100	4 weeks	Oral in diet	Growth (body weight)	Copper sulfate pentahydrate	5.6 [(6)]	7.23	9.34	USEPA 2007b [(14)]
Lead	Noway rat	0.3	7 weeks	Oral in water	Growth (body weight)	Lead acetate	4.7 [(6)]	6.47	8.90	USEPA 2005h [(14)]
Mercury	Rat	0.35	3 generations	Oral in diet	Reproduction (pup viability)	Methyl mercury chloride	0.032	0.072	0.16	Sample et al. 1996 [(14)]
Nickel	House mouse	0.025	35 days	Oral	Reproduction (sperm cell counts)	Nickelous chloride	1.7 [(6)]	2.40	3.40	USEPA 2007c [(14)]
Selenium	Pig	17.800	37 days	Oral in diet	Growth (body weight)	Sodium selenite	0.143 [(6)]	0.175	0.215	USEPA 2007d [(14)]
Silver	Pig	8.86	40 days	Oral in diet	Growth (body weight)	Silver acetate	6.02 [(13)]	19.04	60.2	USEPA 2006 [(14)]
Thallium	Rat	0.365	60 days	Oral in water	Reproduction (male testicular function)	Tallium sufate	0.0074	0.023	0.074	Sample et al. 1996 [(14)]
Tin	Mouse	0.03	Days 6-15 of gestation	Oral (intubation)	Reproduction (fetal weight and survival)	bis(Tributyltin) oxide	23.4	28.6	35.0	Sample et al. 1996 [(14)]
Vanadium	House mouse	0.0471	12 days	Oral (gavage)	Reproduction (offspring development)	Sodium orthovanadate	4.16 [(6)]	5.88	8.31	USEPA 2005i [(14)]
Zinc	Various	Various	Various	Oral in diet or gavage	Reproduction/growth	Various	75.4 [(7)]	26.96	82.3 [(8)]	USEPA 2007e

Notes:

PAH = Polynuclear Aromatic Hydrocarbon
NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level
MATC = Maximum Acceptable Toxicant Concentration

USEPA = United States Environmental Protection Agency
mg/kg/d = milligram per kilogram-body weight per day
NA = Not Available
kg = kilogram

(1) MATC values were derived by calculating the geometric mean of the NOAEL and LOAEL values (values were calculated by Baker Environmental, Inc.).

(2) Source documents for NOAEL and LOAEL values represent primary data sources (as reported by original authors) unless otherwise noted.

(3) A chronic LOAEL value was not available from the study used as the source of the chronic NOAEL value. Therefore, a chronic LOAEL value was estimated by applying a safety factor of 5 to the chronic NOAEL value (Wentsel et al., 1996).

(4) A chronic NOAEL value was not available from the study used as the source of the chronic LOAEL value. Therefore, the chronic NOAEL value shown was estimated by applying a safety factor of 10 to the subchronic NOAEL value (Wentsel et al., 1996).

(5) A chronic NOAEL value was not available from the study used as the source of the chronic LOAEL value. Therefore, the chronic NOAEL value shown was estimated by applying a safety factor of 5 to the chronic LOAEL value (Wentsel et al., 1996).

(6) The NOAEL value shown represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival listed within the cited ecological soil screening levels that meet the minimum required data evaluation score. The value was was used by the USEPA as the toxicity reference value for mammalian ecological soil screening value development. It is noted that a geometric mean of available NOAEL values for growth and reproduction was not used as the toxicity reference value by the USEPA for ecological soil screening value development since the geometric mean is higher than the lowest bounded LOAEL for reproduction, growth, and survival.

(7) The NOAEL value represents the geometric mean of all reproduction and growth-based NOAEL values listed within the cited ecological soil screening level document that meet the minimum required data evaluation score. Because this value is lower than the lowest bounded LOAEL for reproduction, growth, or survival, it was selected by the USEPA as the toxicity reference value for mammalian ecological soil screening level development.

(8) The NOAEL value selected by the USEPA as the ecological soil screening level represents a geometric mean of all reproduction and growth-based NOAEL values that meet the minimum required data evaluation score. Therefore, the LOAEL value shown represents a geometric mean of all reproduction and growth-based LOAEL values listed within the cited ecological soil screening level document that meet the minimum required data evaluation score (value was calculated by Michael Baker Jr., Inc.).

(9) The NOAEL value represents the lowest value of all reproduction, growth, and survival-based NOAEL values listed in the cited ecological soil screening levels document that meet the required data evaluation score. The value was used by the USEPA to derive the mammalian ecological soil screening level. It is noted that a geometric mean of NOAEL values for growth and reproduction could not be calculated by the USEPA because insufficient NOAEL values meeting the minimum required data evaluation score were identified from the literature.

(10) A LOAEL value was not available from the study chosen by the USEPA as the source of the NOAEL value selected as the ecological soil screening level. Therefore, the LOAEL value represents a geometric mean of all reproduction- and growth-based LOAEL values listed within the cited ecological soil screening level document that meet the minimum required data evaluation score (value was calculated by Michael Baker Jr., Inc.).

(11) The NOAEL value represents the geometric mean of all reproduction and growth-based NOAEL values listed within the cited ecological soil screening level document that meet the minimum required data evaluation score. It is noted that there were no bounded LOAEL values for reproduction, growth, or mortality for comparison.

TABLE 7-6
TOXICITY REFERENCE VALUES FOR MAMMALS
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

(12) The NOAEL value shown is for trivalent chromium.
(13) The NOAEL is equal to the lowest value of all reproduction- and growth-based LOAELs listed in the cited ecological soil screening levels document that meet the minimum required data evaluation score divided by ten. The value was used by the USEPA to derive the mammalina ecological soil screening level. It is noted that a geometric mean of NOAEL values for growth and reproduction could not be calculated by the USEPA based on the lack of NOAEL values for reproduction and growth.
(14) The data reference represents a secondary data source.

Table References:

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USEPA. 2007c. Ecological Soil Screening Levels for Nickel (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-76.

USEPA. 2007d. Ecological Soil Screening Levels for Selenium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-72.

USEPA. 2007e. Ecological Soil Screening Levels for Zinc (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-73.

USEPA. 2006. Ecological Soil Screening Levels for Silver (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWEER Directive 9285.7-77

USEPA. 2005a. Ecological Soil Screening Levels for Antimony (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-61.

USEPA. 2005b. Ecological Soil Screening Levels for Arsenic (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-62.

USEPA. 2005c. Ecological Soil Screening Levels for Barium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-63.

USEPA. 2005d. Ecological Soil Screening Levels for Beryllium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-64.

USEPA. 2005e. Ecological Soil Screening Levels for Cadmium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-65.

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USEPA. 2005g. Ecological Soil Screening Levels for Cobalt (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-67

USEPA. 2005h. Ecological Soil Screening Levels for Lead (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-70.

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TABLE 7-7
SOIL TO PLANT AND SOIL TO EARTHWORM BIOACCUMULATION FACTORS AND BIOACCUMULATION UPTAKE EQUATIONS USED
TO ESTIMATE CHEMICAL CONCENTRATIONS IN TERRESTRIAL PLANT AND INVERTEBRATE TISSUE: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Soil-Plant BAF (dry weight) or Uptake Equation (dry weight)			Soil-Invertebrate BAF (dry weight) or Uptake Equation (dry weight)		
	BAF Value/Uptake Equation	**Source Document**	**Description**	**BAF Value/Uptake Equation**	**Source Document**	**Description**
Volatile Organics:						
1,1,1,2-Tetrachloroethane	5.176	USEPA 2007	Regression-based BAF [1]	3.151	USEPA 2007	Modeled BAF [9]
Carbon tetrachloride	4.715	USEPA 2007	Regression-based BAF [1]	3.070	USEPA 2007	Modeled BAF [9]
Chlorobenzene	4.175	USEPA 2007	Regression-based BAF [1]	2.968	USEPA 2007	Modeled BAF [9]
Chloroform	10.047	USEPA 2007	Regression-based BAF [1]	3.790	USEPA 2007	Modeled BAF [9]
Ethylbenzene	3.214	USEPA 2007	Regression-based BAF [1]	2.759	USEPA 2007	Modeled BAF [9]
Pentachloroethane	2.983	USEPA 2007	Regression-based BAF [1]	2.702	USEPA 2007	Modeled BAF [9]
Styrene	3.875	USEPA 2007	Regression-based BAF [1]	2.907	USEPA 2007	Modeled BAF [9]
Toluene	4.627	USEPA 2007	Regression-based BAF [1]	3.054	USEPA 2007	Modeled BAF [9]
Trichloroethene	4.803	USEPA 2007	Regression-based BAF [1]	3.086	USEPA 2007	Modeled BAF [9]
Xylene, total	3.245	USEPA 2007	Regression-based BAF [1]	2.766	USEPA 2007	Modeled BAF [9]
PAHs:						
2-Methylnaphthalene	1.641	USEPA 2007	Regression-based BAF [1]	2.090	USEPA 2007	Modeled BAF [9]
Acenaphthene	$\ln(C_p) = -0.8556[\ln[C_s]) - 5.562$	USEPA 2007	Uptake equation [2]	2.252	USEPA 2007	Modeled BAF [9]
Acenaphthylene	1.522	USEPA 2007	Regression-based BAF [1]	1.560	USEPA 2007	Modeled BAF [9]
Anthracene	$\ln(C_p) = 0.7784[\ln(C_s)] - 0.9887$	USEPA 2007	Uptake equation [2]	1.912	USEPA 2007	Modeled BAF [9]
Benzo(a)anthracene	$\ln(C_p) = 0.5944[\ln(C_s)] - 2.7078$	USEPA 2007	Uptake equation [2]	1.417	USEPA 2007	Modeled BAF [9]
Benzo(a)pyrene	$\ln(C_p) = 0.975[\ln(C_s)] - 2.0615$	USEPA 2007	Uptake equation [2]	1.274	USEPA 2007	Modeled BAF [9]
Benzo(b)fluoranthene	0.48	USEPA 2007	Maximum BAF [3]	1.245	USEPA 2007	Modeled BAF [9]
Benzo(g,h,i)perylene	$\ln(C_p) = 1.1829[\ln(C_s)] - 0.9313$	USEPA 2007	Uptake equation [2]	1.093	USEPA 2007	Modeled BAF [9]
Benzo(k)fluoranthene	$\ln(C_p) = 0.8595[\ln(C_s)] - 2.1579$	USEPA 2007	Uptake equation [2]	1.245	USEPA 2007	Modeled BAF [9]
Chrysene	$\ln(C_p) = 0.5944[\ln(C_s)] - 2.7078$	USEPA 2007	Uptake equation [2]	1.417	USEPA 2007	Modeled BAF [9]
Dibenzo(a,h)anthracene	0.23	USEPA 2007	Maximum BAF [3]	1.096	USEPA 2007	Modeled BAF [9]
Fluoranthene	6.0	USEPA 2007	Maximum BAF [3]	1.648	USEPA 2007	Modeled BAF [9]
Fluorene	$\ln(C_p) = -0.8556[\ln[C_s]) - 5.562$	USEPA 2007	Uptake equation [2]	2.089	USEPA 2007	Modeled BAF [9]
Indeno(1,2,3-cd)pyrene	0.15	USEPA 2007	Maximum BAF [3]	1.107	USEPA 2007	Modeled BAF [9]
Naphthalene	48	USEPA 2007	Maximum BAF [3]	2.606	USEPA 2007	Modeled BAF [9]
Phenanthrene	$\ln(C_p) = 0.6203[\ln(C_s)] - 0.1665$	USEPA 2007	Uptake equation [2]	1.912	USEPA 2007	Modeled BAF [9]
Pyrene	3.7	USEPA 2007	Maximum BAF [3]	1.653	USEPA 2007	Modeled BAF [9]
Metals:						
Antimony	$\ln(C_p) = 0.938[\ln(C_s)] - 3.233$	USEPA 2007	Uptake equation [4]	1.00	USEPA 2007	Assumed BAF
Arsenic	$\ln(C_p) = 0.564[\ln(C_s)] - 1.992$	Bechtel Jacobs 1998	Uptake equation [5]	$\ln(C_e) = 0.706[\ln(C_s)] - 1.421$	USEPA 2007	Uptake equation [10]

TABLE 7-7
SOIL TO PLANT AND SOIL TO EARTHWORM BIOACCUMULATION FACTORS AND BIOACCUMULATION UPTAKE EQUATIONS USED TO ESTIMATE CHEMICAL CONCENTRATIONS IN TERRESTRIAL PLANT AND INVERTEBRATE TISSUE: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Soil-Plant BAF (dry weight) or Uptake Equation (dry weight)			Soil-Invertebrate BAF (dry weight) or Uptake Equation (dry weight)		
	BAF Value/Uptake Equation	**Source Document**	**Description**	**BAF Value/Uptake Equation**	**Source Document**	**Description**
Metals:						
Barium	0.447	Bechtel Jacobs 1998	90th percentile BAF [6]	0.16	Sample et al. 1998	90th percentile BAF [11]
Beryllium	$\ln(C_p) = 0.7345[\ln[C_s]) - 0.5361$	USEPA 2007	Uptake equation [7]	1.182	Sample et al. 1998	90th percentile BAF [11]
Cadmium	$\ln(C_p) = 0.546[\ln(C_s)] - 0.475$	USEPA 2007	Uptake equation [8]	$\ln(C_e) = 0.795[\ln(C_s)] + 2.114$	USEPA 2007	Uptake equation [10]
Chromium, total	0.0839	Bechtel Jacobs 1998	90th percentile BAF [6]	3.162	Sample et al. 1998	90th percentile BAF [12]
Cobalt	0.0248	Bechtel Jacobs 1998	90th percentile BAF [6]	0.291	Sample et al. 1998	90th percentileBAF [11]
Copper	$\ln(C_p) = 0.394[\ln(C_s)] + 0.668$	USEPA 2007	Uptake equation [8]	$\ln(C_e) = 0.264[\ln(C_s)] + 1.675$	Sample et al. 1998	Uptake equation [13]
Lead	$\ln(C_p) = 0.561[\ln(C_s)] - 1.328$	USEPA 2007	Uptake equation [8]	$\ln(C_e) = 0.807[\ln(C_s)] - 2.18$	USEPA 2007	Uptake equation [10]
Mercury	$\ln(C_p) = 0.544[\ln[C_s]) - 0.996$	Bechtel Jacobs 1998	Uptake equation [6]	20.63	Sample et al. 1998	90th percentile BAF [12]
Nickel	$\ln(C_p) = 0.748[\ln(C_s)] - 2.224$	USEPA 2007	Uptake equation [8]	4.73	Sample et al. 1998	90th percentile BAF [12]
Selenium	$\ln(C_p) = 0.1.104[\ln(C_s)] - 0.678$	USEPA 2007	Uptake equation [8]	$\ln(C_e) = 0.733[\ln(C_s)] - 0.075$	USEPA 2007	Uptake equation [10]
Silver	0.0367	Bechtel Jacobs 1998	90th percentile BAF [6]	15.338	Sample et al. 1998	90th percentile BAF [11]
Thallium	0.004	Baes et al. 1984	Geometric mean BAF	1.00	---	Assumed BAF
Tin	0.03	Baes et al. 1984	Geometric mean BAF	1.00	---	Assumed BAF
Vanadium	0.0097	Bechtel Jacobs 1998	90th percentile BAF [6]	0.088	Sample et al. 1998	90th percentile BAF [11]
Zinc	$\ln(C_p) = 0.555[\ln(C_s)] + 1.575$	USEPA 2007	Uptake equation [8]	$\ln(C_e) = 0.328[\ln(C_s)] + 4.449$	USEPA 2007	Uptake equation [10]

Notes:

USEPA = United States Environmental Protection Agency
BAF = Bioaccumulation Factor (unitless)
PAH = Polynuclear Aromatic Hydrocarbon
C_e = Concentration in earthworm tissue (mg/kg - dry weight)
C_p = Concentration in plant tissue (mg/kg - dry weight)
C_s = Maximum concentration in soil (mg/kg - dry weight)
ln = natural logarithm

(1) BAF value was estimated using an inter-chemical regression equation for non-ionic organics based on rinsed plant foliage BAF data: $\log BAF = -0.4057(\log K_{ow}) + 1.781$, where BAF is the bioaccumulation factor and K_{ow} is the octanol-water partition coefficient (see Figure 5, Panel B in USEPA, 2007). The K_{ow} value used in the estimation of the BAF value is listed in Table 7-3.

(2) The concentration in plant tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation) based on rinsed plant foliage BAF data (see Appendix C in USEPA, 2007).

(3) Maximum BAF value for rinsed plant foliage data listed in Appendix C of USEPA (2007).

(4) The concentration in plant tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation; see Table 4a of USEPA[2007]) derived from measured BAF data (see Appendix A, Table A-1 of USEPA, 2007).

TABLE 7-7
SOIL TO PLANT AND SOIL TO EARTHWORM BIOACCUMULATION FACTORS AND BIOACCUMULATION UPTAKE EQUATIONS USED TO ESTIMATE CHEMICAL CONCENTRATIONS IN TERRESTRIAL PLANT AND INVERTEBRATE TISSUE: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

(5) The concentration in plant tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation) listed in Table 7 of Bechtel Jacobs (1998).

(6) 90th percentile BAF value listed in Appendix D, Table D-1 of Bechtel Jacobs (1998).

(7) The concentration in plant tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation; see Table 4a of USEPA, 2007) derived from measured BAF data (see Appendix A, Table A-2 of USEPA, 2007).

(8) The concentration in plant tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation) developed by Bechtel Jacobs (1998) and cited in Table 4a of USEPA (2007).

(9) BAF value was estimated using the relationship BAF = K_{ww}/K_d where K_{ww} is the biota to soil pore water partition coefficient (L soil pore water/kg ww tissue; converted to L soil pore water/kg dw tissue by assuming 16 percent soilds [USEPA, 1993] and dividing by 0.16) and K_d is the soil to pore water partition coefficient (L soil pore water/kg dw soil) (relationship developed by Jager, 1998 and cited in USEPA, 2007). Chemical-specific values for K_{ww} and K_d were derived using the following relationships:

$\log(K_{ww}) = 0.87(\log K_{ow}) - 2.0$ where K_{ow} is the octanol-water partition coefficient (K_{ow} value listed in Table 7-3)

$K_d = (f_{oc})(K_{oc})$ where f_{oc} is the fraction of organic carbon in soil (assumed to be 0.01 [one percent]) and K_{oc} is the organic carbon partition coefficient (K_{oc} value listed in Table 7-3)

(10) The concentration in earthworm tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation) developed by Sample et al. (1998 and 1999) and cited in Table 4a of USEPA (2007).

(11) 90th percentile BAF listed in Appendix C, Table C.1 of Sample et al. (1998).

(12) 90th percentile BAF value listed in Table 11 of Sample et al. (1998).

(13) The concentration in earthworm tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation) listed in Table 12 of Sample et al. (1998).

Table References:

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Table References (continued):

United States Environmental Protection Agency (USEPA). 2007. Attachment 4-1 of Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs): Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-55.

TABLE 7-8
SOIL BIOACCUMULATION FACTORS AND BIOACCUMULATION UPTAKE EQUATIONS USED TO ESTIMATE
CHEMICAL CONCENTRATIONS IN SMALL MAMMAL TISSUE: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Soil-Small Mammal BAF (dry weight)		
	BAF Value/Uptake Equation	**Source Document**	**Description**
Volatile Organics:			
1,1,1,2-Tetrachloroethane	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 (1)
Carbon tetrachloride	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 (1)
Chlorobenzene	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 (1)
Chloroform	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 (1)
Ethylbenzene	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 (1)
Pentachloroethane	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 (1)
Styrene	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 (1)
Toluene	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 (1)
Trichloroethene	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 (1)
Xylenes (total)	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 (1)
PAHs:			
2-Methylnaphthalene	0.000	---	BAF value for other PAH compounds used as a surrogate
Acenaphthene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Acenaphthylene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Anthracene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Benzo(a)anthracene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Benzo(a)pyrene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Benzo(b)fluoranthene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Benzo(g,h,i)perylene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Benzo(k)fluoranthene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Chrysene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Dibenzo(a,h)anthracene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Fluoranthene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Fluorene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Indeno(1,2,3-cd)pyrene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Naphthalene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Phenanthrene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible
Pyrene	0.000	USEPA 2007	Bioaccumulation is assumed to be negligible

TABLE 7-8
SOIL BIOACCUMULATION FACTORS AND BIOACCUMULATION UPTAKE EQUATIONS USED TO ESTIMATE CHEMICAL CONCENTRATIONS IN SMALL MAMMAL TISSUE: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Soil-Small Mammal BAF (dry weight)		
	BAF Value/Uptake Equation	**Source Document**	**Description**
Metals:			
Antimony	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1
Arsenic	$\ln(C_m) = 0.8188[\ln(C_s)] - 4.8471$	USEPA 2007	Regression-based uptake equation for all small mammals (2)
Barium	0.1121	Sample et al. 1998	90th percentile BAF for all small mammals (3)
Beryllium	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1
Cadmium	$\ln(C_m) = 0.4865[In(C_s)] - 0.4306$	Sample et al. 1998	Regression-based uptake equation for all small mammals (4)
Chromium, total	$\ln(C_m) = 0.7338[\ln(C_s)] - 1.4599$	USEPA 2007	Regression-based uptake equation for all small mammals (2)
Cobalt	$\ln(C_m) = 1.3070[\ln(C_s)] - 4.4669$	USEPA 2007	Regression-based uptake equation for all small mammals (2)
Copper	$\ln(C_m) = 0.1444[\ln(C_s)] + 0.2042$	USEPA 2007	Regression-based uptake equation for all small mammals (2)
Lead	$\ln(C_m) = 0.4422[\ln(C_s)] + 0.0761$	USEPA 2007	Regression-based uptake equation for all small mammals (2)
Mercury	0.192	Sample et al. 1998	90th percentile BAF for all small mammals (5)
Nickel	$\ln(C_m) = 0.4658[\ln(C_s)] - 0.2462$	USEPA 2007	Regression-based uptake equation for all small mammals (2)
Selenium	$\ln(C_m) = 0.3764[\ln(C_s)] - 0.4158$	USEPA 2007	Regression-based uptake equation for all small mammals (2)
Silver	0.5013	Sample et al. 1998	90th percentile BAF for all small mammals (3)
Thallium	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1
Tin	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1
Vanadium	0.0179	Sample et al. 1998	90th percentile BAF for all small mammals (3)
Zinc	$\ln(C_m) = 0.0738[\ln(C_s)] + 4.4713$	Sample et al. 1998	Regression-based uptake equation for all small mammals (4)

Notes:

USEPA = United States Environmental Protection Agency
PAH = Polynuclear Aromatic Hydrocarbon
BAF = Bioaccumulation Factor
C_m = Concentration in small mammal tissue (mg/kg - dry weight)

C_s = Maximum concentration in soil (mg/kg - dry weight)
BAF_d = diet-to-small mammal bioaccumulation factor (wet weight)
DI = Small mammal dietary intake (mg/kg-BW/day)

TABLE 7-8
SOIL BIOACCUMULATION FACTORS AND BIOACCUMULATION UPTAKE EQUATIONS USED TO ESTIMATE CHEMICAL CONCENTRATIONS IN SMALL MAMMAL TISSUE: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes (continued):

(1) Most chemical exposure for small mammals is via the diet. Therefore, it is assumed that the concentration of the chemical in small mammal tissue is equal to the chemical concentration in its diet multiplied by a diet to whole-body BAF (BAF_d - wet weight basis). In the absence of literature-based diet to whole-body BAF, a value of 1.0 was assumed. The resulting tissue concentration was converted to a dry weight basis using an estimated solids content for small mammals of 0.32 (USEPA, 1993). Additional explanation is provided in Section 7.5.2.2.1.

(2) The concentration in small mammal tissue was estimated using a chemical-specific bioaccumulation uptake equation for all small mammals (i.e., regression (equation) developed by Sample et al. (1998) and cited in Table 4a of USEPA (2007).

(3) 90th percentile BAF value for all small mammals listed in Appendix C, Table C-1 of Sample et al. (1998).

(4) The concentration in small mammal tissue was estimated using a chemical-specific bioaccumulation uptake equation for all small mammals (i.e., regression equation) listed in Table 8 of Sample et al. (1998).

(5) 90th percentile BAF value for all small mammals listed in Table 7 of Sample et al. (1998).

Table References:

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, and G.W. Suter II. 1998. Development and Validation of Bioaccumulation Models for Small Mammals. Oak Ridge National Laboratory, Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-219.

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USEPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.

TABLE 7-9
EXPOSURE PARAMETERS FOR UPPER TROPHIC LEVEL RECEPTORS: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Receptor	Habitat	Body Weight (kg)		Food Ingestion Rate (kg/day - dry)		Area Use Factor
		Value	Reference	Value	Reference	
Birds:						
American robin	Terrestrial	0.056 (1)	Dunning 2008	0.01503	Allometric equation from Nagy (2001) for insectivorous birds(7): $[0.540((BW*1000)^{0.705})]/1000$	1.00
Mourning dove	Terrestrial	0.115 (2)	Dunning 2008	0.01723	Allometric equation from Nagy (2001) for all birds(7): $[0.638((BW*1000)^{0.685})]/1000$	1.00
Red-tailed hawk	Terrestrial	0.923 (3)	Dunning 2008	0.09679	Allometric equation from Nagy (2001) for carnivorous birds(7): $[0.849((BW*1000)^{0.663})]/1000$	1.00
Mammals:						
Brown flower bat	Terrestrial	0.016 (4)	Gannon et al. 2005	0.00277	Allometric equation from Nagy (2001) for bats(8): $[0.365((BW*1000)^{0.671})]/1000$	1.00
Norway rat (prey item for red-tailed hawk)	Terrestrial	0.200 (5)	Jackson 1992	0.04075	Allometric equation from Nagy (2001) for rodents(9): $[0.332((BW*1000)^{0.774})]/1000$	1.00

TABLE 7-9
EXPOSURE PARAMETERS FOR UPPER TROPHIC LEVEL RECEPTORS: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes:

BW = Body Weight
kg = kilogram
L/day = liter per day
kg/day - dry = kilogram per day - dry weight basis
USEPA = United States Environmental Protection Agency

(1) Minimum body weight for males and females from the western United States (n = 255).
(2) Minimum mean body weight for females from Illinois (n = 95)
(3) Minimum mean body weight for males from the western United States (n = 26)
(4) Minimum body weight for males and females in Puerto Rico (n = 20)
(5) Minimum body weight within the range of reported values (sex and location not specified).
(7) Food ingestion rates for avian receptors were calculated using maximum body weights: 0.123 kg for the mourning dove, 0.112 kg for the American robin, and 1.266 kg forthe red-tailed hawk.
(8) Food ingestion rate for the brown flower bat were calculated using a maximum body weight of 0.0205 kg (Gannon et al., 2005).
(9) Food ingestion rate for the Norway rat were calculated using the maximum body weight within the range of reported values: 0.500 kg (Jackson, 1992).

Table References:

Dunning, J.B., Jr. (ed.). 2008. CRC Handbook of Avian Body Masses, Second Edition. CRC Press, Boca Raton, FL. 655 pp.

Gannon, M.R., A. Kurta, A. Rodriguez-Durán, and M.R. Willig. 2005. Bats of Puerto Rico: An Island Focus and a Caribbean Perspective. Texas Tech University Press, Lubbock, TX. 239 pp.

Jackson, W.B. 1992. Norway Rat and Allies. Chapter 54 *In* Chapman, J.A. and G.A. Feldhamer (eds.), Wild Mammals of North America: Biology, Management, and Economics. The John Hopkins University Press, Baltimore, MD. pp. 1077-1088.

Nagy, K. A. 2001. Food Requirements of Wild Animals: Predictive Equations for Free-Living Mammals, Reptiles, and Birds. Nutr. Abstr. Rev. Series B. 71:21R-31R.

TABLE 7-10
DIETARY COMPOSITION FOR UPPER TROPHIC LEVEL RECEPTORS: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Receptor	Dietary Composition (percent)						Soil/Sediment Ingestion (percent)	
	Terrestrial Plants	Soil Invertebrates	Small Mammals	Aquatic Invertebrates	Fish	Reference	Value	Reference
Birds:								
American robin	0	89.5	0	0	0	Assumed [(1)]	10.5 [(3)]	Sample and Suter II 1994
Mourning dove	95.0	0	0	0	0	Tomlinson et al. 1994	5.0	Assumed
Red-tailed hawk	0	0	100	0	0	USEPA 1993; Sample and Suter II 1994	0	Sample and Suter II 1994
Mammals:								
Brown flower bat	100	0	0	0	0	Gannon et al. 2005	0 [(4)]	Assumed
Norway rat (prey item for red-tailed hawk)	0	98.0	0	0	0	Assumed [(2)]	2.0	Assumed

Notes:

USEPA = United States Environmental Protection Agency

(1) Although the American robin is omnivorous (USEPA, 1993, Sample et al., 1997, Wheelwright et al., 1986, and Martin et al., 1951), an exclusive diet of terrestrial invertebrates (i.e., earthworms) is assumed for the screening level risk calculation.

(2) Although the Norway rat is omnivorous (Jackson, 1992), an exclusive diet of terrestrial invertebrates (i.e., earthworms) is assumed for the screening level risk calculation.

(3) The percentage of soil in the diet of the American robin was estimated using the relationship presented in Sample and Sutter II (1994). An exclusive diet of earthworms extrapolates to a soil contribution of 10.5 percent to the total diet.

(4) Soil ingestion is considered negligible based on the arboreal feeding behavior of nectivorous bats.

Table References:

Gannon, M.R., A. Kurta, A. Rodriguez-Durán, and M.R. Willig. 2005. Bats of Puerto Rico: An Island Focus and a Caribbean Perspective. Texas Tech University Press, Lubbock, TX. 239 pp.

Jackson, W.B. 1992. Norway Rat and Allies. Chapter 54 *In* Chapman, J.A. and G.A. Feldhamer (eds.), Wild Mammals of North America: Biology, Management, and Economics. The John Hopkins University Press, Baltimore, MD. pp. 1077-1088.

Martin, A. C., H.S. Zim, and A.L. Nelson. 1951. American Wildlife and Plants: A Guide to Wildlife Food Habits. Dover Publications, Inc. New York, NY. 500 pp.

TABLE 7-10
DIETARY COMPOSITION FOR UPPER TROPHIC LEVEL RECEPTORS: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Table References (continued):

Sample, B.E., M.S. Aplin, R.A. Efroymson, G.W. Suter II, and C.J.E. Welsh. 1997. Methods and Tools for Estimation of the Exposure of Terrestrial Wildlife to Contaminants. Environmental Sciences Division, Oak Ridge National Laboratory. ORNL/TM-13391.

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Tomlinson, R.E., D.D. Dolton, R.R. George, and R.R. Mirarchi. 1994. Mourning Dove. In T.C. Tacha and C.E. Braun (eds), Migratory Shore and Upland Game Bird Management in North America. Int. Assoc. Fish and Wildlife Agencies, Washington, D.C. pp. 1-26.

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TABLE 7-11
FREQUENCY AND RANGE OF SURFACE SOIL DATA (MAXIMUM CONCENTRATIONS) COMPARED TO SOIL SCREENING VALUES FOR TERRESTRIAL PLANTS AND INVERTEBRATES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Contaminant Frequency/Range									
Analyte	Frequency of Detection	Range of Positive Detections	Range of Non-Detects	Arithmetic Mean (Half Non-Detects)	Value used in Step 2 Screen (1)	Soil Screening Values (SSV)	Reference (2)	Max. HQ (3)	Ecological COPC?	Comments
Volatile Organics (µg/kg)										
1,1,1,2-Tetrachloroethane	0/14	ND	0.95U - 6.3U	2.495	6.3	100	CCME 2007	0.06	No	HQ < 1.0
1,1,1-Trichloroethane	0/14	ND	0.86U - 6.3U	2.491	6.3	100	CCME 2007	0.06	No	HQ < 1.0
1,1,2,2-Tetrachloroethane	0/1	ND	2.1U - 2.1U	1.050	2.1	100	CCME 2007	0.02	No	HQ < 1.0
1,1,2-Trichloroethane	0/14	ND	1.8U - 6.3U	2.525	6.3	100	CCME 2007	0.06	No	HQ < 1.0
1,1-Dichloroethane	0/14	ND	0.74U - 6.3U	2.487	6.3	100	CCME 2007	0.06	No	HQ < 1.0
1,1-Dichloroethene	0/14	ND	0.8U - 6.3U	2.489	6.3	100	CCME 2007	0.06	No	HQ < 1.0
1,2,3-Trichloropropane	0/14	ND	2.1UJ - 6.3U	2.536	6.3	NE	---	NA	Yes	No SSV
1,2-Dibromo-3-Chloropropane	0/14	ND	4.2UJ - 13U	5.079	13	NE	---	NA	Yes	No SSV
1,2-Dibromoethane	0/14	ND	2.2U - 6.3U	2.539	6.3	300	CCME 2007	0.02	No	HQ < 1.0
1,2-Dichloroethane	0/14	ND	1.5U - 6.3U	2.514	6.3	402	MHSPE 2000	0.02	No	HQ < 1.0
1,2-Dichloropropane	0/14	ND	1.6U - 6.3U	2.518	6.3	700,000	Efroymson et al. 1997a	<0.01	No	HQ < 1.0
2-Butanone (MEK)	0/14	ND	7.1UJ - 31U	12.575	31	NE	---	NA	Yes	No SSV
2-Hexanone	0/14	ND	3.1UJ - 31U	12.432	31	NE	---	NA	Yes	No SSV
3-Chloro-1-propene	0/14	ND	2.2UJ - 6.3UJ	2.539	6.3	NE	---	NA	Yes	No SSV
4-Methyl-2-pentanone (MIBK)	0/14	ND	4.3UJ - 31U	12.475	31	NE	---	NA	Yes	No SSV
Acetone	0/14	ND	40U - 70U	27.107	70	NE	---	NA	Yes	No SSV
Acetonitrile	0/14	ND	67UJ - 250U	100.607	250	NE	---	NA	Yes	No SSV
Acrolein	0/13	ND	80UJ - 130UJ	53.077	130	NE	---	NA	Yes	No SSV
Acrylonitrile	0/14	ND	34UJ - 130U	50.500	130	1,000,000	Efroymson et al. 1997a	<0.01	No	HQ < 1.0
Benzene	0/14	ND	1.2U - 6.3U	2.504	6.3	101	MHSPE 2000	0.06	No	HQ < 1.0
Bromodichloromethane	0/14	ND	1.2U - 6.3U	2.504	6.3	NE	---	NA	Yes	No SSV
Bromoform	0/14	ND	1.6U - 6.3U	2.518	6.3	NE	---	NA	Yes	No SSV
Bromomethane	0/14	ND	2.4UJ - 6.3U	2.546	6.3	NE	---	NA	Yes	No SSV
Carbon disulfide	2/14	5.5J - 5.9	0.76U - 6.3U	2.888	5.9	NE	---	NA	Yes	No SSV
Carbon tetrachloride	0/14	ND	1.5U - 6.3U	2.514	6.3	1,000,000	Efroymson et al. 1997a	<0.01	No	HQ < 1.0
Chlorobenzene	0/14	ND	1.1U - 6.3U	2.500	6.3	40,000	Efroymson et al. 1997a	<0.01	No	HQ < 1.0
Chloroethane	0/14	ND	1.8U - 6.3UJ	2.525	6.3	NE	---	NA	Yes	No SSV
Chloroform	0/14	ND	0.74U - 6.3U	2.487	6.3	1,002	MHSPE 2000	<0.01	No	HQ < 1.0
Chloromethane	0/14	ND	1.1U - 6.3U	2.500	6.3	NE	---	NA	Yes	No SSV
Chloroprene	0/14	ND	0.85U - 6.3U	2.491	6.3	NE	---	NA	Yes	No SSV
cis-1,3-Dichloropropene	0/14	ND	1.3U - 6.3U	2.507	6.3	100	CCME 2007	0.06	No	HQ < 1.0
Dibromochloromethane	0/14	ND	0.74U - 6.3U	2.487	6.3	NE	---	NA	Yes	No SSV
Dibromomethane	0/14	ND	1.8U - 6.3U	2.525	6.3	NE	---	NA	Yes	No SSV
Dichlorodifluoromethane	0/14	ND	1.3U - 6.3U	2.507	6.3	NE	---	NA	Yes	No SSV
Ethyl methacrylate	0/14	ND	3.3U - 6.3U	2.579	6.3	NE	---	NA	Yes	No SSV
Ethylbenzene	0/14	ND	1.1U - 6.3U	2.500	6.3	5,003	MHSPE 2000	<0.01	No	HQ < 1.0
Iodomethane	0/14	ND	1.5U - 6.3U	2.514	6.3	NE	---	NA	Yes	No SSV
Isobutyl alcohol	0/13	ND	160U - 250U	105.769	250	NE	---	NA	Yes	No SSV
Methacrylonitrile	0/14	ND	36U - 130U	50.571	130	NE	---	NA	Yes	No SSV
Methyl methacrylate	0/14	ND	5.5U - 13U	5.125	13	NE	---	NA	Yes	No SSV
Methylene Chloride	0/14	ND	1.5U - 6.3U	2.514	6.3	1,040	MHSPE 2000	<0.01	No	HQ < 1.0
Pentachloroethane	0/14	ND	3.3UJ - 31U	12.439	31	NE	---	NA	Yes	No SSV
Propionitrile	0/14	ND	31UJ - 130U	50.393	130	NE	---	NA	Yes	No SSV
Styrene	0/14	ND	0.98U - 6.3U	2.496	6.3	10,030	MHSPE 2000	<0.01	No	HQ < 1.0
Tetrachloroethene	0/14	ND	1.1U - 6.3U	2.500	6.3	400	MHSPE 2000	0.02	No	HQ < 1.0
Toluene	0/14	ND	1.2U - 6.3U	2.504	6.3	13,001	MHSPE 2000	<0.01	No	HQ < 1.0
trans-1,2-Dichloroethene	0/14	ND	1.4U - 6.3U	2.511	6.3	100	CCME 2007	0.06	No	HQ < 1.0
trans-1,3-Dichloropropene	0/14	ND	1.3U - 6.3U	2.507	6.3	100	CCME 2007	0.06	No	HQ < 1.0
trans-1,4-Dichloro-2-butene	0/14	ND	4.6U - 13U	5.093	13	1,000,000	Efroymson et al. 1997a	<0.01	No	HQ < 1.0

TABLE 7-11
FREQUENCY AND RANGE OF SURFACE SOIL DATA (MAXIMUM CONCENTRATIONS) COMPARED TO SOIL SCREENING VALUES FOR TERRESTRIAL PLANTS AND INVERTEBRATES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Analyte	Contaminant Frequency/Range					Soil Screening Values (SSV)	Reference [2]	Max. HQ [3]	Ecological COPC?	Comments
	Frequency of Detection	Range of Positive Detections	Range of Non-Detects	Arithmetic Mean (Half Non-Detects)	Value used in Step 2 Screen [1]					
Volatile Organics (µg/kg)										
Trichloroethene	0/14	ND	1.5U - 6.3U	2.514	6.3	6,010	MHSPE 2000	<0.01	No	HQ < 1.0
Trichlorofluoromethane	0/14	ND	2.2U - 6.3UJ	2.539	6.3	NE	---	NA	Yes	No SSV
Vinyl acetate	0/14	ND	2.2U - 13U	5.007	13	NE	---	NA	Yes	No SSV
Vinyl chloride	0/14	ND	0.86U - 6.3U	2.491	6.3	11.0	MHSPE 2000	0.57	No	HQ < 1.0
Xylenes, Total	0/14	ND	3.4U - 13U	5.050	13	1,000	USEPA 2003	0.01	No	HQ < 1.0
PAHs (µg/kg)										
Low molecular weight PAHs [4]	NA	NA	NA	NA	745	29,000	USEPA 2007a	0.03	No	HQ < 1.0
High molecular weight PAHs [5]	NA	NA	NA	NA	1,907	18,000	USEPA 2007a	0.11	No	HQ < 1.0
Metals (mg/kg)										
Antimony	2/14	1.8J - 2.9	0.39U - 2.2U	1.157	2.9	78.0	USEPA 2005a	0.04	No	HQ < 1.0
Arsenic	14/14	1.6 - 21	NA	5.093	21	18.0	USEPA 2005b	1.17	Yes	HQ > 1.0
Barium	14/14	15J - 190J	NA	61.143	190	330	USEPA 2005c	0.58	No	HQ < 1.0
Beryllium	11/14	0.059J - 0.25	0.038U - 0.11U	0.094	0.25	40.0	USEPA 2005d	<0.01	No	HQ < 1.0
Cadmium	14/14	0.047J - 1.8	NA	0.440	1.8	32.0	USEPA 2005e	0.06	No	HQ < 1.0
Chromium	14/14	4.2 - 27	NA	12.900	27	57.0	USEPA 2008	0.47	No	HQ < 1.0
Cobalt	14/14	1.7J - 10J	NA	5.393	10	13.0	USEPA 2005f	0.77	No	HQ < 1.0
Copper	14/14	9.3 - 550	NA	65.521	550	70.0	USEPA 2007b	7.86	Yes	HQ > 1.0
Lead	12/12	3.5 - 120	NA	32.458	120	120	USEPA 2005g	1.00	No	HQ = 1.0
Mercury	11/14	0.0085J - 0.21	0.02U - 0.021U	0.027	0.21	0.10	Efroymson et al. 1997a	2.10	Yes	HQ > 1.0
Nickel	14/14	2.2 - 27	NA	6.621	27	38.0	USEPA 2007c	0.71	No	HQ < 1.0
Selenium	7/14	0.26J - 1.8	0.97U - 1.1U	0.760	1.8	0.52	USEPA 2007d	3.46	Yes	HQ > 1.0
Silver	5/14	0.04J - 0.84	0.2U - 0.21U	0.206	0.84	560	USEPA 2006	<0.01	No	HQ < 1.0
Thallium	5/14	0.054J - 0.21J	0.2U - 0.25U	0.107	0.21	1.00	Efroymson et al. 1997b	0.21	No	HQ < 1.0
Tin	0/14	ND	8.4U - 22U	9.729	22	50.0	Efroymson et al. 1997b	0.44	No	HQ < 1.0
Vanadium	14/14	13 - 64J	NA	36.143	64	20.0	USEPA 2005h	3.20	Yes	HQ > 1.0
Zinc	14/14	12 - 920	NA	135.786	920	120	USEPA 2007e	7.67	Yes	HQ > 1.0

Notes:

MHSPE = Ministry of Housing, Spatial Planning and Environmen
CCME = Canadian Council of Ministries of the Environmen
USEPA = United States Environmental Protection Agency
COPC = Chemical of Potential Concern
PAH = Polynuclear Aromatic Hydrocarbor

SSV = Soil Screening Value
µg/kg = microgram per kilogram
mg/kg = milligram per kilogram
HQ = Hazard Quotient
NE = Not Established

NA = Not Applicable
ND = Not Detected
J = Estimated value
U = Not detected
UJ = Not detected, estimated value

(1) Maximum detected concentration (or maximum non-detected result for chemicals that were not detected)

(2) See Table 7-4 for reference citations.

(3) For a given chemical, the Hazard Quotient (HQ) is the maximum detected concentration (or maximum non-detected result for chemicals that were not detected) divided by the soil screening valu

(4) Low molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of fewer than four rings. The low molecular weight PAH compounds analyzed for in SWMU 74 - Fueling Piers Area surface soil were 2-methylnaphthalene acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. The concentration value used in the Step 2 risk calculation was calculated by summing maximum detected concentrations in SWMU 74 - Fueling Pier Area surface soil for each PAH. Maximum non-detected results were used for PAHs that were not detected.

(5) High molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of four or more rings. The high molecular weight PAH compounds analyzed for in SWMU 74 Fueling Piers area surface soil were benzo(a)anthracene benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene. The concentration value used in the Step 2 risk calculation was calculated by summing maximum detected concentrations in SWMU 74 - Fueling Piers Area surface soil for each PAH. Maximum non-detected results were used for PAHs that were not detected

TABLE 7-12
FREQUENCY AND RANGE OF SUBSURFACE SOIL DATA (MAXIMUM CONCENTRATIONS) COMPARED TO SOIL SCREENING VALUES FOR TERRESTRIAL PLANTS AND INVERTEBRATES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Analyte	Contaminant Frequency/Range					Soil Screening Values (SSV)	Reference [2]	Max. HQ [3]	Ecological COPC?	Comments
	Frequency of Detection	Range of Positive Detections	Range of Non-Detects	Arithmetic Mean (Half Non-Detects)	Value used in Step 2 Screen [1]					
Volatile Organics (µg/kg)										
1,1,1,2-Tetrachloroethane	0/6	ND	4.8U - 6.9U	2.858	6.9	100	CCME 2007	0.07	No	HQ < 1.0
1,1,1-Trichloroethane	0/6	ND	4.8U - 6.9U	2.858	6.9	100	CCME 2007	0.07	No	HQ < 1.0
1,1,2-Trichloroethane	0/6	ND	4.8U - 6.9U	2.858	6.9	100	CCME 2007	0.07	No	HQ < 1.0
1,1-Dichloroethane	0/6	ND	4.8U - 6.9U	2.858	6.9	100	CCME 2007	0.07	No	HQ < 1.0
1,1-Dichloroethene	0/6	ND	4.8U - 6.9U	2.858	6.9	100	CCME 2007	0.07	No	HQ < 1.0
1,2,3-Trichloropropane	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
1,2-Dibromo-3-Chloropropane	0/6	ND	9.6U - 14U	5.692	14	NE	---	NA	Yes	No SSV
1,2-Dibromoethane	0/6	ND	4.8U - 6.9U	2.858	6.9	300	CCME 2007	0.02	No	HQ < 1.0
1,2-Dichloroethane	0/6	ND	4.8U - 6.9U	2.858	6.9	402	MHSPE 2000	0.02	No	HQ < 1.0
1,2-Dichloropropane	0/6	ND	4.8U - 6.9U	2.858	6.9	700,000	Efroymson et al. 1997a	<0.01	No	HQ < 1.0
2-Butanone (MEK)	0/6	ND	24U - 34U	14.250	34	NE	---	NA	Yes	No SSV
2-Hexanone	0/6	ND	24U - 34U	14.250	34	NE	---	NA	Yes	No SSV
3-Chloro-1-propene	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
4-Methyl-2-pentanone (MIBK)	0/6	ND	24U - 34U	14.250	34	NE	---	NA	Yes	No SSV
Acetone	0/6	ND	48U - 69U	28.583	69	NE	---	NA	Yes	No SSV
Acetonitrile	0/6	ND	190U - 280U	114.167	280	NE	---	NA	Yes	No SSV
Acrolein	0/6	ND	96UJ - 140U	56.917	140	NE	---	NA	Yes	No SSV
Acrylonitrile	0/6	ND	96U - 140U	56.917	140	1,000,000	Efroymson et al. 1997a	<0.01	No	HQ < 1.0
Benzene	0/6	ND	4.8U - 6.9U	2.858	6.9	101	MHSPE 2000	0.07	No	HQ < 1.0
Bromodichloromethane	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Bromoform	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Bromomethane	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Carbon disulfide	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Carbon tetrachloride	0/6	ND	4.8U - 6.9U	2.858	6.9	1,000,000	Efroymson et al. 1997a	<0.01	No	HQ < 1.0
Chlorobenzene	0/6	ND	4.8U - 6.9U	2.858	6.9	40,000	Efroymson et al. 1997a	<0.01	No	HQ < 1.0
Chloroethane	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Chloroform	0/6	ND	4.8U - 6.9U	2.858	6.9	1,002	MHSPE 2000	<0.01	No	HQ < 1.0
Chloromethane	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Chloroprene	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
cis-1,3-Dichloropropene	0/6	ND	4.8U - 6.9U	2.858	6.9	100	CCME 2007	0.07	No	HQ < 1.0
Dibromochloromethane	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Dibromomethane	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Dichlorodifluoromethane	0/6	ND	4.8UJ - 6.9UJ	2.858	6.9	NE	---	NA	Yes	No SSV
Ethyl methacrylate	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Ethylbenzene	0/6	ND	4.8U - 6.9U	2.858	6.9	5,003	MHSPE 2000	<0.01	No	HQ < 1.0
Iodomethane	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Isobutyl alcohol	0/6	ND	190U - 280U	114.167	280	NE	---	NA	Yes	No SSV
Methacrylonitrile	0/6	ND	96U - 140U	56.917	140	NE	---	NA	Yes	No SSV
Methyl methacrylate	0/6	ND	9.6U - 14U	5.692	14	NE	---	NA	Yes	No SSV
Methylene Chloride	0/6	ND	4.8U - 6.9U	2.858	6.9	1,040	MHSPE 2000	<0.01	No	HQ < 1.0
Pentachloroethane	0/6	ND	24U - 34U	14.250	34	NE	---	NA	Yes	No SSV
Propionitrile	0/6	ND	96U - 140U	56.917	140	NE	---	NA	Yes	No SSV
Styrene	0/6	ND	4.8U - 6.9U	2.858	6.9	10,030	MHSPE 2000	<0.01	No	HQ < 1.0
Tetrachloroethene	0/6	ND	4.8U - 6.9U	2.858	6.9	400	MHSPE 2000	0.02	No	HQ < 1.0
Toluene	0/6	ND	4.8U - 6.9U	2.858	6.9	13,001	MHSPE 2000	<0.01	No	HQ < 1.0
trans-1,2-Dichloroethene	0/6	ND	4.8U - 6.9U	2.858	6.9	100	CCME 2007	0.07	No	HQ < 1.0
trans-1,3-Dichloropropene	0/6	ND	4.8U - 6.9U	2.858	6.9	100	CCME 2007	0.07	No	HQ < 1.0
trans-1,4-Dichloro-2-butene	0/6	ND	9.6U - 14U	5.692	14	1,000,000	Efroymson et al. 1997a	<0.01	No	HQ < 1.0
Trichloroethene	0/6	ND	4.8U - 6.9U	2.858	6.9	6,010	MHSPE 2000	<0.01	No	HQ < 1.0

TABLE 7-12
FREQUENCY AND RANGE OF SUBSURFACE SOIL DATA (MAXIMUM CONCENTRATIONS) COMPARED TO SOIL SCREENING VALUES FOR TERRESTRIAL PLANTS AND INVERTEBRATES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Contaminant Frequency/Range									
Analyte	**Frequency of Detection**	**Range of Positive Detections**	**Range of Non-Detects**	**Arithmetic Mean (Half Non-Detects)**	**Value used in Step 2 Screen (1)**	**Soil Screening Values (SSV)**	**Reference (2)**	**Max. HQ (3)**	**Ecological COPC?**	**Comments**
Volatile Organics (µg/kg)										
Trichlorofluoromethane	0/6	ND	4.8U - 6.9U	2.858	6.9	NE	---	NA	Yes	No SSV
Vinyl acetate	0/6	ND	9.6U - 14U	5.692	14	NE	---	NA	Yes	No SSV
Vinyl chloride	0/6	ND	4.8U - 6.9U	2.858	6.9	11.0	MHSPE 2000	0.63	No	HQ < 1.0
Xylenes, Total	0/6	ND	9.6U - 14U	5.692	14	1000	USEPA 2003	0.01	No	HQ < 1.0
LLPAH Totals (µg/kg)										
Low molecular weight PAHs	NA	NA	NA	NA	518	29,000	USEPA 2007a	0.02	No	HQ < 1.0
High molecular weight PAHs	NA	NA	NA	NA	621	18,000	USEPA 2007a	0.03	No	HQ < 1.0
Metals (mg/kg)										
Antimony	1/6	2.9 - 2.9	2.1U - 2.2U	1.367	2.9	78.0	USEPA 2005a	0.04	No	HQ < 1.0
Arsenic	6/6	2 - 4.1	NA	3.317	4.1	18.0	USEPA 2005b	0.23	No	HQ < 1.0
Barium	6/6	9.7J - 56J	NA	27.783	56	330	USEPA 2005c	0.17	No	HQ < 1.0
Beryllium	2/6	0.054J - 0.072J	0.11U - 0.11U	0.058	0.072	40.0	USEPA 2005d	<0.01	No	HQ < 1.0
Cadmium	3/6	0.029J - 2.8	0.11U - 0.11U	0.506	2.8	32.0	USEPA 2005e	0.09	No	HQ < 1.0
Chromium	6/6	3.5 - 13	NA	7.883	13	57.0	USEPA 2008	0.23	No	HQ < 1.0
Cobalt	6/6	0.37 - 2.2	NA	1.302	2.2	13.0	USEPA 2005f	0.17	No	HQ < 1.0
Copper	6/6	1.9 - 53	NA	16.217	53	70.0	USEPA 2007b	0.76	No	HQ < 1.0
Lead	6/6	0.32J - 110	NA	20.865	110	120	USEPA 2005g	0.92	No	HQ < 1.0
Mercury	5/6	0.0098J - 0.027	0.021U - 0.021U	0.014	0.027	0.10	Efroymson et al. 1997a	0.27	No	HQ < 1.0
Nickel	6/6	1.2 - 4.2	NA	2.417	4.2	38.0	USEPA 2007c	0.11	No	HQ < 1.0
Selenium	0/6	ND	1U - 1.1U	0.542	1.1	0.52	USEPA 2007d	2.12	Yes	HQ > 1.0
Silver	1/6	0.4 - 0.4	0.21U - 0.22U	0.155	0.4	560	USEPA 2006	<0.01	No	HQ < 1.0
Thallium	1/6	0.057J - 0.057J	0.21U - 0.22U	0.098	0.057	1.00	Efroymson et al. 1997b	0.06	No	HQ < 1.0
Tin	0/6	ND	21U - 22U	10.667	22	50.0	Efroymson et al. 1997b	0.44	No	HQ < 1.0
Vanadium	6/6	5.1J - 20J	NA	12.600	20	20.0	USEPA 2005h	1.00	No	HQ = 1.0
Zinc	6/6	1.9J - 110	NA	30.050	110	120	USEPA 2007e	0.92	No	HQ < 1.0

Notes:

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(1) Maximum detected concentration (or maximum non-detected result for chemicals that were not detected)

(2) See Table 7-4 for reference citations.

(3) For a given chemical, the Hazard Quotient (HQ) is the maximum detected concentration (or maximum non-detected result for chemicals that were not detected) divided by the soil screening valu

(4) Low molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of fewer than four rings. The low molecular weight PAH compounds analyzed for in SWMU 74 - Fueling Piers Area ssuburface soil wer 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. The concentration value used in the Step 2 risk calculation was calculated by summing maximum detected concentrations i SWMU 74 - Fueling Piers Area subsurface soil for each PAH. Maximum non-detected results were used for PAHs that were not detected

(5) High molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of four or more rings. The high molecular weight PAH compounds analyzed for in SWMU 74 Fueling Piers area subsurface soil were benzo(a)anthracene benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene. The concentration value used in the Step 2 risk calculation was calculated by summing maximum detected concentrations in SWMU 74 - Fueling Piers Area subsurface soil for each PAH. Maximum non-detected results were used for PAHs that were not detected

TABLE 7-13
HAZARD QUOTIENT VALUES FOR AVIAN AND MAMMALIAN DIETARY EXPOSURES TO CHEMICALS IN SURFACE SOIL: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Brown flower bat			American robin			Mourning dove			Red-tailed hawk		
	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC
Volatile Organics:												
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylenes, total	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PAHs:												
2-Methylnaphthalene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	0.04	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenz(a,h)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	0.45	0.09	0.20	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Metals:												
Antimony	0.31	0.03	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	0.13	0.08	0.10	0.49	0.24	0.34	0.12	0.06	0.08	<0.01	<0.01	<0.01
Barium	0.28	0.18	0.22	0.61	0.30	0.43	0.65	0.32	0.46	<0.01	<0.01	<0.01
Beryllium	0.07	0.06	0.07	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.19	0.02	0.06	2.19	0.51	1.06	0.09	0.02	0.04	0.06	0.01	0.03

TABLE 7-13
HAZARD QUOTIENT VALUES FOR AVIAN AND MAMMALIAN DIETARY EXPOSURES TO CHEMICALS IN SURFACE SOIL: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Brown flower bat			American robin			Mourning dove			Red-tailed hawk		
	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC
Metals:												
Chromium, total	0.16	<0.01	0.03	8.00	1.36	3.30	0.20	0.03	0.08	0.10	0.02	0.04
Cobalt	<0.01	<0.01	<0.01	0.13	0.05	0.08	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	0.72	0.43	0.56	5.50	1.84	3.18	1.84	0.62	1.07	0.50	0.17	0.29
Lead	0.14	0.08	0.10	2.87	1.43	2.03	0.89	0.45	0.63	0.58	0.29	0.41
Mercury	0.85	0.17	0.38	40.27	13.42	23.25	0.93	0.31	0.53	0.16	0.05	0.09
Nickel	0.13	0.06	0.09	4.69	1.69	2.81	0.06	0.02	0.03	0.06	0.02	0.03
Selenium	1.18	0.78	0.96	1.36	0.68	0.96	0.52	0.26	0.37	0.30	0.15	0.21
Silver	<0.01	<0.01	<0.01	1.54	0.15	0.49	<0.01	<0.01	<0.01	0.02	<0.01	<0.01
Thallium	0.02	<0.01	<0.01	0.16	0.03	0.07	<0.01	<0.01	<0.01	0.04	<0.01	0.02
Tin	<0.01	<0.01	<0.01	0.87	0.35	0.55	0.04	0.02	0.02	0.22	0.09	0.14
Vanadium	0.03	0.01	0.02	9.18	4.59	6.49	1.65	0.83	1.17	0.35	0.17	0.25
Zinc	0.45	0.42	0.43	3.31	1.28	2.06	0.53	0.21	0.33	0.23	0.09	0.14

Notes:

Shaded cells indicate a hazard quotient value greater than 1.0

NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level
MATC = Maximum Acceptable Toxicant Concentration
NA = Toxicity Reference Value not available (hazard quotient value could not be calculated)

TABLE 7-14
HAZARD QUOTIENT VALUES FOR AVIAN AND MAMMALIAN DIETARY EXPOSURES TO CHEMICALS IN SUBSURFACE SOIL: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Brown flower bat			American robin			Mourning dove			Red-tailed hawk		
	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC
Volatile Organics:												
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylenes, total	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PAHs:												
2-Methylnaphthalene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenz(a,h)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	0.11	0.02	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Metals:												
Antimony	0.31	0.03	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	0.05	0.03	0.04	0.12	0.06	0.09	0.03	0.02	0.02	<0.01	<0.01	<0.01
Barium	0.08	0.05	0.07	0.18	0.09	0.13	0.19	0.10	0.14	<0.01	<0.01	<0.01
Beryllium	0.03	0.03	0.03	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.25	0.02	0.08	3.12	0.72	1.50	0.12	0.03	0.06	0.08	0.02	0.04
Chromium, total	0.08	<0.01	0.02	3.85	0.66	1.59	0.10	0.02	0.04	0.06	0.01	0.02
Cobalt	<0.01	<0.01	<0.01	0.03	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

TABLE 7-14
HAZARD QUOTIENT VALUES FOR AVIAN AND MAMMALIAN DIETARY EXPOSURES TO CHEMICALS IN SUBSURFACE SOIL: STEP 2 SCREENING LEVEL RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Brown flower bat			American robin			Mourning dove			Red-tailed hawk		
	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC
Metals:												
Copper	0.29	0.17	0.22	1.27	0.43	0.74	0.43	0.14	0.25	0.35	0.12	0.20
Lead	0.14	0.07	0.10	2.64	1.32	1.87	0.83	0.41	0.59	0.55	0.28	0.39
Mercury	0.28	0.06	0.13	5.18	1.73	2.99	0.29	0.10	0.17	0.02	<0.01	0.01
Nickel	0.03	0.02	0.02	0.73	0.26	0.44	0.01	<0.01	<0.01	0.02	<0.01	0.01
Selenium	0.68	0.45	0.56	0.93	0.47	0.66	0.31	0.15	0.22	0.25	0.12	0.18
Silver	<0.01	<0.01	<0.01	0.74	0.07	0.23	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Thallium	<0.01	<0.01	<0.01	0.04	<0.01	0.02	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Tin	<0.01	<0.01	<0.01	0.87	0.35	0.55	0.04	0.02	0.02	0.22	0.09	0.14
Vanadium	<0.01	<0.01	<0.01	2.87	1.43	2.03	0.52	0.26	0.36	0.11	0.05	0.08
Zinc	0.14	0.13	0.14	1.50	0.58	0.93	0.15	0.06	0.09	0.20	0.08	0.12

Notes:

Shaded cells indicate a hazard quotient value greater than 1.0

NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level
MATC = Maximum Acceptable Toxicant Concentration
NA = Toxicity Reference Value not available (hazard quotient value could not be calculated)

TABLE 7-15
DIETARY COMPOSITION FOR UPPER TROPHIC LEVEL RECEPTORS: STEP 3A RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Receptor	Dietary Composition (percent)						Soil/Sediment Ingestion (percent)	
	Terrestrial Plants	Soil Invertebrates	Small Mammals	Aquatic Invertebrates	Fish	Reference	Value	Reference
Birds:								
American robin	7.3	83.0 (1)	0	0	0	Wheelwright et al. 1986	8.7 (2)	Sample and Suter II 1994
Mourning dove	95.0	0	0	0	0	Tomlinson et al. 1994	5.0	Assumed
Red-tailed hawk	0	0	100	0	0	USEPA 1993; Sample and Suter II 1994	0	Sample and Suter II 1994
Mammals:								
Brown flower bat	100	0	0	0	0	Gannon et al. 2005	0 (3)	Assumed
Norway rat (prey item for red-tailed hawk)	49.0	49.0	0	0	0	Assumed	2.0	Assumed

Notes:

USEPA = United States Environmental Protection Agency

(1) The value shown represents the highest seasonal percentage of invertebrates in the diet of the American robin as reported by Wheelwright et al. (1986).
(2) The percentage of soil in the diet of the American robin was estimated using the relationship presented in Sample and Sutter II (1994). A diet of 83 percent earthworms extrapolates to a soil contribution of 8.7 percent to the total diet.
(3) Soil ingestion is considered negligible based on the arboreal feeding behavior of nectivorous bats.

Table References:

Gannon, M.R., A. Kurta, A. Rodriguez-Durán, and M.R. Willig. 2005. Bats of Puerto Rico: An Island Focus and a Caribbean Perspective. Texas Tech University Press, Lubbock, TX. 239 pp.

Sample, B.E. and G.W. Suter II. 1994. Estimating Exposure of Terrestrial Wildlife to Contaminants. Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-125.

Tomlinson, R.E., D.D. Dolton, R.R. George, and R.R. Mirarchi. 1994. Mourning Dove. In T.C. Tacha and C.E. Braun (eds), Migratory Shore and Upland Game Bird Management in North America. Int. Assoc. Fish and Wildlife Agencies, Washington, D.C. pp. 1-26.

USEPA. 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.

Wheelwright, N. T. 1986. The Diet of American Robins: An Analysis of U.S. Biological Survey Records. Auk. 103: 710-725.

TABLE 7-16
EXPOSURE PARAMETERS FOR UPPER TROPHIC LEVEL RECEPTORS: STEP 3A RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Receptor	Habitat	Body Weight (kg)		Food Ingestion Rate (kg/day - dry)		Area Use Factor
		Value	Reference	Value	Reference	
Birds:						
American robin	Terrestrial	0.0785 (1)	Dunning 2008	0.01033	Allometric equation from Nagy (2001) for omnivorous birds (6): $[0.67((BW*1000)^{0.627})]/1000$	1.00
Mourning dove	Terrestrial	0.115 (2)	Dunning 2008	0.01646	Allometric equation from Nagy (2001) for all birds (6): $[0.638((BW*1000)^{0.685})]/1000$	1.00
Red-tailed hawk	Terrestrial	1.0945 (3)	Dunning 2008	0.08788	Allometric equation from Nagy (2001) for carnivorous birds (6): $[0.849((BW*1000)^{0.663})]/1000$	1.00
Mammals:						
Brown flower bat	Terrestrial	0.0183 (4)	Gannon et al. 2005	0.00257	Allometric equation from Nagy (2001) for bats (7): $[0.365((BW*1000)^{0.671})]/1000$	1.00
Norway rat (prey item for red-tailed hawk)	Terrestrial	0.350 (5)	Jackson 1992	0.03092	Allometric equation from Nagy (2001) for rodents (8): $[0.332((BW*1000)^{0.774})]/1000$	1.00

TABLE 7-16
EXPOSURE PARAMETERS FOR UPPER TROPHIC LEVEL RECEPTORS: STEP 3A RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes:

BW = Body Weight
kg = kilogram
L/day = liter per day
kg/day - dry = kilogram per day - dry weight basis
USEPA = United States Environmental Protection Agency

(1) Mean body weight for males and females from the western United States (n = 255).
(2) Mean mean body weight for males and females from Illinois (n = 95)
(3) Mean body weight for males and females from the western United States (n = 50)
(4) Mean body weight for males and females in Puerto Rico (n = 20)
(5) The body weight shown represents the midpoint within the range of reported values (sex and location not specified).
(6) Food ingestion rates for avian receptors were calculated using mean body weights: 0.115 kg for the mourning dove, 0.0785 kg for the American robin, 1.0945 kg for the red-tailed hawk, and 0.187 kg for the green heron (Dunning, 2008).
(7) Food ingestion rate for the brown flower bat were calculated using a mean body weight of 0.0183 kg (Gannon et al., 2005).
(8) Food ingestion rate for the Norway rat were calculated using the midpoint within the range of reported values: 0.350 kg (Jackson, 1992).

Table References:

Dunning, J.B., Jr. (ed.). 2008. CRC Handbook of Avian Body Masses, Second Edition. CRC Press, Boca Raton, FL. 655 pp.

Gannon, M.R., A. Kurta, A. Rodriguez-Durán, and M.R. Willig. 2005. Bats of Puerto Rico: An Island Focus and a Caribbean Perspective. Texas Tech University Press, Lubbock, TX. 239 pp.

Jackson, W.B. 1992. Norway Rat and Allies. Chapter 54 *In* Chapman, J.A. and G.A. Feldhamer (eds.), Wild Mammals of North America: Biology, Management, and Economics. The John Hopkins University Press, Baltimore MD. pp. 1077-1088.

Nagy, K. A. 2001. Food Requirements of Wild Animals: Predictive Equations for Free-Living Mammals, Reptiles, and Birds. Nutr. Abstr. Rev. Series B. 71:21R-31R.

TABLE 7-17
SOIL TO PLANT AND SOIL TO EARTHWORM BIOACCUMULATION FACTORS AND BIOACCUMULATION UPTAKE EQUATIONS
USED TO ESTIMATE CHEMICAL CONCENTRATIONS IN TERRESTRIAL PLANT AND INVERTEBRATE TISSUE: STEP 3A RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical [1]	Soil-Plant BAF (dry weight)			Soil-Invertebrate BAF (dry weight)		
	BAF Value/Uptake Equation	**Source Document**	**Description**	**BAF Value/Uptake Equation**	**Source Document**	**Description**
Metals:						
Beryllium	$In(C_p) = 0.7345[ln(C_s)] - 0.5361$	USEPA 2007	Uptake equation [2]	0.045	USEPA 2007	Median BAF [5]
Cadmium	$ln(C_p) = 0.546[ln(C_s)] - 0.475$	USEPA 2007	Uptake equation [3]	$ln(C_e) = 0.795[ln(C_s)] + 2.114$	USEPA 2007	Uptake equation [6]
Chromium, total	0.041	USEPA 2007	Median BAF [4]	0.306	USEPA 2007	Median BAF [7]
Copper	$ln(C_p) = 0.394[ln(C_s)] + 0.668$	USEPA 2007	Uptake equation [3]	$ln(C_e) = 0.264[ln(C_s)] + 1.675$	Sample et al. 1998	Uptake equation [8]
Lead	$ln(C_p) = 0.561[ln(C_s)] - 1.328$	USEPA 2007	Uptake equation [3]	$ln(C_e) = 0.807[ln(C_s)] - 2.18$	USEPA 2007	Uptake equation [6]
Mercury	$In(C_p) = 0.544[ln[C_s]) - 0.996$	Bechtel Jacobs 1998	Uptake equation [3]	1.693	Sample et al. 1998	Median BAF [9]
Nickel	$ln(C_p) = 0.748[ln(C_s)] - 2.224$	USEPA 2007	Uptake equation [3]	1.059	Sample et al. 1998	Median BAF [9]
Selenium	$ln(C_p) = 0.1.104[ln(C_s)] - 0.678$	USEPA 2007	Uptake equation [3]	$ln(C_e) = 0.733[ln(C_s)] - 0.075$	USEPA 2007	Uptake equation [6]
Silver	0.014	USEPA 2007	Median BAF [4]	2.045	USEPA 2007	Median BAF [5]
Vanadium	0.00485	USEPA 2007	Median BAF [4]	0.042	USEPA 2007	Median BAF [5]
Zinc	$ln(C_p) = 0.554[ln(C_s)] + 1.575$	USEPA 2007	Uptake equation [3]	$ln(C_e) = 0.328[ln(C_s)] + 4.449$	USEPA 2007	Uptake equation [6]

Notes:

USEPA = United States Environmental Protection Agency
BAF = Bioaccumulation Factor (unitless)
ln = natural logarithm
C_e = Concentration in earthworm tissue (mg/kg - dry weight)
C_p = Concentration in plant tissue (mg/kg - dry weight)
C_s = 95 percent UCL of the mean concentration in soil (mg/kg - dry weight) - for a given chemical, the maximum concentration is used if the number of detected results is less than eight

(1) The chemicals listed are those detected in surface and/or subsurface soil and identified as ecological COPCs in the Step 2 screening level risk calculation for the brown flower bat, American robin, and/or mourning dove. Non-detected chemicals identified as ecological COPCs because maximum exposure doses exceed toxicity reference values also are listed.

(2) The concentration in plant tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation; see Table 4a of USEPA, 2007) derived from measured BAF data (see Appendix A, Table A-2 of USEPA, 2007).

(3) The concentration in plant tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation; see Table 4a of USEPA[2007]) developed by Bechtel Jacobs (1998) and cited in Table 4a of USEPA (2007).

(4) Median BAF value listed in Table 4a of USEPA (2007). The value corresponds to the median BAF value listed in Appendix D, Table D-1 of Bechtel Jacobs (1998).

(5) Median BAF value listed in Table 4a of USEPA (2007). The value corresponds to the median BAF value listed in Appendix C, Table C-1 of Sample et al. (1998).

(6) The concentration in earthworm tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation) developed by Sample et al. (1998 and 1999) and cited in Table 4a of USEPA (2007).

(7) Median BAF value listed in Table 4a of USEPA (2007). The value corresponds to the median BAF value listed in Table 11 of Sample et al. (1998).

(8) The concentration in earthworm tissue was estimated using a chemical-specific bioaccumulation uptake equation (i.e., regression equation) listed in Table 12 of Sample et al. (1998).

(9) Median BAF value listed in Table 11 of Sample et al. (1998).

Table References:

Bechtel Jacobs. 1998. Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants. Prepared for U.S. Department of Energy. BJC/OR-133. September 1998.

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G.W. Suter II, and T.L. Ashwood. 1998. Development and Validation of Bioaccumulation Models for Earthworms. Oak Ridge National Laboratory, Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-220.

United States Environmental Protection Agency (USEPA). 2007. Attachemnt 4-1 of Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs): Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-55.

TABLE 7-18
SOIL BIOACCUMULATION FACTORS AND BIOACCUMULATION UPTAKE EQUATIONS USED TO ESTIMATE CHEMICAL CONCENTRATIONS IN SMALL MAMMAL TISSUE: STEP 3A RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical [1]	Soil-Small Mammal BAF (dry weight) or Uptake Equation (dry weight)		
	BAF Value/Uptake Equation	**Source Document**	**Description**
Metals:			
Beryllium	$C_m = [(BAF_d)(DI)]/0.32$	---	See Section 7.5.2.2.1 [2]

Notes:

USEPA = United States Environmental Protection Agency
BAF = Bioaccumulation Factor
COPC = Chemical of Potential Concern
C_m = Concentration in small mammal tissue (mg/kg - dry weight)
BAF_d = diet-to-small mammal bioaccumulation factor (wet weight)
DI = Small mammal dietary intake (mg/kg-BW/day)

[1] The chemicals listed are those detected in surface and/or subsurface soil and identified as ecological COPCs in the Step 2 screening level risk calculation for the red-tailed hawk. Non-detected chemicals identified as ecological COPCs because maximum exposure doses exceed toxicity reference values also are listed.

[2] Most chemical exposure for small mammals is via the diet. Therefore, it is assumed that the concentration of the chemical in the tissue of small mammals is equal to the chemical concentration in its diet multiplied by a diet-to-whole body BAF (BAF_d - wet weight basis). In the absence of literature-based diet-to whole-body BAF, a value of 1.0 was assumed. The resulting tissue concentration was converted to a dry weight basis using an estimated solids content for small mammals of 0.32 (USEPA, 1993). Additional explanation if provided in Section 7.5.2.2.1.

Table References:

United States Environmental Protection Agency (USEPA). 1993. Wildlife Exposure Factors Handbook. Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.2007.

TABLE 7-19
FREQUENCY AND RANGE OF SURFACE SOIL DATA (95 PERCENT UCL OF THE MEAN CONCENTRATIONS) COMPARED TO SOIL SCREENING VALUES FOR TERRESTRIAL PLANTS AND INVERTEBRATES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Contaminant Frequency/Range									
Ecological COPC [1]	**Frequency of Detection**	**Range of Positive Detections**	**Range of Non-Detects**	**Arithmetic Mean (Half Non-Detects)**	**95% UCL of the Mean [2]**	**Value used in Step 2 Screen [3]**	**Soil Screening Values (SSV)**	**Reference [4]**	**95% UCL of the Mean HQ [5]**	**Comments**
Metals (mg/kg)										
Arsenic	14/14	1.6 - 21	ND	5.093	7.447	21	18.0	USEPA 2005b	0.41	HQ < 1.0
Copper	14/14	9.3 - 550	ND	65.521	229.100	550	70.0	USEPA 2007b	3.27	HQ > 1.0
Mercury	11/14	0.0085J - 0.21	0.02U - 0.021U	0.027	0.056	0.21	0.10	Efroymson et al. 1997a	0.56	HQ < 1.0
Vanadium	14/14	13 - 64J	ND	36.143	44.420	64	20.0	USEPA 2005h	2.22	HQ > 1.0
Zinc	14/14	12 - 920	ND	135.786	413.000	920	120	USEPA 2007e	3.44	HQ < 1.0

Notes:

HQ = Hazard Quotient
SSV = Soil Screening Value
PAH = Polynuclear Aromatic Hydrocarbon
J = Estimated value
U = Not detected
USEPA = United States Environmental Protection Agency

(1) The ecological COPCs shown are those with a minimum of eight detected values.
(2) 95% Upper Conficence Limit of the mean concentrations were calculated using USEPA ProUCL Version 4.1.00 software (USEPA, 2010a and 2010b).
(3) Step 2 screening level risk estimates were derived using maximum detected concentrations.
(4) See Table 7-4 for reference citations.
(5) The 95% UCL of the mean HQ is the 95% UCL of the mean concentration divided by the soil screening value.

Table References:

United states Environmental Protection Agency (USEPA). 2010a. ProUCL Version 4.1.00 User Guide (Draft). Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. Office of Research and Development. EPA/600/R-07/041. May 2010. Available at: http://www.epa.gov/osp/hst/tsc/ProUCL_v4.1_user.pdf.

USEPA. 2010b. ProUCL Version 4.1.00 Technical Guide (Draft). Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. Office of Research and Development. EPA/600/R-07/041. Available at http://www.epa.gov/osp/hstl/tsc/ProUCL_v4.1_tech.pdf.

TABLE 7-20
SUMMARY OF DESCRIPTIVE AND DISTRIBUTIONAL STATISTICS FOR INORGANIC ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Population [1]	Descriptive Statistics [2]							Test for Normality [6]	Test for Lognormality [6]	Test for Homogeneity of Variance [7]	Distributional Statistics		
		Frequency of Detection	Range of Detections	Range of Non-Detections	Arithmetic Mean [3]	SE	95% UCL [4]	ULM [5]				Mean/Median of the Distribution	Right Tail of the Distribution [8] Quantile Test	Slippage Test
Arsenic	SWMU 74 - Fueling Piers Area	14/14	1.6 - 21	NA	5.09	1.28	7.45	--	Test was not performed [9]	Test was not performed [9]	Variances are not equal at α = 0.05 (p < 0.0001)	Gehan test [11]; G(4.435) > Z (1.645); Elevated a α = 0.05	Elevated at α = 0.05	Elevated at α = 0.05
	NAPR Background	14/20	0.21J - 2.5J	0.69UJ - 1.8U	1.18	0.17	1.50	2.70	Test was not performed [9]	Test was not performed [9]				
Beryllium	SWMU 74 - Fueling Piers Area	11/14	0.059J - 0.25	0.038U -0.11U	0.09	0.02	0.12	--	Not normal at α = 0.05 (p = 0.0002)	Not lognormal at α = 0.05 (p = 0.0192)	Variances are not equal at α = 0.05 (p = 0.0042)	Gehan test [12]; G(-2.193) < Z (1.645); Not elevated a α = 0.05	Not elevated at α = 0.05	Not elevated at α = 0.05
	NAPR Background	16/18	0.085B - 0.58	0.04U -0.1U	0.28	0.04	0.35	0.60	Normal at α = 0.05 (p = 0.7580)	Not lognormal at α = 0.05 (p = 0.0051)				
Cadmium	SWMU 74 - Fueling Piers Area	14/14	0.047J - 1.8	NA	0.44	0.14	0.79	--	Test was not performed [9]	Test was not performed [9]	Test was not performed [10]	Gehan test [11]; G(1.124) < Z (1.645); Not elevated at α = 0.05	Test was not performed [16]	Test was not performed [17]
	NAPR Background	7/20	0.18J - 0.92J	0.059U - 1.2U	0.26	0.06	0.36	0.76	Test was not performed [9]	Test was not performed [9]				
Chromium	SWMU 74 - Fueling Piers Area	14/14	4.2 - 27	NA	12.90	1.66	15.84	--	Normal at α = 0.05 (p = 0.7750)	Lognormal at α = 0.05 (p = 0.8681)	Variances are not equal at α = 0.05 (p = 0.0298)	Satterthwait's t-test [13]; Not elevated at α = 0.05 (p = 0.9995) Power < 0.0001	Not elevated at α = 0.05	Not elevated at α = 0.05
	NAPR Background	20/20	5.9J - 47	NA	25.69	2.73	30.42	50.13	Normal at α = 0.05 (p = 0.1109)	Not lognormal at α = 0.05 (p = 0.0134)				
Copper	SWMU 74 - Fueling Piers Area	14/14	9.3 - 550	NA	65.52	37.53	229.10	--	Not normal at α = 0.05 (p < 0.0001)	Not lognormal at α = 0.05 (p = 0.0109)	Variances are not equal at α = 0.05 (p < 0.0001)	Gehan test [12]; G(-2.855) < Z (1.645); Not elevated at α = 0.05	Not elevated at α = 0.05	Not elevated at α = 0.05
	NAPR Background	18/18	13N - 180	NA	77.11	11.01	96.27	170.56	Normal at α = 0.05 (p = 0.1418)	Lognormal at α = 0.05 (p = 0.5606)				
Lead	SWMU 74 - Fueling Piers Area	12/12	3.5 - 120	NA	32.46	10.26	61.29	--	Not normal at α = 0.05 (p = 0.0220)	Lognormal at α = 0.05 (p = 0.3050)	Variances are equal at α = 0.05 (p = 0.1868)	Two sample t-test [14]; Elevated at α = 0.05 (p = 0.0043); Power = 0.8696	Elevated at α = 0.05	Elevated at α = 0.06
	NAPR Background	18/18	2 - 21J	NA	8.68	1.62	12.38	22.42	Not normal at α = 0.05 (p = 0.0055)	Lognormal at α = 0.05 (p = 0.0670)				
Mercury	SWMU 74 - Fueling Piers Area	11/14	0.0085J - 0.21	0.02U - 0.021U	0.03	0.01	0.06	--	Test was not performed [9]	Test was not performed [9]	Variances are not equal at α = 0.05 (p = 0.0218)	Gehan test [11]; G(-3.472) < Z (1.645); Not elevated a α = 0.05	Not elevated at α = 0.05	Not elevated at α = 0.05
	NAPR Background	17/20	0.012B - 0.12J	0.02U - 0.04U	0.05	0.01	0.06	0.11	Test was not performed [9]	Test was not performed [9]				
Nickel	SWMU 74 - Fueling Piers Area	14/14	2.2 - 27	NA	6.62	1.67	9.51	---	Not normal at α = 0.05 (p = 0.0002)	Lognormal at α = 0.05 (p = 0.1595)	Variances are equal at α = 0.05 (p = 0.4120)	Two sample t-test [14]; Not elevated at α = 0.05 (p = 0.9878); Power < 0.0001	Not elevated at α = 0.05	Not elevated at α = 0.05
	NAPR Background	19/19	3.4B - 19	NA	10.54	1.20	13.08	20.99	Not normal at α = 0.05 (p = 0.0460)	Lognormal at α = 0.05 (p = 0.1374)				
Selenium	SWMU 74 - Fueling Piers Area	7/14	0.26J - 1.8	0.97U - 1.1U	0.76	0.11	---	---	Test was not performed [9]	Test was not performed [9]	Test was not performed [10]	Test was not performed [15]	Test was not performed [16]	Test was not performed [17]
	NAPR Background	5/20	0.45J - 1.2J	0.13UJ - 2.1UJ	0.51	0.07	0.65	1.12	Test was not performed [9]	Test was not performed [9]				
Silver	SWMU 74 - Fueling Piers Area	5/14	0.04J - 0.84	0.2U - 0.21U	0.21	0.07	---	---	Test was not performed [9]	Test was not performed [9]	Test was not performed [10]	Test was not performed [15]	Test was not performed [16]	Test was not performed [18]
	NAPR Background	0/20	ND	0.067U - 1.2U	0.20	0.04	---	0.60	Test was not performed [9]	Test was not performed [9]				
Vanadium	SWMU 74 - Fueling Piers Area	14/14	13 - 64J	NA	36.14	4.67	44.42	---	Normal at α = 0.05 (p = 0.2138)	Lognormal at α = 0.05 (p = 0.4866)	Variances are not equal at α = 0.05 (p = 0.0007)	Satterthwait's t-test [12]; Not elevated at α = 0.05 (p = 1.0000) Power < 0.0001	Not elevated at α = 0.05	Not elevated at α = 0.05
	NAPR Background	18/18	35 - 230	NA	141.57	13.85	165.70	259.11	Normal at α = 0.05 (p = 0.4146)	Lognormal at α = 0.05 (p = 0.0730)				

TABLE 7-20
SUMMARY OF DESCRIPTIVE AND DISTRIBUTIONAL STATISTICS FOR INORGANIC ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Population [1]	Descriptive Statistics [2]							Test for Normality [6]	Test for Lognormality [6]	Test for Homogeneity of Variance [7]	Distributional Statistics		
		Frequency of Detection	Range of Detections	Range of Non-Detections	Arithmetic Mean [3]	SE	95% UCL [4]	ULM [5]				Mean/Median of the Distribution	Right Tail of the Distribution [8]	
													Quantile Test	Slippage Test
Zinc	SWMU 74 - Fueling Piers Area	14/14	12 - 920	NA	135.79	63.60	413.00	---	Not normal at α = 0.05 (p< 0.0001)	Lognormal at α = 0.05 (p = 0.1375)	Variances are equal at α = 0.05 (p = 0.0958)	Two sample t-test [14]; Not elevated at α = 0.05 (p = 0.1312); Power = 0.2987	Not elevated at α = 0.05	Elevated at α = 0.05
	NAPR Background	18/18	6.2E - 120E	NA	52.48	7.62	65.73	117.14	Normal at α = 0.05 (p = 0.1552)	Lognormal at α = 0.05 (p = 0.2416)				

Notes:

J = Estimated value
U = Not detected
UJ = Not detected, estimated value
E = The reported concentrations is estimated due to the presence of matrix interference
NA = Not Applicable
ND = Not Detected
SE = Standard Error
95% UCL = 95 Percent Upper Confidence Limit of the Mean
ULM = Upper Limit of the Mean

(1) Background surface soil analytical data taken from Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds, Naval Activity Puerto Rico, Ceiba, Puerto Rico (Baker, 2010).
(2) Units in mg/kg.
(3) For those data sets with non-detected results, one-half non-detected values were used in the calculation of arithmetic mean concentrations.
(4) 95 percent upper conficence limit of the mean concentrations were calculated using USEPA ProUCL Version 4.1.00 software (USEPA, 2010).
(5) Upper limit of the mean concentration is equal to the mean plus two standard deviations.
(6) Normality and lognormality verified by the Shapiro-Wilks test. For a given metal, tests for normality and lognormality were performed if each individual data set (Fueling Piers Area and and background) has less than fifteen percent non-detected results (NFESC, 2002).
(7) Homogeneity of variance verified by F test. For a given metal, the test for homogeneity of variance was performed if each individual data set (Fueling Piers Area and background) has less than forty percent non-detected results (NFESC, 2002).
(8) Quantile and slippage tests only determine if a particular inorganic chemical is likely present at equivalent or elevated concentrations relative to background (NFESC, 2002).
(9) Test for normality/lognormality were not performed because the number of non-detected results in the Fueling Piers Area and/or background data set exceeds fifteen percent (NFESC, 2002).
(10) Test for homogeneity of variance was not performed because the number of non-detected results in the Fueling Piers Area and/or background data set exceeds forty percent (NFESC, 2002).
(11) The Gehan test was used because: (a) the number of non-detected results in the Fueling Piers Area and/or background data sets is greater than fifteen percent; (b) there are less than than fifty percent non-detected results in the combined Fueling Piers Area and background data set; and (c) there is more than one value for non-detected results within the background data set (NFESC, 2002).
(12) Gehan test was used because (a) each data set does not exhibit either a normal or lognormal distribution; (b) the Fueling Piers Area and background data set distributions do not have equal variences; and (c) there is more than one value for non-detected results within the background and/or Fueling Piers Area data set (NFESC, 2002).
(13) Satterthwaite t-test was used because: (a) there are less than fifteen percent non-detected results in the combined data set (Fueling Piers Area and background); (b) each data set has a normal or lognormal distribution; and (c) the Fueling Piers Area and background data set variances are not equal (NFESC, 2002).
(14) Two sample t-test was used because: (a) there are less than fifteen percent non-detected results in the Fueling Piers Area and background data sets; (b) each data set exhibits either a normal or lognormal distribution; and (c) the Fueling Piers Area and background data set distributions have equal variances (NFESC, 2002).
(15) A statistical evaluation of the mean/median of the distributions was not performed because there are greater than fifty percent non-detected results in the combined Fueling Piers Area and background data sets (NFESC, 2002).
(16) Quantile test was not performed because (a) non-detected results within the Fueling Piers Area and/or background data set are greater than the smallest of the "r" largest detected results in the combined data set; or (b) there are 100 percent non-detected results in the background data set (NFESC, 2002).
(17) The slippage test was not performed because the largest detected results for the background data set is less than the largest non-detected result (NFESC, 2002).
(18) The slippage test was not performed because there were 100 percent non-detected results in the background data set (NFESC, 2002).

Table references:

Baker Environmental, Inc. (Baker). 2010. Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds, Naval Activity Puerto Rico, Ceiba, Puerto Rico. July 30, 2010.

Naval Facilities Engineering Service Center (NFESC). 2002. Guidance for Environmental Background Analysis. Volume I: Soil. NFESC User's Guide UG-209-ENV. April 2002.

USEPA, 2010. ProUCLVersion 4.1.00 May 2010. http://www.epa.gov/osp/hstl/tsc/software.htm.

TABLE 7-21
COMPARISON OF FUELING PIERS AREA AND BACKGROUND SUBSURFACE SOIL ANALYTICAL DATA FOR INORGANIC ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Ecological COPC [1]	SWMU 74 - Fueling Piers Area Contaminant Frequency/Range				Background Frequency/Range [2][3]				Is Maximum SWMU Concentration greater than the Upper Limit of the Mean Background Concentration
	No. of Positive Detects/No. of Samples	Range of Positive Detections	Range of Non-Detects	Arithmetic Mean (Half Non-Detects)	No. of Positive Detects/No. of Samples	Range of Positive Detections	Range of Non-Detects	Upper Limit of the Mean Concentration	
Metals (mg/kg)									
Beryllium	2/6	0.054J - 0.072J	0.11U	0.058	9/14	0.18B - 0.87	0.05U - 0.06U	0.933	No
Cadmium	3/6	0.029J - 2.8	0.11U	0.506	4/15	0.3 - 0.62	0.07U - 0.97U	0.57	Yes
Chromium	6/6	3.5 - 13	NA	7.883	15/15	2.7 - 52	NA	47.9	No
Copper	6/6	1.9 - 53	NA	16.217	13/13	22N - 131	NA	120	No
Lead	6/6	0.32J - 110	NA	20.865	13/14	0.47J - 7.8	0.5U	6.2	Yes
Mercury	5/6	0.0098J - 0.027	0.021U	0.014	2/15	0.022 - 0.06	0.02U - 0.18U	0.067	No
Selenium	0/6	ND	1U - 1.1U	0.542	2/13	0.21J - 1J	0.16UJ - 2.1U	1.19	No
Vanadium	6/6	5.1J - 20J	NA	12.600	14/14	24 - 232	NA	256	No
Zinc	6/6	1.9J - 110	NA	30.050	12/12	14E - 98.5J	NA	92	Yes

Notes:

COPC = Chemical of Potential Concern
mg/kg = milligram per kilogram
B = The compound was detected at a concentration less than the reporting limit, but greater than the method detection limit
N = The matrix spike recovery was not within the control limit
E = The reported concentrations is estimated due to the presence of matrix interference
U = Not Detected
UJ = Not Detected (estimated value)
J = Detected (estimated value)
ND = Not Detected
NA = Not Applicable

(1) The chemicals listed are those identified as ecological COPCs for terrestrial invertebrates and plants and/or avian food web exposures in Step 2 of the screening level ecological risk assessme
(2) Background subsurface soil analytical data taken from Addendum B of the Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compound (Baker, 2010).
(3) The descriptive statistics shown are for the background subsurface soil data set classified as “fine sand/silt”

Table References:

Baker Environmental, Inc. (Baker). 2010. Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds, Naval Activity Puerto Rico, Ceiba, Puerto Ric. July 30, 2010.

TABLE 7-22
HAZARD QUOTIENT VALUES FOR AVIAN AND MAMMALIAN DIETARY EXPOSURES TO ECOLOGICAL CHEMCIALS OF CONCERN IN SURFACE SOIL: STEP 3A RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Ecological COPC	Brown flower bat			American robin			Mourning dove			Red-tailed hawk		
	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC
Metals:												
Beryllium	---	---	---	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	---	---	---	0.52	0.12	0.25	0.05	0.01	0.03	---	---	---
Chromium, total	---	---	---	0.27	0.05	0.11	0.08	0.01	0.03	---	---	---
Copper	---	---	---	1.29	0.43	0.75	0.96	0.32	0.56	---	---	---
Lead	---	---	---	0.66	0.33	0.46	0.49	0.25	0.35	---	---	---
Mercury	---	---	---	0.45	0.15	0.26	0.42	0.14	0.24	---	---	---
Nickel	---	---	---	0.18	0.07	0.11	0.02	<0.01	0.01	---	---	---
Selenium	0.21	0.14	0.17	0.44	0.22	0.31	---	---	---	---	---	---
Silver	---	---	---	0.10	<0.01	0.03	---	---	---	---	---	---
Vanadium	---	---	---	2.08	1.04	1.47	1.01	0.50	0.71	---	---	---
Zinc	---	---	---	1.11	0.43	0.69	0.31	0.12	0.19	---	---	---

Notes:

Shaded cells indicate a hazard quotient value greater than 1.0

NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level
MATC = Maximum Acceptable Toxicant Concentration
NA = Refined risk estimate could not be calculated (Toxicity Reference Value not available from the literature)
--- = Refined risk estimate was not calculated (chemical does not present an unacceptable risk as determined by the Step 2 screening level risk calculation [see Table 7-13])

TABLE 7-23
HAZARD QUOTIENT VALUES FOR AVIAN AND MAMMALIAN DIETARY EXPOSURES TO ECOLOGICAL CHEMCIALS OF CONCERN IN SUBSURFACE SOIL: STEP 3A RISK CALCULATION
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Ecological COPC	Brown flower bat			American robin			Mourning dove			Red-tailed hawk		
	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC	NOAEL	LOAEL	MATC
Metals:												
Beryllium	---	---	---	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	---	---	---	1.42	0.33	0.68	---	---	---	---	---	---
Chromium, total	---	---	---	0.22	0.04	0.09	---	---	---	---	---	---
Copper	---	---	---	0.58	0.20	0.34	---	---	---	---	---	---
Lead	---	---	---	1.13	0.57	0.80	---	---	---	---	---	---
Mercury	---	---	---	0.22	0.07	0.13	---	---	---	---	---	---
Vanadium	---	---	---	0.94	0.47	0.66	---	---	---	---	---	---
Zinc	---	---	---	0.69	0.27	0.43	---	---	---	---	---	---

Notes:

Shaded cells indicate a hazard quotient value greater than 1.0

NOAEL = No Observed Adverse Effect Level
LOAEL = Lowest Observed Adverse Effect Level
MATC = Maximum Acceptable Toxicant Concentration
NA = Refined risk estimate could not be calculated (Toxicity Reference Value not available from the literature)
--- = Refined risk estimate was not calculated (chemical does not present an unacceptable risk as determined by the Step 2 screening level risk calculation [see Table 7-13])

TABLE 7-24
SUMMARY OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN AND ECOLOGICAL CHEMICALS OF CONCERN
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemcials	Lower Trophic Level Receptor Groups (1)		Upper Trophic Level Receptors (2)	
	Surface Soil	**Subsurface Soil**	**Surface soil**	**Subsurface Soil**
Ecological COCS Identified in Step 3a of the BERA	None	None	None	None
Ecological COPCs Identified in Step 2 of the SERA	Carbon disulfide Arsenic Copper Mercury Selenium Vanadium Zinc 27 non-detected VOCs (3)	Selenium 28 non-detected VOCs (4)	Beryllium Cadmium Chromium Copper lead Mercury Nickel Selenium Silver Vanadium Zinc 9 non-detected VOCs (5)	Beryllium Cadmium Chromium Copper Lead Mercury Vanadium Zinc 9 non-detected VOCs (6)

Notes:

SERA = Screening Level Ecological Risk Assessment
BERA = Baseline Ecological Risk Assessment
COPC = Chemical of Potential Concern
COC = Chemical of Concern
VOC = Volatile Organic Compound

(1) The lower trophic level receptor groups evaluated by the ecological risk assessment were Terrestrial plants and invertebrates
(2) The upper trophic level receptors evaluated by the ecological risk assessment were avian and mammalian herbivores, avian omnivores, and avian carnivores.
(3) See Table 7-11 for the specific non-detected VOCs identified as ecological COPCs in Step 2 of the SERA for surface soil.
(4) See Table 7-12 for the specific non-detected VOCs identified as ecological COPCs in Step 2 of the SERA for subsurface soil.
(5) See Table 7-13 for the specific non-detected VOCs identified as ecological COPCs in Step 2 of the SERA for avian/mammalin detary exposures.
(6) See Table 7-14 for the specific non-detected VOCs identified as ecological COPCs in Step 2 of the SERA for avian/mammalian dietary exposures.

TABLE 8-1

SURFACE SOIL DATA AND COPC SELECTION SUMMARY
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Criteria [1]	Contaminant Frequency / Range / Location			Background [2]	COPC Selection		Exposure Concentration Selection		
Contaminant	RegionaI Screening Level Residential Soil	No. of Positive Detects / No. of Samples	Range of Positive Detections	Location of Maximum Detection	Upper Limit of Means (ULM)	Selected as a COPC?	Rationale for Selection or Deletion	95% UCL [3] (ProUCL)	Exposure Concentration	Rationale for Concentration Selection
Volatile Organic Compounds (ug/kg)										
Carbon disulfide	82,000	2/14	5.5 J - 5.9	74SB754-00	NA	NO	BSL	NA	NA	NA
LLPAHs (ug/kg)										
2-Methylnaphthalene	31,000	1/13	4.2 J	74SB756-00	NA	NO	BSL	NA	NA	NA
Acenaphthene	340,000	2/13	3.8 J - 9.4	74SB760-00	NA	NO	BSL	NA	NA	NA
Acenaphthylene	340,000 [4][5]	3/13	11 - 17	74SB759-00, 74SB760-00	NA	NO	BSL	NA	NA	NA
Anthracene	1,700,000	6/13	4 J - 52	74SB760-00	NA	NO	BSL	NA	NA	NA
Benzo[a]anthracene	150	8/13	13 - 190	74SB749-00	NA	YES	ASL	110 (NP)	110	95% KM (t) UCL
Benzo[a]pyrene	15.0	12/13	20 - 200	74SB750-00	NA	YES	ASL	127 (NP)	127	95% KM (t) UCL
Benzo[b]fluoranthene	150	9/13	36 - 270 J	74SB759-00	NA	YES	ASL	169 (NP)	169	95% KM (t) UCL
Benzo[g,h,i]perylene	170,000 [4][6]	10/13	24 - 170	74SB749-00	NA	NO	BSL	NA	NA	NA
Benzo[k]fluoranthene *	1,500	9/13	33 - 230 J	74SB759-00	NA	YES	CHEM	146 (NP)	146	95% KM (t) UCL
Chrysene *	15,000	11/13	31 - 250	74SB760-00	NA	YES	CHEM	142 (NP)	142	95% KM (t) UCL
Dibenz(a,h)anthracene	15.0	4/13	20 - 57 J	74SB749-00	NA	YES	ASL	40.2 (NP)	40.2	95% KM (t) UCL
Fluoranthene	230,000	9/13	32 - 400	74SB760-00	NA	NO	BSL	NA	NA	NA
Fluorene	230,000	2/13	3.6 J - 7.6	74SB760-00	NA	NO	BSL	NA	NA	NA
Indeno[1,2,3-cd]pyrene *	150	9/13	5 J - 110	74SB749-00	NA	YES	CHEM	53.2 (NP)	53.2	95% KM (t) UCL
Phenanthrene	170,000 [4][6]	9/13	6.2 J - 180	74SB760-00	NA	NO	BSL	NA	NA	NA
Pyrene	170,000	10/13	33 - 430	74SB760-00	NA	NO	BSL	NA	NA	NA
TPH DRO and GRO (mg/kg)										
Diesel Range Organics	100 [7]	14/14	24 - 410	74SB748-00	ND	YES	ASL	207 (L)	207	95% H-UCL
Gasoline Range Organics	100 [7]	8/14	0.12 J - 2,500 J	74SB748-00	ND	YES	ASL	2,011 (NP)	2,011	99% KM (Chebyshev) UCL
Metals (mg/kg)										
Antimony	3.10	2/14	1.8 J - 2.9	74SB749-00	2.46	NO	BSL	NA	NA	NA
Arsenic	0.390	14/14	1.6 - 21	74SB756-00	2.70	YES	ASL	7.45 (L)	8.03	See Total Soil Exposure
Barium	1,500	14/14	15 J - 190 J	74SB748-00	203	NO	BSL	NA	NA	NA
Beryllium	16.0	11/14	0.059 J - 0.25	74SB753-00	0.595	NO	BSL	NA	NA	NA
Cadmium	7.0	14/14	0.047 J - 1.8	74SB755-00	5.53	NO	BSL	NA	NA	NA
Chromium	12,000 [4][8]	14/14	4.2 - 27	74SB756-00	50.1	NO	BSL	NA	NA	NA
Cobalt	2.30	14/14	1.7 J - 10 J	74SB755-00, 74SB756-00	23.6	YES	ASL	6.82 (N)	6.82	95% Student's-t UCL
Copper	310	14/14	9.3 - 550	74SB758-00	171	YES	ASL	229 (NP)	229	95% Chebyshev (Mean, Sd) UCL
Lead	400 [9]	12/12	3.5 - 120	74SB749-00	10.9	NO	BSL	NA	NA	NA
Mercury	1.0	11/14	0.0085 J - 0.21	74SB756-00	0.111	NO	BSL	NA	NA	NA
Nickel	150	14/14	2.2 - 27	74SB756-00	12.7	NO	BSL	NA	NA	NA
Selenium	39.0	7/14	0.26 J - 1.8	74SB753-00	1.12	NO	BSL	NA	NA	NA
Silver	39.0	5/14	0.04 J - 0.84	74SB749-00	ND	NO	BSL	NA	NA	NA

TABLE 8-1

SURFACE SOIL DATA AND COPC SELECTION SUMMARY
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Contaminant	Criteria (1)	Contaminant Frequency / Range / Location			Background (2)	COPC Selection		Exposure Concentration Selection		
	Regional Screening Level Residential Soil	No. of Positive Detects / No. of Samples	Range of Positive Detections	Location of Maximum Detection	Upper Limit of Means (ULM)	Selected as a COPC?	Rationale for Selection or Deletion	95% UCL (3) (ProUCL)	Exposure Concentration	Rationale for Concentration Selection
Metals (mg/kg)(Continued)										
Thallium	0.0780	5/14	0.054 J - 0.21 J	74SB755-00	ND	YES	ASL	0.139 (NP)	0.139	95% KM (t) UCL
Vanadium	39.0	14/14	13 - 64 J	74SB753-00	259	YES	ASL	44.4 (N)	44.4	95% Student's-t UCL
Zinc	2,300	14/14	12 - 920	74SB750-00	117	NO	BSL	NA	NA	NA

Notes:

COPC - Chemical of Potential Concern
J - Analyte present - Reported value is estimated
NA - Not Applicable
ND - Not Detected
UCL - Upper Confidence Limit
ULM - Upper Limit of Means

mg/kg = milligrams per kilogram
ug/kg = microgram per kilogram

Rationale Codes:

(ASL) Above Screening Level
(CHEM) Same Chemical Class
(BSL) Below Screening Level

Shaded constituents were identified as COPCs for quantitative risk evaluation.
* These compounds were retained because one or more of its related carcinogenic PAHs were retained, and these compounds are known to exist together in mixtures

(1) All non-carcinogenic criteria were divided by 10 to account for potential additive effects of chemicals.
USEPA Regional Screening Levels, Residential Soil (June 2011)
(2) Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2010): Upper Limit of Mean (Mean+2 Std Dev)
(3) ProUCL was used to calculate the 95% UCL and distribution (>8 samples and >4 detections):
(N) - Normal distribution
(NP) - Nonparametric distribution
(L) - Lognormal distribution
(4) Noncarcinogenic Regional Screening Levels based on a target hazard quotient of 0.1 for conservative screening purposes.
(5) Value for **acenaphthene** used as a surrogate.
(6) Value for **pyrene** used as a surrogate.
(7) Puerto Rico specific value
(8) Value for **chromium III** used as a surrogate.
(9) USEPA Residential Soil Action Level

TABLE 8-2

TOTAL SOIL DATA AND COPC SELECTION SUMMARY
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Contaminant	Criteria [(1)]		Contaminant Frequency / Range / Location			Background [(2)]	COPC Selection		Exposure Concentration Selection		
	Regional Screening Level Residential Soil		No. of Positive Detects / No. of Samples	Range of Positive Detections	Location of Maximum Detection	Upper Limit of Means (ULM)	Selected as a COPC?	Rationale for Selection or Deletion	95% UCL [(3)] (ProUCL)	Exposure Concentration	Rationale for Concentration Selection
Volatile Organic Compounds (ug/kg)											
Carbon disulfide	82,000		3/24	5.5 J - 12	74SB232-05	NA	NO	BSL	NA	NA	NA
LLPAHs (ug/kg)											
2-Methylnaphthalene	31,000		1/19	4.2 J	74SB756-00	NA	NO	BSL	NA	NA	NA
Acenaphthene	340,000		2/19	3.8 J - 9.4	74SB760-00	NA	NO	BSL	NA	NA	NA
Acenaphthylene	340,000	(4)(5)	3/19	11 - 17	74SB759-00, 74SB760-00	NA	NO	BSL	NA	NA	NA
Anthracene	1,700,000		7/19	4 J - 52	74SB760-00	NA	NO	BSL	NA	NA	NA
Benzo[a]anthracene	150		10/19	13 - 190	74SB749-00	NA	YES	ASL	84.0 (NP)	110	See Surface Soil Exposure
Benzo[a]pyrene	15.0		16/19	20 - 200	74SB750-00	NA	YES	ASL	102 (NP)	127	See Surface Soil Exposure
Benzo[b]fluoranthene	150		12/19	4.7 J - 270 J	74SB759-00	NA	YES	ASL	129 (NP)	169	See Surface Soil Exposure
Benzo[g,h,i]perylene	170,000	(4)(6)	12/19	24 - 170	74SB749-00	NA	NO	BSL	NA	NA	NA
Benzo[k]fluoranthene *	1,500		13/19	2.3 J - 230 J	74SB759-00	NA	YES	CHEM	112 (NP)	146	See Surface Soil Exposure
Chrysene *	15,000		14/19	24 - 250	74SB760-00	NA	YES	CHEM	111 (NP)	142	See Surface Soil Exposure
Dibenz(a,h)anthracene	15.0		5/19	10 - 57 J	74SB749-00	NA	YES	ASL	30.3 (NP)	40.2	See Surface Soil Exposure
Fluoranthene	230,000		11/19	10 - 400	74SB760-00	NA	NO	BSL	NA	NA	NA
Fluorene	230,000		2/19	3.6 J - 7.6	74SB760-00	NA	NO	BSL	NA	NA	NA
Indeno[1,2,3-cd]pyrene *	150		11/19	5 J - 110	74SB749-00	NA	YES	CHEM	44.1 (NP)	53.2	See Surface Soil Exposure
Phenanthrene	170,000	(4)(6)	10/19	6.2 J - 180	74SB760-00	NA	NO	BSL	NA	NA	NA
Pyrene	170,000		12/19	15 - 430	74SB760-00	NA	NO	BSL	NA	NA	NA
TPH DRO and GRO (mg/kg)											
Diesel Range Organics	100	(7)	20/24	15 - 410	74SB748-00	ND	YES	ASL	169 (NP)	207	See Surface Soil Exposure
Gasoline Range Organics	100	(7)	14/24	0.12 J - 2,500 J	74SB748-00	ND	YES	ASL	1,163 (NP)	2,011	See Surface Soil Exposure
Metals (mg/kg)											
Antimony	3.10		3/24	1.8 J - 2.9	74SB749-00, 74SB749-01	3.94	NO	BSL	NA	NA	NA
Arsenic	0.390		24/24	1.6 - 21	74SB756-00	2.92	YES	ASL	8.03 (NP)	8.03	95% Chebyshev (Mean, Sd) UCL
Barium	1,500		24/24	8.4 - 190 J	74SB748-00	203	NO	BSL	NA	NA	NA
Beryllium	16.0		14/24	0.054 J - 0.25	74SB753-00	0.760	NO	BSL	NA	NA	NA
Cadmium	7.0		18/24	0.029 J - 2.8	74SB749-01	0.679	NO	BSL	NA	NA	NA
Chromium	12,000	(5)(8)	24/24	1.8 - 27	74SB756-00	49.1	NO	BSL	NA	NA	NA
Cobalt	2.30		24/24	0.37 - 10 J	74SB755-00, 74SB756-00	53.8	YES	ASL	5.13 (G)	6.82	See Surface Soil Exposure
Copper	310		21/24	1.9 - 550	74SB758-00	152	YES	ASL	183 (NP)	229	See Surface Soil Exposure
Lead	400	(9)	19/22	0.32 J - 120	74SB749-00	18.2	NO	BSL	NA	NA	NA
Mercury	1.0		16/24	0.0063 J - 0.21	74SB756-00	0.0998	NO	BSL	NA	NA	NA
Nickel	150		24/24	0.86 - 27	74SB756-00	23.5	NO	BSL	NA	NA	NA
Selenium	39.0		7/24	0.26 J - 1.8	74SB753-00	1.14	NO	BSL	NA	NA	NA
Silver	39.0		7/24	0.04 J - 0.84	74SB749-00	0.605	NO	BSL	NA	NA	NA

TABLE 8-2

TOTAL SOIL DATA AND COPC SELECTION SUMMARY
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Criteria (1)	Contaminant Frequency / Range / Location			Background (2)	COPC Selection		Exposure Concentration Selection		
Contaminant	RegionaI Screening Level Residential Soil	No. of Positive Detects / No. of Samples	Range of Positive Detections	Location of Maximum Detection	Upper Limit of Means (ULM)	Selected as a COPC?	Rationale for Selection or Deletion	95% UCL (3) (ProUCL)	Exposure Concentration	Rationale for Concentration Selection
Metals (mg/kg) (Continued)										
Thallium	0.0780	6/24	0.054 J - 0.21 J	74SB755-00	0.644	YES	ASL	0.114 (NP)	0.139	See Surface Soil Exposure
Vanadium	39.0	24/24	2.9 - 64 J	74SB753-00	257	YES	ASL	34.9 (G)	44.4	See Surface Soil Exposure
Zinc	2,300	23/24	0.88 J - 920	74SB750-00	107	NO	BSL	NA	NA	NA

Notes:

NA - Not Applicable
ND - Not Detected
COPC - Chemical of Potential Concern
UCL - Upper Confidence Limit
ULM - Upper Limit of Means
mg/kg = milligrams per kilogram
ug/kg = microgram per kilogram

J - Analyte present - Reported value is estimated

Rationale Codes:
(ASL) Above Screening Level
(CHEM) Same Chemical Class
(BSL) Below Screening Level

Shaded constituents were identified as COPCs for quantitative risk evaluation.
* These compounds were retained because one or more of its related carcinogenic PAHs were retained, and these compounds are known to exist together in mixtures

(1) All non-carcinogenic criteria were divided by 10 to account for potential additive effects of chemicals.
USEPA Regional Screening Levels, Residential Soil (June 2011)
(2) Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2010): Upper Limit of Mean (Mean+2 Std Dev)
(3) ProUCL was used to calculate the 95% UCL and distribution (>8 samples and >4 detections):
(NP) - Nonparametric distribution
(G) - Gamma distribution
(4) Noncarcinogenic Regional Screening Levels based on a target hazard quotient of 0.1 for conservative screening purposes.
(5) Value for **acenaphthene** used as a surrogate.
(6) Value for **pyrene** used as a surrogate.
(7) Puerto Rico specific value
(8) Value for **chromium III** used as a surrogate.
(9) USEPA Residential Soil Action Level

TABLE 8-3

SUMMARY OF EXPOSURE PARAMETERS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Parameter	Units	Current and Future Adult Trespassers RME	Current and Future Youth Trespassers RME	Current and Future Adult On-Site Workers RME	Future Adult Residents RME	Future Young Child Residents RME	Future Adult Industrial / Commercial Workers RME	Future Adult Construction Workers RME
Soil								
Ingestion Rate of Soil (IR-S)	mg/day	100 USEPA, 1991	100 USEPA, 1991	100 USEPA, 2002	100 USEPA, 1991	200 USEPA, 1991	100 USEPA, 2002	330 USEPA, 2002
Fraction Ingested from Source (FI)	NA	1 Prof Judge (1)	1 Prof Judge (1)	1 Prof Judge (1)	1 Prof Judge (1)	1 Prof Judge (1)	1 Prof Judge (1)	1 Prof Judge (1)
Exposure Frequency (EF)	days/year	52 Prof Judge (2)	52 Prof Judge (2)	250 USEPA, 2004	350 USEPA, 2004	350 USEPA, 2004	250 USEPA, 2004	250 USEPA, 2004
Exposure Duration (ED)	years	24 USEPA, 1991	11 USEPA, 1991	25 USEPA, 2004	24 USEPA, 1991	6 USEPA, 1991	25 USEPA, 2004	1 Prof Judge (3)
Exposure Time (ET)	hours/day	2 USEPA, 1997 (4)	2 USEPA, 1997 (4)	8 Prof Judge (5)	24 Prof Judge (6)	24 Prof Judge (6)	8 Prof Judge (5)	8 Prof Judge (5)
Surface Area Available for Contact (SA)	cm2/day	5,700 USEPA, 2004	3,200 USEPA, 1997	3,300 USEPA, 2004	5,700 USEPA, 2004	2,800 USEPA, 2004	3,300 USEPA, 2004	3,300 USEPA, 2004
Conversion Factor (CF)	kg/mg	1.00E-06 USEPA, 1989	1.00E-06 USEPA, 1989	1.00E-06 USEPA, 1989	1.00E-06 USEPA, 1989	1.00E-06 USEPA, 1989	1.00E-06 USEPA, 1989	1.00E-06 USEPA, 1989
Averaging Time (Non-Cancer) (AT-N)	days	8,760 USEPA, 1989	4,015 USEPA, 1989	9,125 USEPA, 1989	8,760 USEPA, 1989	2,190 USEPA, 1989	9,125 USEPA, 1989	365 USEPA, 1989
Other Parameters								
Body Weight (BW)	kg	70 USEPA, 1997	45 USEPA, 1997	70 USEPA, 1997	70 USEPA, 1997	15 USEPA, 1997	70 USEPA, 1997	70 USEPA, 1997
Soil to Skin Adherence Factor (AF)	mg/cm2	0.07 USEPA, 2004	0.2 USEPA, 2004	0.2 USEPA, 2004	0.07 USEPA, 2004	0.2 USEPA, 2004	0.2 USEPA, 2004	0.3 USEPA, 2002
Particulate Emission Factor (PEF)	m3/kg	1.36E+09 USEPA, 2002	1.36E+09 USEPA, 2002	1.36E+09 USEPA, 2002	1.36E+09 USEPA, 2002	1.36E+09 USEPA, 2002	1.36E+09 USEPA, 2002	3.31E+06 USEPA, 2002
Averaging Time (Cancer) (AT-C)	days	25,550 USEPA, 1989	25,550 USEPA, 1989	25,550 USEPA, 1989	25,550 USEPA, 1989	25,550 USEPA, 1989	25,550 USEPA, 1989	25,550 USEPA, 1989

Notes:

RME - Reasonalble Maximum Exposure
CT - Central Tendency

Prof Judge - Professional Judgment
Gastrointestinal absorption efficiencies (GIABS), dermal absorption factors (ABS), and permeability constants (Kp) obtained from RAGS Part E (USEPA, 2004).

(1) Conservative assumption of 100% ingested from source.
(2) Assumes individuals trespass on site 1 day/week. This value represents the default value for NAPR but may be revised based on site-specific factors such as accessibility and attractiveness to trespassers.
(3) Assumes a construction period of 1 year.
(4) Recommended outdoor activity factor for adults.
(5) Assumes an 8 hour work day.
(6) Conservatively assumes receptor remains at residence 24 hours/day.

USEPA, 1989: Risk Assessment Guidance for Superfund Vol 1, Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
USEPA, 1991: Risk Assessment Guidance for Superfund Vol 1, Human Health Evaluation Manual Supplemental Guidance: Standard Default Exposure Factors.
USEPA, 1997: Exposure Factors Handbook. Vol. 1: General Factors. ORD. EPA/600/P-95/002Fa.
USEPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.
USEPA, 2004: Risk Assessment Guidance for Superfund Vol 1, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA/540/R-99/005.
Virginia Department of Environmental Quality (VDEQ), 2010. Virginia Voluntary Remediation Program Risk Assessment Guidance, Section 3.2.2 (http://www.deq.state.va.us/vrprisk/raguide.html). Accessed February 2010.

TABLE 8-4

HUMAN HEALTH RISK ASSESSMENT TOXICITY FACTORS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Constituents	Oral CSF $(mg/kg/day)^{-1}$	Inhalation UR $1/(\mu g/m^3)$	Oral RfD $(mg/kg/day)^{-1}$	Inhalation RfC (mg/m^3)	Oral Absorption Factors (1)	Oral to (2) Dermal Adjustment	WOE	Target Organ (Systemic Toxicity)	Critical Effect (Systemic Toxicity)
Volatiles									
Benzo[a]anthracene	7.30E-01	1.10E-04	NA	NA	0.13	100%	(o) B2, (i) D	NA	NA
Benzo[a]pyrene	7.30E+00	1.10E-03	NA	NA	0.13	100%	B2	NA	NA
Benzo[b]fluoranthene	7.30E-01	1.10E-04	NA	NA	0.13	100%	B2	NA	NA
Benzo[k]fluoranthene	7.30E-02	1.10E-04	NA	NA	0.13	100%	B2	NA	NA
Chrysene	7.30E-03	1.10E-05	NA	NA	0.13	100%	B2	NA	NA
Dibenz(a,h)anthracene	7.30E+00	1.20E-03	NA	NA	0.13	100%	(o) B2, (i) D	NA	NA
Indeno[1,2,3-cd]pyrene	7.30E-01	1.10E-04	NA	NA	0.13	100%	B2	NA	NA
Diesel Range Organics	NA	NA	NA	NA	NA	100%	(o) D, (i) B2	NA	NA
Gasoline Range Organics	NA	NA	NA	NA	NA	100%	D	NA	NA
Arsenic	1.50E+00	4.30E-03	3.00E-04	1.50E-05	0.03	100%	A	Skin / CVS	Skin / CVS: Hyperpigmentation, keratosis, possible vascular complications
Cobalt	NA	9.00E-03	3.00E-04	6.00E-06	0.01	100%	D	(o) CVS, (i) RsS	(o) - CVS: Blood; (i) - RsS: Lesions on the respiratory tract
Copper	NA	NA	4.00E-02	NA	0.01	100%	D	GIS	GIS: GIS Irritation
Thallium	NA	NA	1.00E-05	NA	0.01	100%	D	Liver / CVS / Skin	Liver / CVS / Skin: Increased levels of SGOT and LDH in blood
Vanadium	NA	NA	5.00E-03	NA	0.01	100%	D	GIS / Kidney	GIS / Kidney: Gastrointestinal disturbances, Discoloration of mouth and tongue

Notes:

CSF = Cancer Slope Factor
UR = Unit Risk
RfD = Reference Dose
RfC = Reference Concentration
WOE = Weight of Evidence

NA = Not Available
(o) = Toxicty due to oral exposure
(i) = Toxicity due to inhalation exposure

WOE / EPA Group:

A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

Known/Likely (EPA classes A, B1, B2, C)
Cannot be Determined (EPA class D)
Not Likely (EPA class E)

Target Organ Abbreviations:

CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

(1) - ABS - Absorption Factors
The following USEPA Region IV default absorbance factors will be applied in the absence of reference values from USEPA, 2004 to estimate dermal intake of COPCs in soil and sediment in tl
0.1% - Inorganics

(2) - Oral to dermal adjustment taken from RAGS Part E (USEPA, 2004)

TABLE 8-5
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	5.6E-09	--	2.9E-09	--	8.5E-09	NA	--	--	--	--
			Benzo[a]pyrene	6.5E-08	--	3.4E-08	--	9.8E-08	NA	--	--	--	--
			Benzo[b]fluoranthene	8.6E-09	--	4.5E-09	--	1.3E-08	NA	--	--	--	--
			Benzo[k]fluoranthene	7.4E-10	--	3.9E-10	--	1.1E-09	NA	--	--	--	--
			Chrysene	7.2E-11	--	3.8E-11	--	1.1E-10	NA	--	--	--	--
			Dibenz(a,h)anthracene	2.0E-08	--	1.1E-08	--	3.1E-08	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	2.7E-09	--	1.4E-09	--	4.1E-09	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	8.4E-07	--	1.0E-07	--	9.4E-07	Skin / CVS	<0.01	--	<0.01	<0.01
			Cobalt	--	--	--	--	--	CVS	<0.01	--	<0.01	<0.01
			Copper	--	--	--	--	--	GIS	<0.01	--	<0.01	<0.01
			Thallium	--	--	--	--	--	Liver / CVS / Skin	<0.01	--	<0.01	<0.01
			Vanadium	--	--	--	--	--	GIS / Kidney	<0.01	--	<0.01	<0.01
			Chemical Total	9.4E-07	--	1.5E-07	--	1.1E-06		0.02	--	<0.01	0.02
		Exposure Point Total						1.1E-06					0.02
	Exposure Medium Total							1.1E-06					0.02
	Air	Fugative Dust											
			Benzo[a]anthracene	--	2.8E-12	--	--	2.8E-12	NA	--	--	--	--
			Benzo[a]pyrene	--	1.7E-11	--	--	1.7E-11	NA	--	--	--	--
			Benzo[b]fluoranthene	--	3.6E-12	--	--	3.6E-12	NA	--	--	--	--
			Benzo[k]fluoranthene	--	1.5E-12	--	--	1.5E-12	NA	--	--	--	--
			Chrysene	--	2.3E-12	--	--	2.3E-12	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	2.4E-12	--	--	2.4E-12	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	3.1E-13	--	--	3.1E-13	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	1.0E-10	--	--	1.0E-10	NA	--	<0.01	--	<0.01
			Cobalt	--	1.8E-10	--	--	1.8E-10	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	3.2E-10	--	--	3.2E-10		--	<0.01	--	<0.01
		Exposure Point Total						3.2E-10					<0.01
	Exposure Medium Total							3.2E-10					<0.01
Soil Total								**1.10E-06**					**0.02**

TABLE 8-5
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Adult Trespassers Total								**1.10E-06**					**0.02**

Total Risk Across Soil	1.1E-06	Total Hazard Index Across Soil	0.02
Total Risk Across All Media and All Exposure Routes	1.1E-06	Total Hazard Index Across All Media and All Exposure Routes	0.02

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		<0.01	<0.01
Cardiovascular System HI =		0.01	0.01
Skin HI =		<0.01	<0.01
Kidney HI =		<0.01	<0.01
Liver HI =		<0.01	<0.01
Respiratory System HI =	<0.01		<0.01

TABLE 8-6
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	4.0E-09	--	3.3E-09	--	7.3E-09	NA	--	--	--	--
			Benzo[a]pyrene	4.6E-08	--	3.8E-08	--	8.4E-08	NA	--	--	--	--
			Benzo[b]fluoranthene	6.1E-09	--	5.1E-09	--	1.1E-08	NA	--	--	--	--
			Benzo[k]fluoranthene	5.3E-10	--	4.4E-10	--	9.7E-10	NA	--	--	--	--
			Chrysene	5.2E-11	--	4.3E-11	--	9.4E-11	NA	--	--	--	--
			Dibenz(a,h)anthracene	1.5E-08	--	1.2E-08	--	2.7E-08	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	1.9E-09	--	1.6E-09	--	3.5E-09	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	6.0E-07	--	1.2E-07	--	7.1E-07	Skin / CVS	<0.01	--	<0.01	0.01
			Cobalt	--	--	--	--	--	CVS	<0.01	--	<0.01	<0.01
			Copper	--	--	--	--	--	GIS	<0.01	--	<0.01	<0.01
			Thallium	--	--	--	--	--	Liver / CVS / Skin	<0.01	--	<0.01	<0.01
			Vanadium	--	--	--	--	--	GIS / Kidney	<0.01	--	<0.01	<0.01
			Chemical Total	6.7E-07	--	1.8E-07	--	8.5E-07		0.02	--	<0.01	0.03
		Exposure Point Total						8.5E-07					0.03
	Exposure Medium Total							8.5E-07					0.03
	Air	Fugative Dust											
			Benzo[a]anthracene	--	1.3E-12	--	--	1.3E-12	NA	--	--	--	--
			Benzo[a]pyrene	--	7.6E-12	--	--	7.6E-12	NA	--	--	--	--
			Benzo[b]fluoranthene	--	1.7E-12	--	--	1.7E-12	NA	--	--	--	--
			Benzo[k]fluoranthene	--	6.9E-13	--	--	6.9E-13	NA	--	--	--	--
			Chrysene	--	1.1E-12	--	--	1.1E-12	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	1.1E-12	--	--	1.1E-12	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	1.4E-13	--	--	1.4E-13	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	4.7E-11	--	--	4.7E-11	NA	--	<0.01	--	<0.01
			Cobalt	--	8.4E-11	--	--	8.4E-11	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	1.5E-10	--	--	1.5E-10		--	<0.01	--	<0.01
		Exposure Point Total						1.5E-10					<0.01
	Exposure Medium Total							1.5E-10					<0.01
Soil Total								**8.49E-07**					**0.03**

TABLE 8-6
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Youth Trespassers Total								**8.49E-07**					**0.03**

Total Risk Across Soil	8.5E-07
Total Risk Across All Media and All Exposure Routes	8.5E-07

Total Hazard Index Across Soil	0.03
ɔss All Media and All Exposure Routes	0.03

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		<0.01	<0.01
Cardiovascular System HI =		0.02	0.02
Skin HI =		0.01	0.01
Kidney HI =		<0.01	<0.01
Liver HI =		<0.01	<0.01
Respiratory System HI =	<0.01		<0.01

TABLE 8-7
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: On-Site Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	2.8E-08	--	2.4E-08	--	5.2E-08	NA	--	--	--	--
			Benzo[a]pyrene	3.2E-07	--	2.8E-07	--	6.0E-07	NA	--	--	--	--
			Benzo[b]fluoranthene	4.3E-08	--	3.7E-08	--	8.0E-08	NA	--	--	--	--
			Benzo[k]fluoranthene	3.7E-09	--	3.2E-09	--	6.9E-09	NA	--	--	--	--
			Chrysene	3.6E-10	--	3.1E-10	--	6.7E-10	NA	--	--	--	--
			Dibenz(a,h)anthracene	1.0E-07	--	8.8E-08	--	1.9E-07	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	1.4E-08	--	1.2E-08	--	2.5E-08	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	4.2E-06	--	8.3E-07	--	5.0E-06	Skin / CVS	0.03	--	<0.01	0.03
			Cobalt	--	--	--	--	--	CVS	0.02	--	<0.01	0.02
			Copper	--	--	--	--	--	GIS	<0.01	--	<0.01	<0.01
			Thallium	--	--	--	--	--	Liver / CVS / Skin	0.01	--	<0.01	0.01
			Vanadium	--	--	--	--	--	GIS / Kidney	<0.01	--	<0.01	<0.01
			Chemical Total	4.7E-06	--	1.3E-06	--	6.0E-06		0.08	--	<0.01	0.08
		Exposure Point Total						6.0E-06					0.08
	Exposure Medium Total							6.0E-06					0.08
	Air	Fugative Dust											
			Benzo[a]anthracene	--	5.5E-11	--	--	5.5E-11	NA	--	--	--	--
			Benzo[a]pyrene	--	3.3E-10	--	--	3.3E-10	NA	--	--	--	--
			Benzo[b]fluoranthene	--	7.3E-11	--	--	7.3E-11	NA	--	--	--	--
			Benzo[k]fluoranthene	--	3.0E-11	--	--	3.0E-11	NA	--	--	--	--
			Chrysene	--	4.7E-11	--	--	4.7E-11	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	4.8E-11	--	--	4.8E-11	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	6.2E-12	--	--	6.2E-12	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	2.1E-09	--	--	2.1E-09	NA	--	<0.01	--	<0.01
			Cobalt	--	3.7E-09	--	--	3.7E-09	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	6.3E-09	--	--	6.3E-09		--	<0.01	--	<0.01
		Exposure Point Total						6.3E-09					<0.01
	Exposure Medium Total							6.3E-09					<0.01
Soil Total								**6.01E-06**					**0.09**

TABLE 8-7
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: On-Site Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotien				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
On-Site Workers Total								**6.01E-06**					**0.09**

Total Risk Across Soil	6.0E-06	Total Hazard Index Across Soil	0.09
Total Risk Across All Media and All Exposure Routes	6.0E-06	oss All Media and All Exposure Routes	0.09

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		0.02	0.02
Cardiovascular System HI =		0.07	0.07
Skin HI =		0.05	0.05
Kidney HI =		<0.01	<0.01
Liver HI =		0.01	0.01
Respiratory System HI =	<0.01		<0.01

TABLE 8-8
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	6.3E-07	--	2.4E-07	--	8.7E-07	NA	--	--	--	--
			Benzo[a]pyrene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Benzo[b]fluoranthene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Benzo[k]fluoranthene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Chrysene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Dibenz(a,h)anthracene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	5.7E-06	--	6.8E-07	--	6.3E-06	Skin / CVS	0.04	--	<0.01	0.04
			Cobalt	--	--	--	--	--	CVS	0.03	--	<0.01	0.03
			Copper	--	--	--	--	--	GIS	<0.01	--	<0.01	<0.01
			Thallium	--	--	--	--	--	Liver / CVS / Skin	0.02	--	<0.01	0.02
			Vanadium	--	--	--	--	--	GIS / Kidney	0.01	--	<0.01	0.01
			Chemical Total	6.3E-06	--	9.2E-07	--	7.2E-06		0.11	--	<0.01	0.11
		Exposure Point Total						7.2E-06					0.11
	Exposure Medium Total							7.2E-06					0.11
	Air	Fugative Dust											
			Benzo[a]anthracene	--	1.8E-10	--	--	1.8E-10	NA	--	--	--	--
			Benzo[a]pyrene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Benzo[b]fluoranthene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Benzo[k]fluoranthene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Chrysene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	8.3E-09	--	--	8.3E-09	NA	--	<0.01	--	<0.01
			Cobalt	--	1.5E-08	--	--	1.5E-08	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	2.3E-08	--	--	2.3E-08		--	<0.01	--	<0.01
		Exposure Point Total						2.3E-08					<0.01
	Exposure Medium Total							2.3E-08					<0.01
Soil Total								**7.22E-06**					**0.12**

TABLE 8-8
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Adult Residents Total								**7.22E-06**					**0.12**

Total Risk Across Soil	7.2E-06
Total Risk Across All Media and All Exposure Routes	7.2E-06

Total Hazard Index Across Soil	0.12
ɔss All Media and All Exposure Routes	0.12

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		0.02	0.02
Cardiovascular System HI =		0.09	0.09
Skin HI =		0.06	0.06
Kidney HI =		0.01	0.01
Liver HI =		0.02	0.02
Respiratory System HI =	<0.01		<0.01

TABLE 8-9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Young Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	5.5E-07	--	2.0E-07	--	7.5E-07	NA	--	--	--	--
			Benzo[a]pyrene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Benzo[b]fluoranthene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Benzo[k]fluoranthene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Chrysene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Dibenz(a,h)anthracene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	1.3E-05	--	1.1E-06	--	1.4E-05	Skin / CVS	0.34	--	0.03	0.37
			Cobalt	--	--	--	--	--	CVS	0.29	--	<0.01	0.30
			Copper	--	--	--	--	--	GIS	0.07	--	<0.01	0.08
			Thallium	--	--	--	--	--	Liver / CVS / Skin	0.18	--	<0.01	0.18
			Vanadium	--	--	--	--	--	GIS / Kidney	0.11	--	<0.01	0.12
			Chemical Total	1.4E-05	--	1.3E-06	--	1.5E-05		1.00	--	0.05	**1.04**
		Exposure Point Total						1.5E-05					**1.04**
	Exposure Medium Total							1.5E-05					**1.04**
	Air	Fugative Dust											
			Benzo[a]anthracene	--	8.1E-11	--	--	8.1E-11	NA	--	--	--	--
			Benzo[a]pyrene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Benzo[b]fluoranthene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Benzo[k]fluoranthene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Chrysene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	2.1E-09	--	--	2.1E-09	NA	--	<0.01	--	<0.01
			Cobalt	--	3.7E-09	--	--	3.7E-09	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	5.9E-09	--	--	5.9E-09		--	<0.01	--	<0.01
		Exposure Point Total						5.9E-09					<0.01
	Exposure Medium Total							5.9E-09					<0.01
Soil Total								**1.51E-05**					**1.05**

TABLE 8-9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Young Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Young Child Residents Total								**1.51E-05**					**1.05**

Total Risk Across Soil	1.5E-05
Total Risk Across All Media and All Exposure Routes	1.5E-05

Total Hazard Index Across Soil	**1.05**
ɔss All Media and All Exposure Routes	**1.05**

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		0.19	0.19
Cardiovascular System HI =		0.85	0.85
Skin HI =		0.55	0.55
Kidney HI =		0.12	0.12
Liver HI =		0.18	0.18
Respiratory System HI =	<0.01		<0.01

TABLE 8-10
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Industrial / Commercial Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	2.8E-08	--	2.4E-08	--	5.2E-08	NA	--	--	--	--
			Benzo[a]pyrene	3.2E-07	--	2.8E-07	--	6.0E-07	NA	--	--	--	--
			Benzo[b]fluoranthene	4.3E-08	--	3.7E-08	--	8.0E-08	NA	--	--	--	--
			Benzo[k]fluoranthene	3.7E-09	--	3.2E-09	--	6.9E-09	NA	--	--	--	--
			Chrysene	3.6E-10	--	3.1E-10	--	6.7E-10	NA	--	--	--	--
			Dibenz(a,h)anthracene	1.0E-07	--	8.8E-08	--	1.9E-07	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	1.4E-08	--	1.2E-08	--	2.5E-08	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	4.2E-06	--	8.3E-07	--	5.0E-06	Skin / CVS	0.03	--	<0.01	0.03
			Cobalt	--	--	--	--	--	CVS	0.02	--	<0.01	0.02
			Copper	--	--	--	--	--	GIS	<0.01	--	<0.01	<0.01
			Thallium	--	--	--	--	--	Liver / CVS / Skin	0.01	--	<0.01	0.01
			Vanadium	--	--	--	--	--	GIS / Kidney	<0.01	--	<0.01	<0.01
			Chemical Total	4.7E-06	--	1.3E-06	--	6.0E-06		0.08	--	<0.01	0.08
		Exposure Point Total						6.0E-06					0.08
	Exposure Medium Total							6.0E-06					0.08
	Air	Fugative Dust											
			Benzo[a]anthracene	--	5.5E-11	--	--	5.5E-11	NA	--	--	--	--
			Benzo[a]pyrene	--	3.3E-10	--	--	3.3E-10	NA	--	--	--	--
			Benzo[b]fluoranthene	--	7.3E-11	--	--	7.3E-11	NA	--	--	--	--
			Benzo[k]fluoranthene	--	3.0E-11	--	--	3.0E-11	NA	--	--	--	--
			Chrysene	--	4.7E-11	--	--	4.7E-11	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	4.8E-11	--	--	4.8E-11	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	6.2E-12	--	--	6.2E-12	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	2.1E-09	--	--	2.1E-09	NA	--	<0.01	--	<0.01
			Cobalt	--	3.7E-09	--	--	3.7E-09	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	6.3E-09	--	--	6.3E-09		--	<0.01	--	<0.01
		Exposure Point Total						6.3E-09					<0.01
	Exposure Medium Total							6.3E-09					<0.01
Soil Total								**6.01E-06**					**0.09**

TABLE 8-10
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Industrial / Commercial Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Industrial / Commercial Workers Total								**6.01E-06**					**0.09**

Total Risk Across Soil	6.0E-06
Total Risk Across All Media and All Exposure Routes	6.0E-06

Total Hazard Index Across Soil	0.09
ɔss All Media and All Exposure Routes	0.09

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		0.02	0.02
Cardiovascular System HI =		0.07	0.07
Skin HI =		0.05	0.05
Kidney HI =		<0.01	<0.01
Liver HI =		0.01	0.01
Respiratory System HI =	<0.01		<0.01

TABLE 8-11
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	3.7E-09	--	1.4E-09	--	5.1E-09	NA	--	--	--	--
			Benzo[a]pyrene	4.3E-08	--	1.7E-08	--	5.9E-08	NA	--	--	--	--
			Benzo[b]fluoranthene	5.7E-09	--	2.2E-09	--	7.9E-09	NA	--	--	--	--
			Benzo[k]fluoranthene	4.9E-10	--	1.9E-10	--	6.8E-10	NA	--	--	--	--
			Chrysene	4.8E-11	--	1.9E-11	--	6.6E-11	NA	--	--	--	--
			Dibenz(a,h)anthracene	1.4E-08	--	5.3E-09	--	1.9E-08	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	1.8E-09	--	7.0E-10	--	2.5E-09	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	5.6E-07	--	5.0E-08	--	6.1E-07	Skin / CVS	0.09	--	<0.01	0.09
			Cobalt	--	--	--	--	--	CVS	0.07	--	<0.01	0.08
			Copper	--	--	--	--	--	GIS	0.02	--	<0.01	0.02
			Thallium	--	--	--	--	--	Liver / CVS / Skin	0.04	--	<0.01	0.05
			Vanadium	--	--	--	--	--	GIS / Kidney	0.03	--	<0.01	0.03
			Chemical Total	6.2E-07	--	7.7E-08	--	7.0E-07		0.25	--	0.01	0.26
		Exposure Point Total						7.0E-07					0.26
	Exposure Medium Total							7.0E-07					0.26
	Air	Fugative Dust											
			Benzo[a]anthracene	--	3.2E-11	--	--	3.2E-11	NA	--	--	--	--
			Benzo[a]pyrene	--	3.6E-10	--	--	3.6E-10	NA	--	--	--	--
			Benzo[b]fluoranthene	--	4.9E-11	--	--	4.9E-11	NA	--	--	--	--
			Benzo[k]fluoranthene	--	4.1E-11	--	--	4.1E-11	NA	--	--	--	--
			Chrysene	--	5.7E-12	--	--	5.7E-12	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	1.2E-10	--	--	1.2E-10	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	1.5E-11	--	--	1.5E-11	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	8.6E-08	--	--	8.6E-08	NA	--	0.09	--	0.09
			Cobalt	--	1.5E-07	--	--	1.5E-07	RsS	--	0.20	--	0.20
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	2.4E-07	--	--	2.4E-07		--	0.29	--	0.29
		Exposure Point Total						2.4E-07					0.29
	Exposure Medium Total							2.4E-07					0.29
Soil Total								**9.39E-07**					**0.56**

TABLE 8-11
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Construction Workers Total								**9.39E-07**					**0.56**

Total Risk Across Soil	9.4E-07	Total Hazard Index Across Soil	0.56
Total Risk Across All Media and All Exposure Routes	9.4E-07	ɔss All Media and All Exposure Routes	0.56

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		0.05	0.05
Cardiovascular System HI =		0.22	0.22
Skin HI =		0.14	0.14
Kidney HI =		0.03	0.03
Liver HI =		0.05	0.05
Respiratory System HI =	0.20		0.20

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

TABLE 8-12

SUMMARY OF UNCERTAINTIES IN THE RESULTS OF THE HUMAN HEALTH RISK ASSESSMENT FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS PHASE II INVESTIGATION AND CMS REPORT NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Potential Magnitude for Over-Estimation of Risks	Potential Magnitude for Under-Estimation of Risks	Potential Magnitude for Over or Under-Estimation of Risks
Environmental Sampling and Analysis			
Sufficient samples may not have been taken to characterize the media being evaluated.			Moderate
Systematic or random errors in the chemical analysis may yield erroneous data.			Low
Selection of COPCs			
The use of site-specific background and USEPA Regional Screening Levels in selecting COPCs in all media of concern.		Low	
Maximum detection limits in excess of screening levels.		Low	
Exposure Assessment			
The standard assumptions regarding body weight, exposure period, life expectancy, population characteristics, and lifestyle may not be representative of the actual exposure situations.			Moderate
The use of the 95th percentile upper confidence level data for the normal or lognormal distribution in the estimation of the RME.			Low
The amount of media intake is assumed to be constant and representative of any actual exposure.			Low
The use of an ABS of 0.01 for metals in the absence of reference values from USEPA RAGS Part E.	Moderate		
Toxicological Assessment			
Toxicological indices derived from high dose animal studies, extrapolated to low dose human exposure.	Moderate		
Chemicals lacking screening criteria.		Low	
Risk Characterization			
Assumption of additivity in the quantitation of cancer risks without consideration of synergism, antagonism, promotion and initiation.			Moderate
Assumption of additivity in the estimation of systemic health effects without consideration of synergism, antagonism, etc.			Moderate
Additivity of risks by individual exposure pathways (dermal and ingestion and inhalation).			Low

Notes:

Low - Assumptions categorized as “low” may effect risk estimates by less than one order of magnitude.
Moderate - Assumptions categorized as “moderate” may effect estimates of risk by between one and two orders of magnitude.
High - Assumptions categorized as “high” may effect estimates of risk by more than two orders of magnitude.

Source: Risk Assessment Guidance for Superfund, Volume 1, Part A: Human Health Evaluation Manual. USEPA, 1989.

FIGURES

K:_SOUTHNAVFAC\119197 JM01\SWMU 74\Fueling Piers Area\CAD\119197_74PIERS_01.dwg

4 0 2 4 8

1 inch = 4 miles

Baker

FIGURE 2-1
NAPR LOCATION MAP
FUELING PIERS AREA
SWMU 74-FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT

SOURCE: METRODATA, INC., 1999.

NAVAL ACTIVITY PUERTO RICO

LEGEND

– SWMUs

– AREA TO WHICH THIS INVESTIGATION PERTAINS

AOC D – AOCs

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

3000 0 1500 3000

1 inch = 3000 ft.

FIGURE 2–2
SWMU/AOC LOCATION MAP
FUELING PIERS AREA
SWMU 74–FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO

1200 0 600 1200

1 inch = 1200 ft.

Baker

LEGEND

—SWMU BOUNDARY

NOTE

SWMU 74 INCLUDES THE FUEL PIPELINES AND HYDRANT PITS.
SWMU 74 DOES NOT INCLUDE THE FUEL FARMS OR TANKS.

FIGURE 2–3
SWMU 74 LOCATION MAP
FUELING PIERS AREA
SWMU 74–FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT

NAVAL ACTIVITY PUERTO RICO

LEGEND

- SWMU 74 BOUNDARY
- GEOGRAPHIC AREAS OF SWMU 74

1200 0 600 1200

1 inch = 1200 ft.

Baker

SOURCE: USGS 2006

FIGURE 2–4
INDEX MAP OF SWMU 74 AREAS
FUELING PIERS AREA
SWMU 74–FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO

1200 0 600 1200

1 inch = 1200 ft.

Baker

SOURCE: USGS 2006

LEGEND

- ⊕ – SUBSURFACE SOIL AND GROUNDWATER SAMPLE LOCATION
- ○ – SUBSURFACE SOIL SAMPLE LOCATION
- ● (red) – TANK FAILED INTEGRITY TEST
- ● (green) – TANK AREA IMPACTED BY TVHC
- ● (orange) – VALVE PIT IMPACTED BY TVHC
- (orange) – PIPELINE/OTHER IMPACTED BY TVHC
- (blue line) – FUEL PIPELINE
- (pink line) – DFM PIPELINE
- (green line) – SWMU BOUNDARY

FIGURE 2-5
SAMPLE LOCATION MAP-PHASE II ECP INVESTIGATION
FUELING PIERS AREA
SWMU 74-FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO

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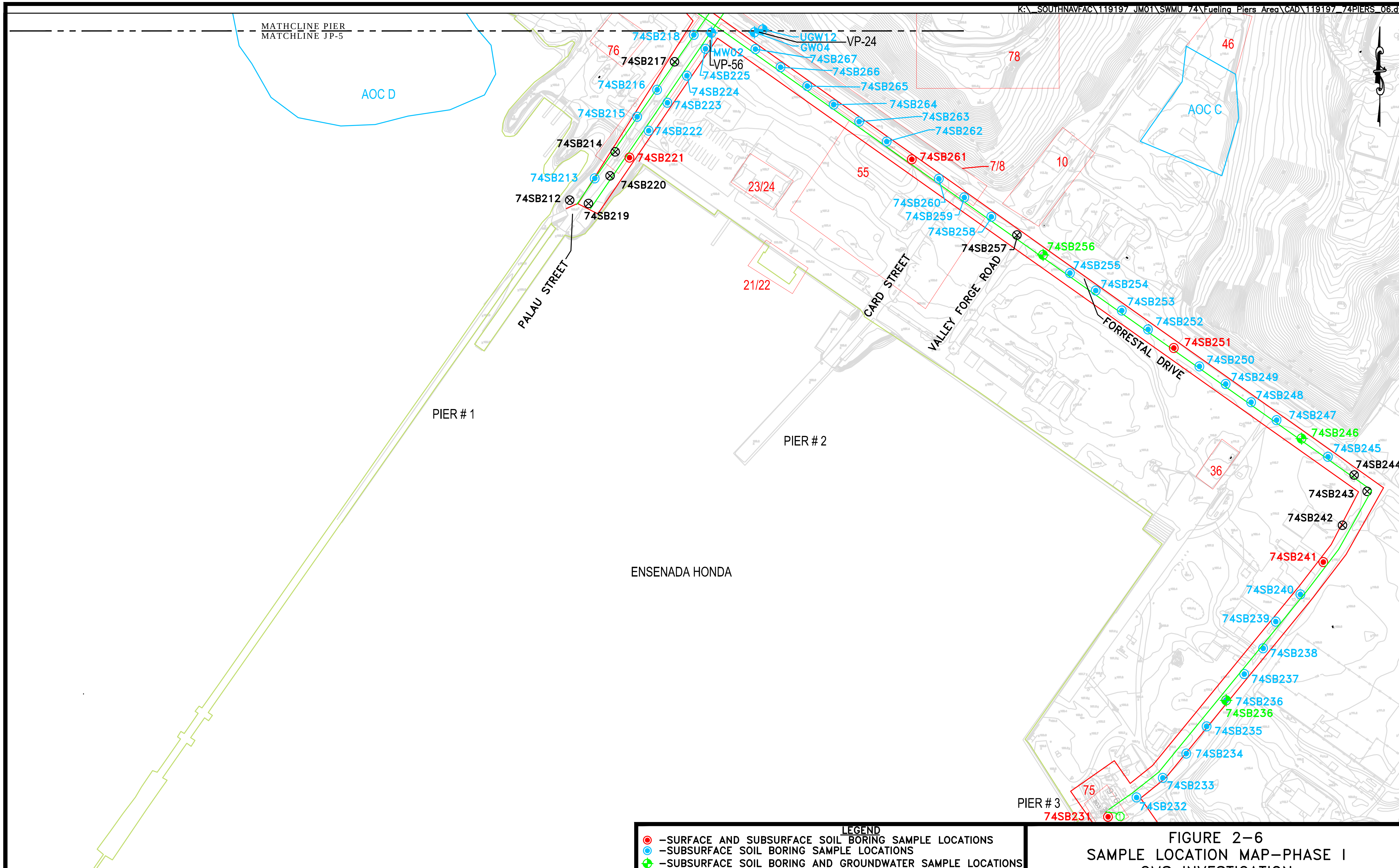
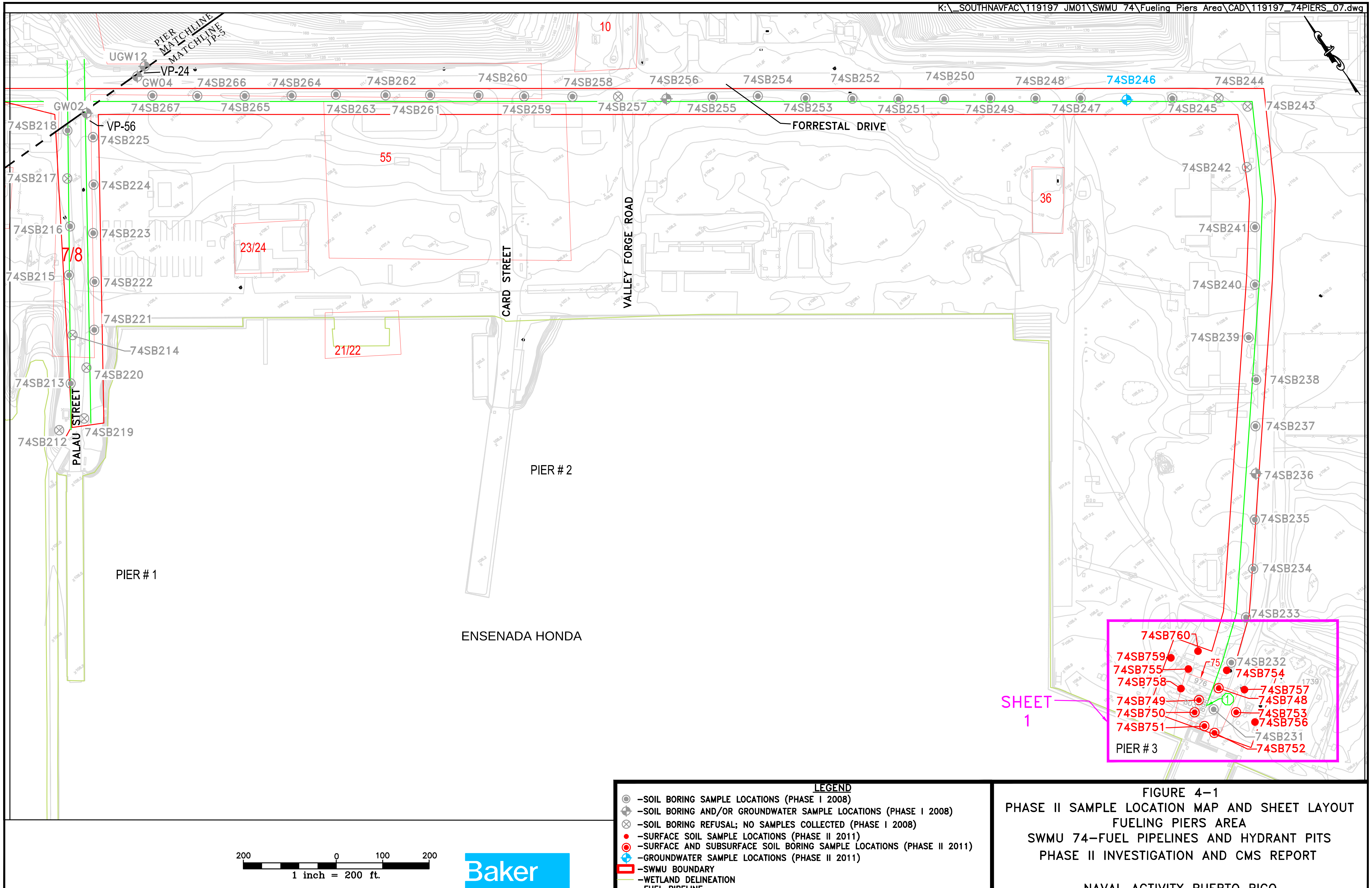


Baker

LEGEND

- SURFACE AND SUBSURFACE SOIL BORING SAMPLE LOCATIONS
- SUBSURFACE SOIL BORING SAMPLE LOCATIONS
- SUBSURFACE SOIL BORING AND GROUNDWATER SAMPLE LOCATIONS
- GROUNDWATER SAMPLE LOCATIONS
- SOIL BORING REFUSAL; NO SAMPLES COLLECTED
- FUEL PIPELINE
- WETLAND DELINEATION
- SWMU BOUNDARY
- FUEL PIPELINE CONTINUED TO BERTHING PIER #3

FIGURE 2-6
SAMPLE LOCATION MAP-PHASE I
CMS INVESTIGATION
FUELING PIERS AREA
SWMU 74-FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO

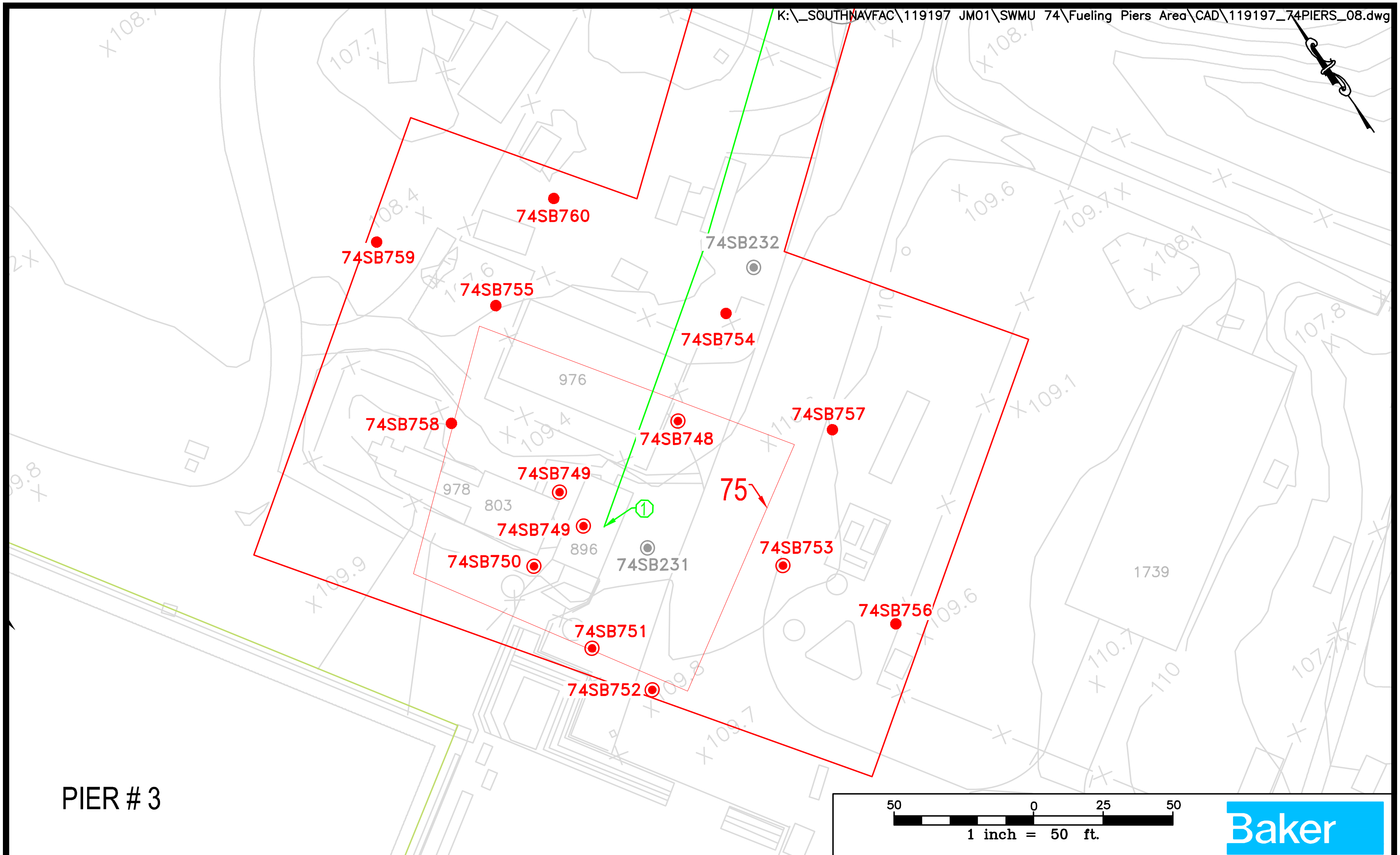


LEGEND

- SOIL BORING SAMPLE LOCATIONS (PHASE I 2008)
- SOIL BORING AND/OR GROUNDWATER SAMPLE LOCATIONS (PHASE I 2008)
- SOIL BORING REFUSAL; NO SAMPLES COLLECTED (PHASE I 2008)
- SURFACE SOIL SAMPLE LOCATIONS (PHASE II 2011)
- SURFACE AND SUBSURFACE SOIL BORING SAMPLE LOCATIONS (PHASE II 2011)
- GROUNDWATER SAMPLE LOCATIONS (PHASE II 2011)
- SWMU BOUNDARY
- WETLAND DELINEATION
- FUEL PIPELINE
- FUEL PIPELINE CONTINUED TO BERTHING PIER #3

FIGURE 4-1
PHASE II SAMPLE LOCATION MAP AND SHEET LAYOUT
FUELING PIERS AREA
SWMU 74-FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT

NAVAL ACTIVITY PUERTO RICO

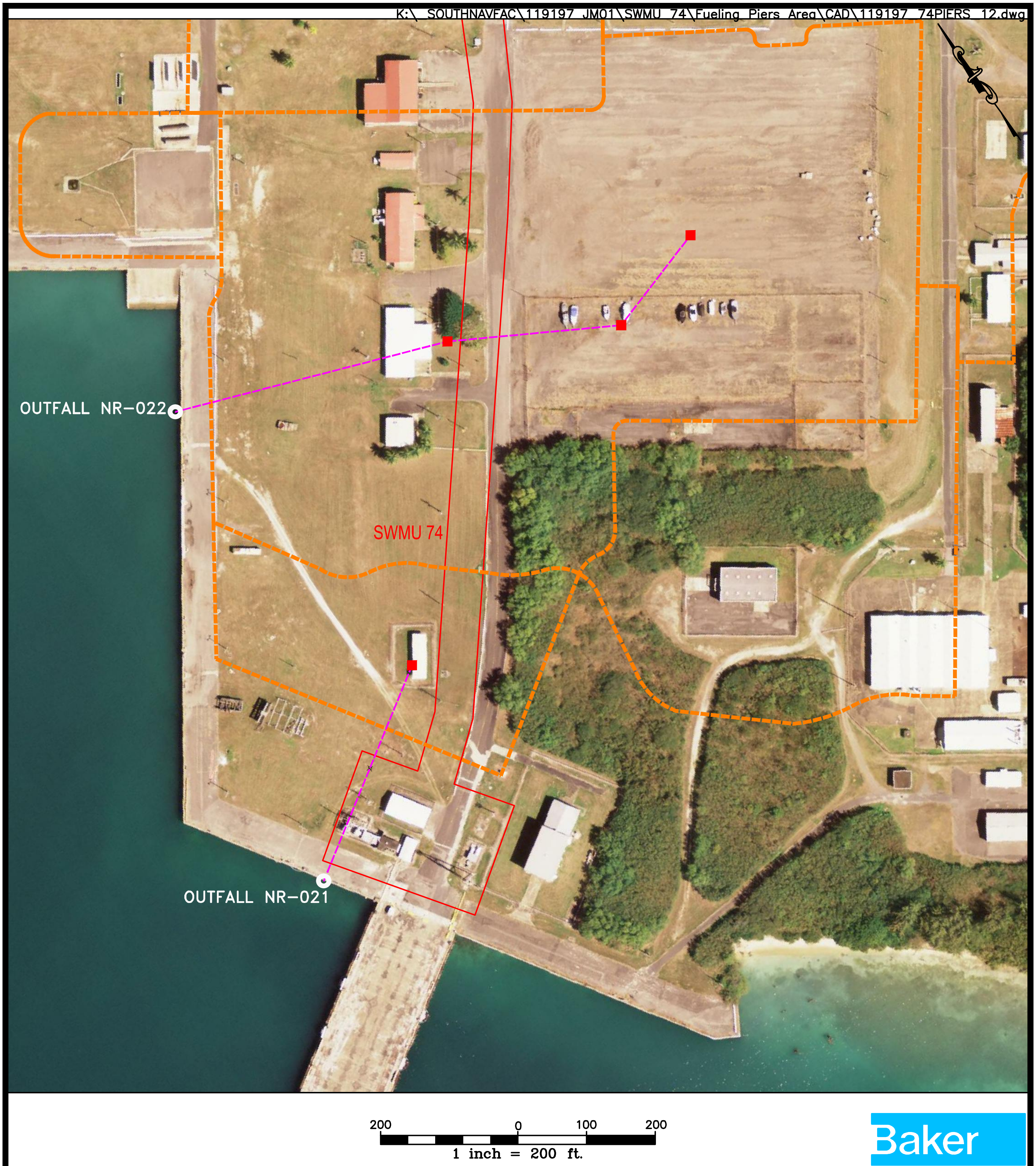


LEGEND

- SOIL BORING SAMPLE LOCATIONS (PHASE I 2008)
- SURFACE SOIL SAMPLE LOCATIONS (PHASE II 2011)
- SURFACE AND SUBSURFACE SOIL BORING SAMPLE LOCATIONS (PHASE II 2011)
- SWMU BOUNDARY
- WETLAND DELINEATION
- FUEL PIPELINE
- (1) FUEL PIPELINE CONTINUED TO BERTHING PIER #3

FIGURE 4-2
PHASE II SAMPLE LOCATION MAP, SHEET 1
FUELING PIERS AREA
SWMU 74-FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT

NAVAL ACTIVITY PUERTO RICO



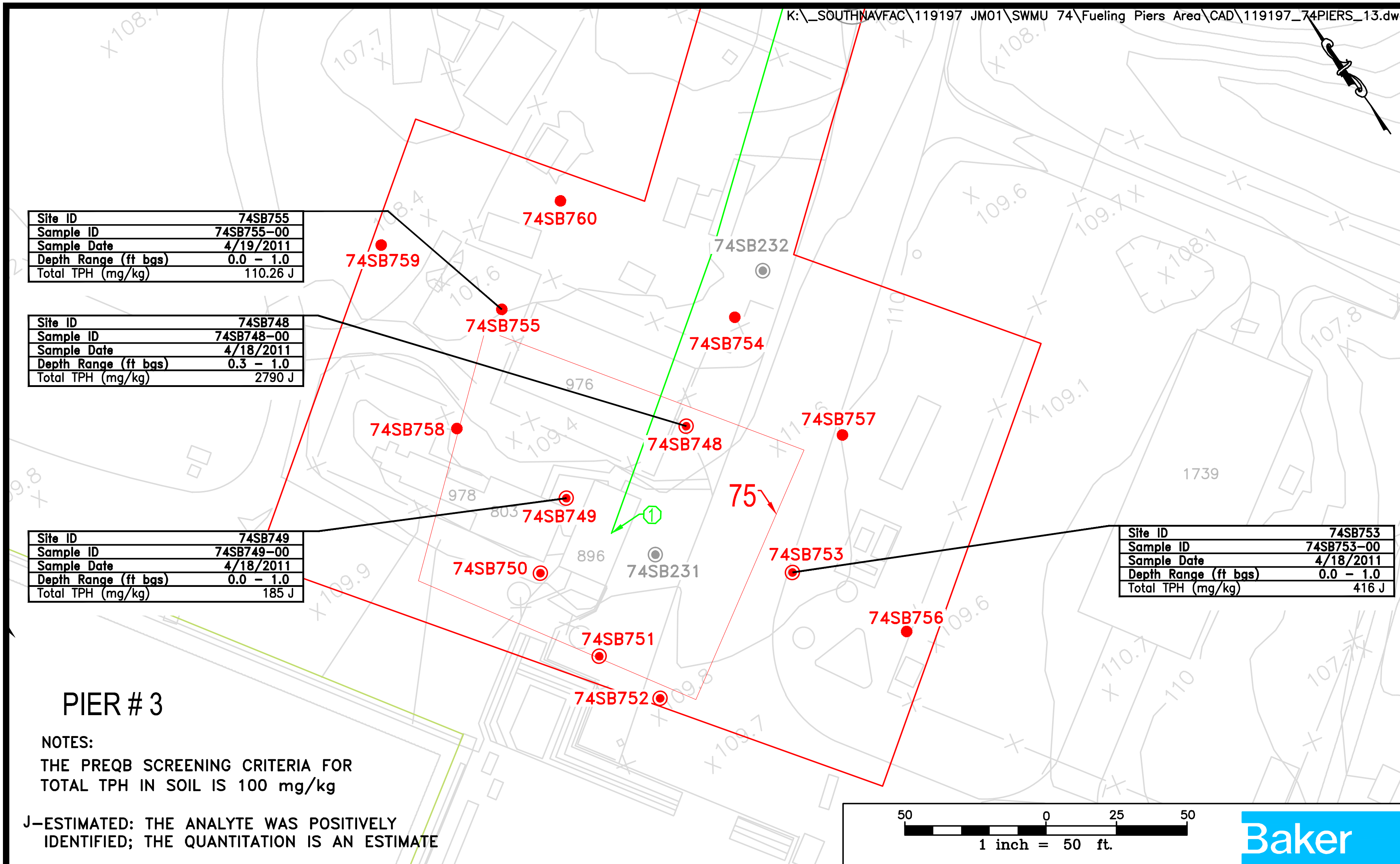
LEGEND

- SWMU BOUNDARY
- DRAINAGE BOUNDARY
- OUTFALLS
- DROP INLETS
- STORM SEWER

SOURCE: USGS 2006

FIGURE 5-1
DRAINAGE FEATURE MAP
FUELING PIERS AREA
SWMU 74-FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT

NAVAL ACTIVITY PUERTO RICO



NOTES:

THE PREQB SCREENING CRITERIA FOR TOTAL TPH IN SOIL IS 100 mg/kg

J–ESTIMATED: THE ANALYTE WAS POSITIVELY IDENTIFIED; THE QUANTITATION IS AN ESTIMATE

LEGEND

- –SOIL BORING SAMPLE LOCATIONS (PHASE I 2008)
- –SURFACE SOIL SAMPLE LOCATIONS (PHASE II 2011)
- –SURFACE AND SUBSURFACE SOIL BORING SAMPLE LOCATIONS (PHASE II 2011)
- –SWMU BOUNDARY
- –WETLAND DELINEATION
- –FUEL PIPELINE
- (1) –FUEL PIPELINE CONTINUED TO BERTHING PIER #3

FIGURE 6–1

TPH EXCEEDING PREQB SCREENING CRITERA IN SOIL

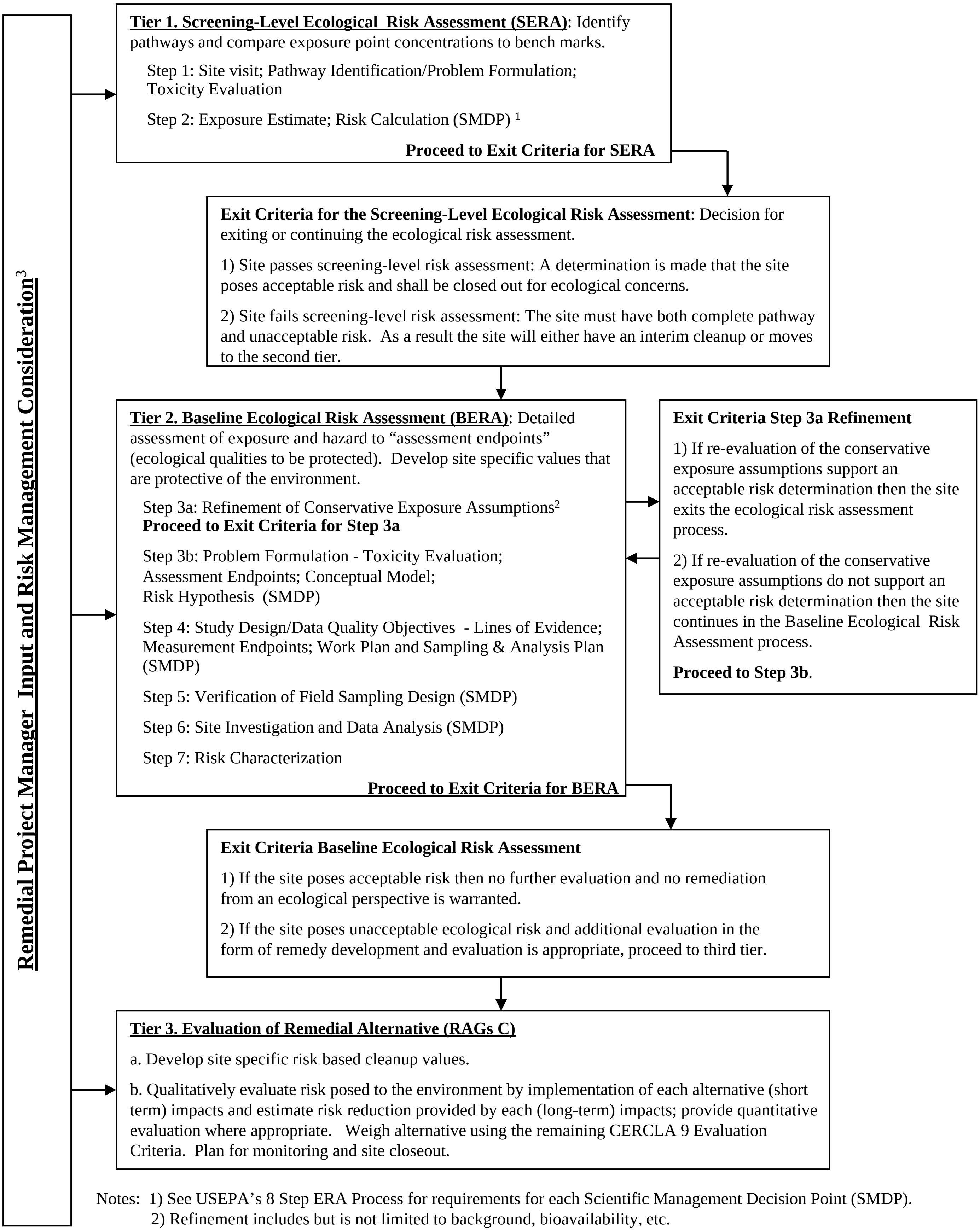
FUELING PIERS AREA

SWMU 74–FUEL PIPELINES AND HYDRANT PITS

PHASE II INVESTIGATION AND CMS REPORT

NAVAL ACTIVITY PUERTO RICO

Figure 7-1
Navy Ecological Risk Assessment Tiered Approach



Notes: 1) See USEPA's 8 Step ERA Process for requirements for each Scientific Management Decision Point (SMDP).
2) Refinement includes but is not limited to background, bioavailability, etc.
3) Risk management is incorporated throughout the tiered approach.

K:_SOUTHNAVFAC\119197_JM01\SWMU_74\Fueling_Piers_Area\CAD\119197_74PIERS_09.dwg

200 0 100 200

1 inch = 200 ft.

Baker

LEGEND

—SWMU BOUNDARY

SOURCE: USGS 2006

FIGURE 7–2
NOVEMBER 29, 2006 AERIAL PHOTOGRAPH
FUELING PIERS AREA
SWMU 74–FUEL PIPELINES AND HYDRANT PITS
PHASE II CORRECTIVE MEASURES STUDY REPORT

NAVAL ACTIVITY PUERTO RICO

K:_SOUTHNAVFAC\119197_JM01\SWMU_74\Fueling_Piers_Area\CAD\119197_74PIERS_10.dwg

200 0 100 200
1 inch = 200 ft.

Baker

LEGEND

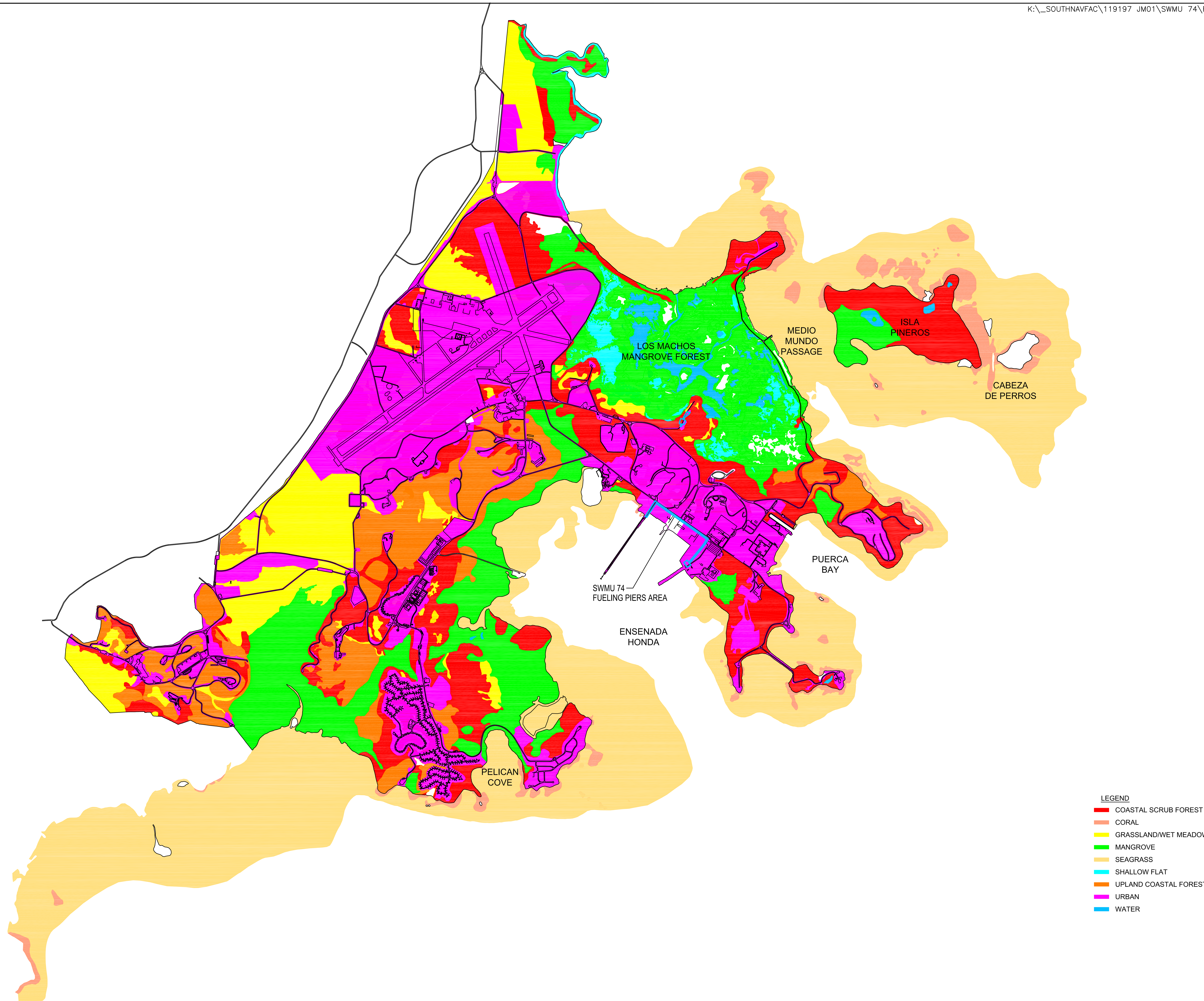
—SWMU BOUNDARY

SOURCE: GOOGLE 2009

FIGURE 7-3
SEPTEMBER 21, 2009 AERIAL PHOTOGRAPH
FUELING PIERS AREA
SWMU 74-FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT

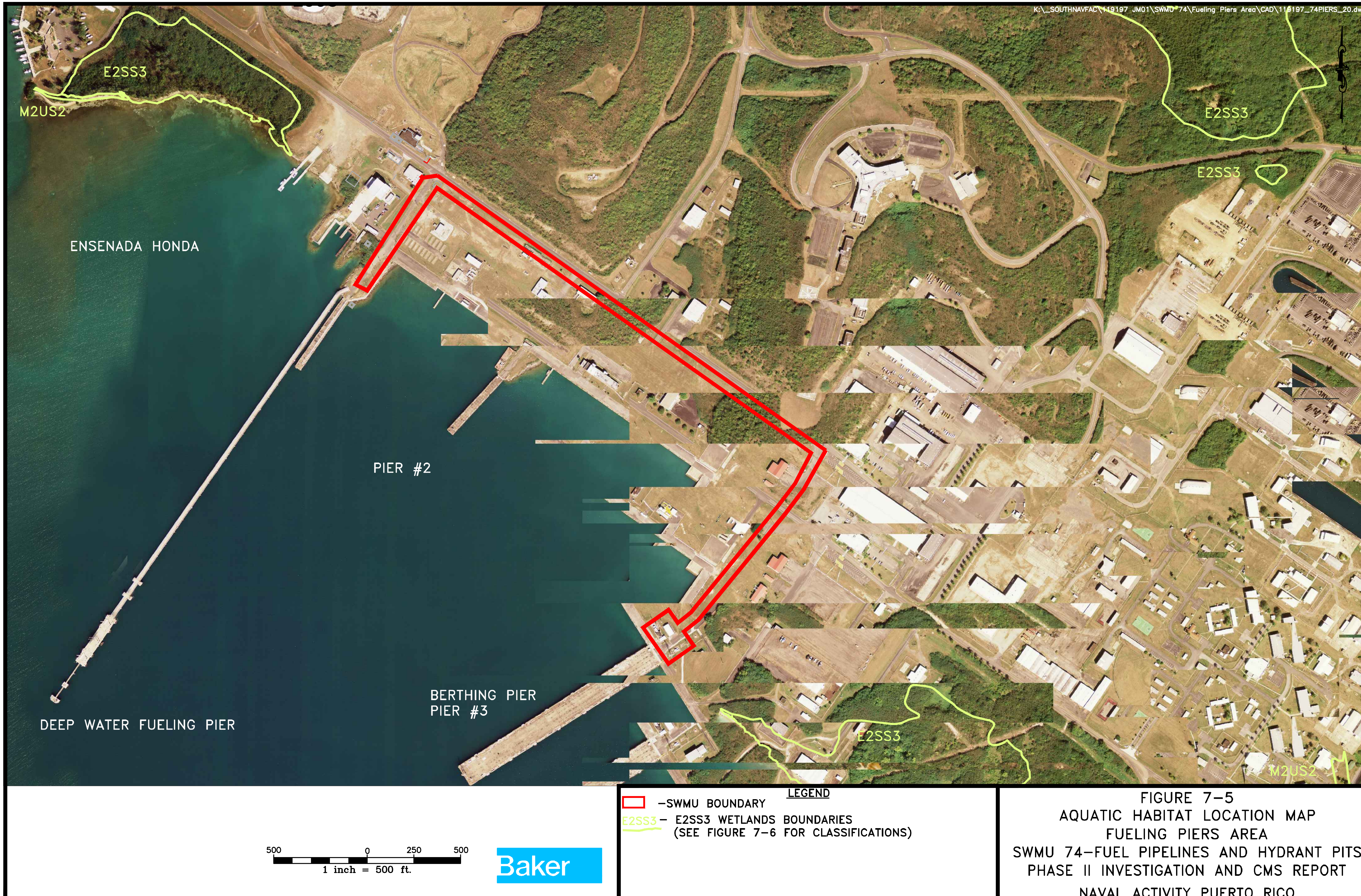
NAVAL ACTIVITY PUERTO RICO

K:_SOUTHNAVFAC\119197 JM01\SWMU 74\Fueling Piers Area\CAD\119197_74PIERS_17.dwg



SOURCE: GEO-MARINE, INC.

REVISIONS	DRAWN /RRR REVIEWED MEK S.O.# 119197 CADD# 119197_74PIERS_17.DWG	NORTH	FUELING PIERS AREA SWMU 74-FUEL PIPELINES AND HYDRANT PITS NAVAL ACTIVITY PUERTO RICO BAKER ENVIRONMENTAL, Inc. Coraopolis, Pennsylvania	Baker	"TERRESTRIAL AND AQUATIC HABITAT OCCURRING AT NAVAL ACTIVITY PUERTO RICO" PHASE II INVESTIGATION AND CMS REPORT SCALE 1" = 2000' DATE JULY 2011	FIGURE 7-4



LEGEND

- SWMU BOUNDARY
- E2SS3 – E2SS3 WETLANDS BOUNDARIES (SEE FIGURE 7–6 FOR CLASSIFICATIONS)

FIGURE 7–5
AQUATIC HABITAT LOCATION MAP
FUELING PIERS AREA
SWMU 74–FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO

M - MARINE

SUBSYSTEM	1 - SUBTIDAL					2 - INTERTIDAL			
CLASS	RB - Rock Bottom	UB - Uncon-solidated Bottom	AB - Aquatic Bed	RF - Reef	OW - Open Water (unknown bottom)	AB - Aquatic Bed	RF - Reef	RS - Rocky Shore	US - Uncon-solidated Shore
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vasc 5 Unknown	1 Coral 3 Worm		1 Algal 3 Rooted Vasc 5 Unknown	1 Coral 3 Worm	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic

E - ESTUARINE

SUBSYSTEM	1 - SUBTIDAL					2 - INTERTIDAL							
CLASS	RB - Rock Bottom	UB - Uncon-solidated Bottom	AB - Aquatic Bed	RF - Reef	OW - Open Water (*unknown bottom*)	AB - Aquatic Bed	RF - Reef	SB - Streambed	RS - Rocky Shore	US - Uncon-solidated Shore	EM - Emergent	SS - Scrub-Shrub	FO - Forested
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*	2 Mollusk 3 Worm		1 Algal 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*	2 Mollusk 3 Worm	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Dead	1 Persistent 2 Nonpersistent	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*

R - RIVERINE

SUBSYSTEM	1 - TIDAL	2 - LOWER PERENNIAL		3 - UPPER PERENNIAL		4 INTERMITTENT		5 - UNKNOWN PERENNIAL
CLASS	RB - Rock	UB - Uncon-solidated Bottom	SB - Streambed	AB - Aquatic Bed	RS - Rocky Shore	US - Uncon-solidated Shore	OW - Open Water (*unknown bottom*)	**EM - Emergent
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble 3 Cobble - Gravel 4 Sand 5 Mud 6 Organic 7 Vegetated	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic		2 Nonpersistent

L - LACUSTRINE

SUBSYSTEM	1 - LIMNETIC				2 - LITTORAL						
CLASS	RB - Rock Bottom	UB - Uncon-solidated Bottom	AB - Aquatic Bed	OW - Open Water (*unknown bottom)*	RB - Rock Bottom	RS - Rocky Shore	UB - Uncon-solidated Bottom	AB - Aquatic Bed	US - Uncon-solidated Shore	EM - Emergent	OW - Open Water (*unknown bottom*)
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*		1 Bedrock 2 Rubble	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent	

P - PALUSTRINE

CLASS	RB - Rock Bottom	UB - Uncon-solidated Bottom	AB - Aquatic Bed	US - Uncon-solidated Shore	ML - Moss-Lichen	EM - Emergent	SS - Scrub-Shrub	FO - Forested	OW - Open Water (*unknown bottom*)
Subclass	1 Bedrock 2 Rubble	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*	

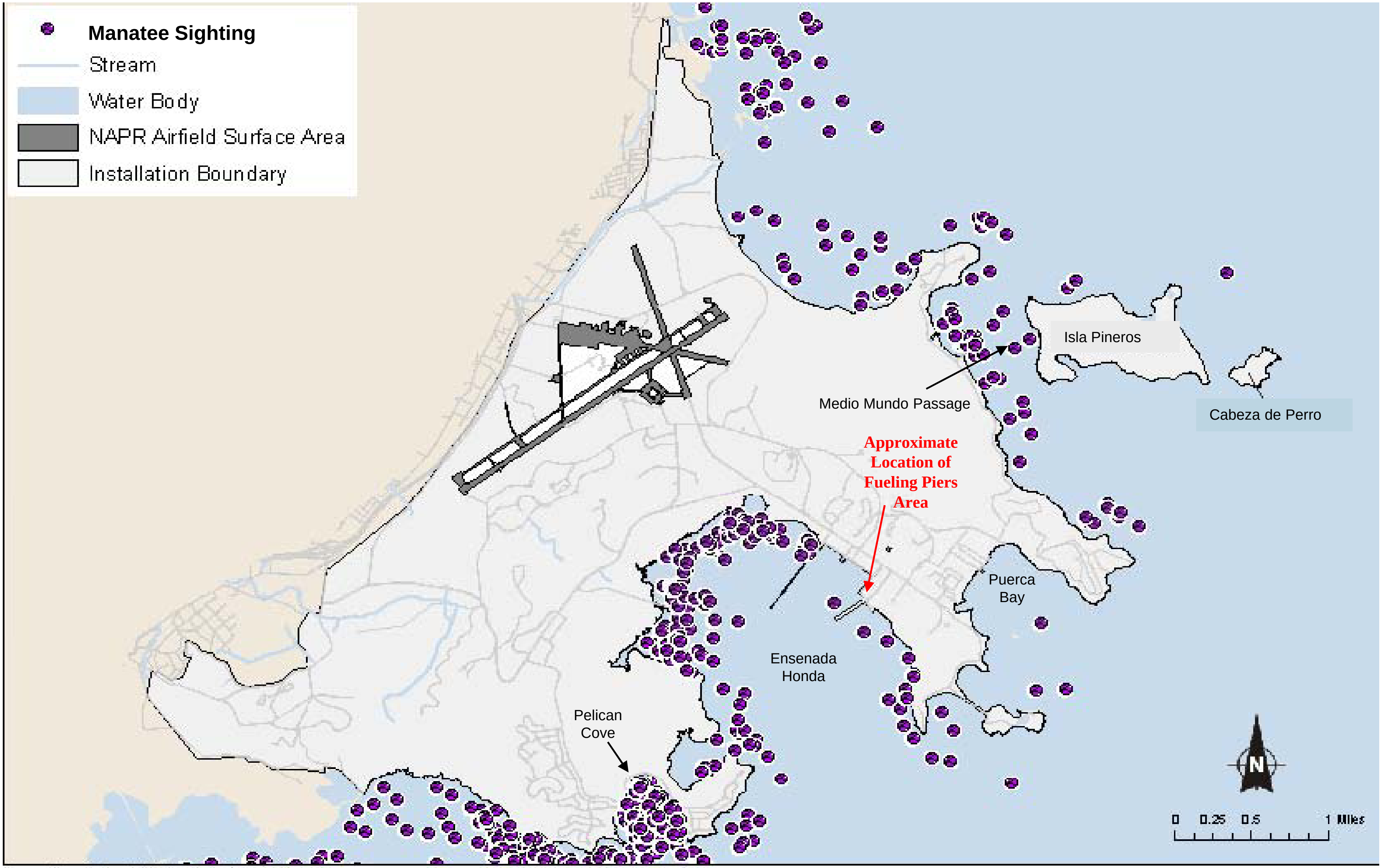
MODIFIERS

WATER REGIME				WATER CHEMISTRY			SOIL	SPECIAL
	Non-Tidal		**Tidal**	**Coastal Halinity**	**Inland Salinity**	**pH (fresh water)**		
A Temp. Flooded B Saturated C Seasonally Flooded D Seasonally Flooded/ Well Drained E Seasonally Flooded/ Saturated F Semipermanently Flooded G Intermittently Exposed	H Permanently Flooded J Intermittently Flooded K Artificially Flooded W Intermittently Flooded/ Temporary Y Saturated/Semipermanent/ Seasonal Z Intermittently Exposed Permanent U Unknown	K Artificially Flooded L Subtidal M Irregularly Flooded N Regularly Flooded P Irregularly Flooded * These water regimes are only used in tidally influenced, freshwater systems.	*S Temporary-Tidal *R Seasonal-Tidal *T Semipermanent- Tidal *V Permanent-Tidal U Unknown	1 Hyperhaline 2 Euhaline 3 Mixohaline 4 Polyhaline 5 Mesohaline 6 Oligohaline 0 Fresh	7 Hypersaline 8 Eusaline 9 Mixosaline 0 Fresh	a Acid t circumneutral i Alkaline	g Organic n Mineral	b Beaver d partially drained/ditched f Farmed h Diked/Impounded r Artificial Substrate s Spoil x Excavated

SOURCE: UNITED STATES, FISH AND WILDLIFE SERVICE. CLASSIFICATION OF WETLANDS AND DEEPWATER HABITATS OF THE UNITED STATES, 1985

Baker

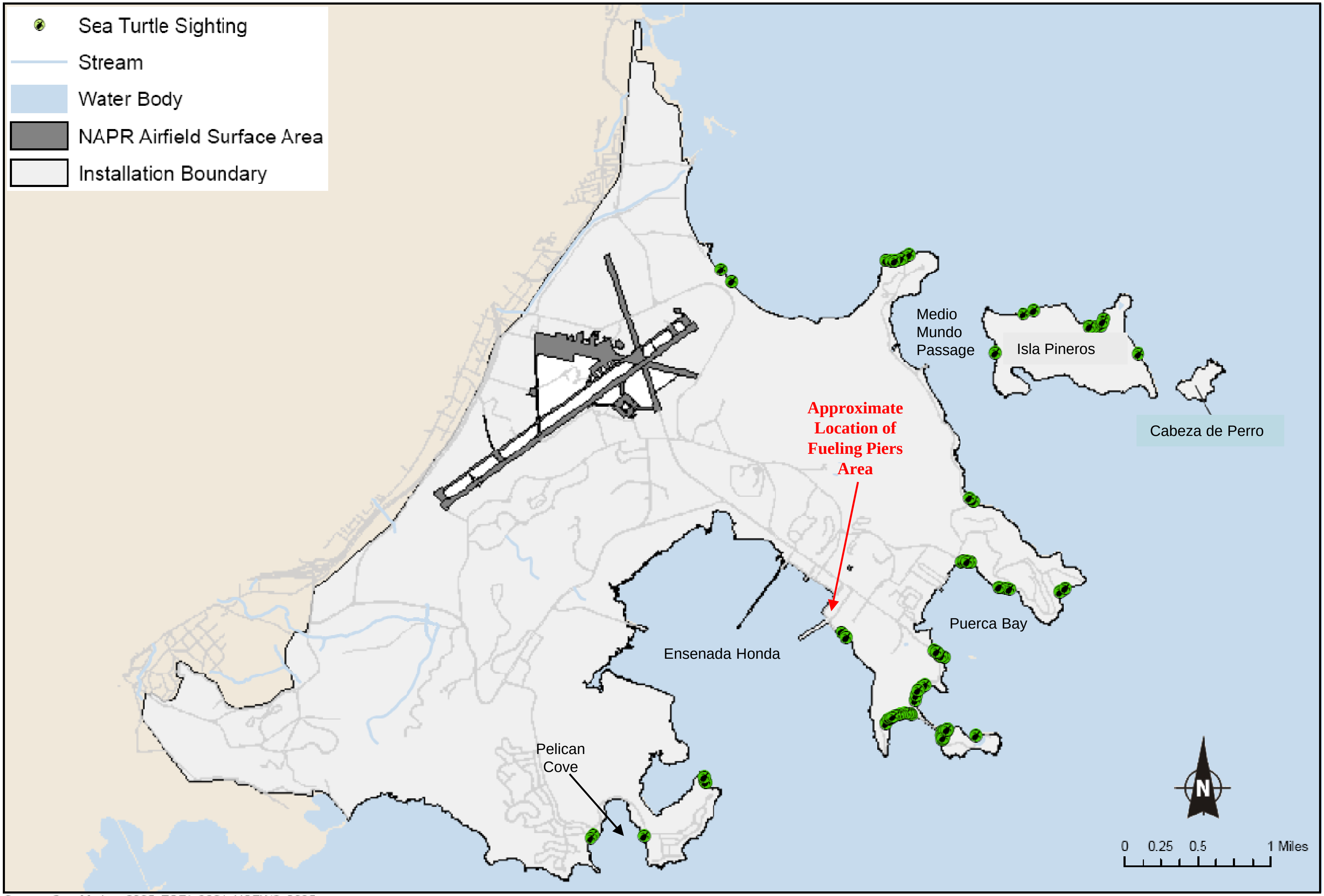
FIGURE 7-6
THE COWARDIN WETLAND CLASSIFICATION SYSTEM
FUELING PIERS AREA
SWMU 74-FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO



Source: Geo-Marine, 2005; ESRI, 2004; USFWS, 2005;

Figure from: Department of the Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads).* April 2007.

FIGURE 7-7
HISTORICAL MANATEE SIGHTINGS IN EASTERN PUERTO RICO
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

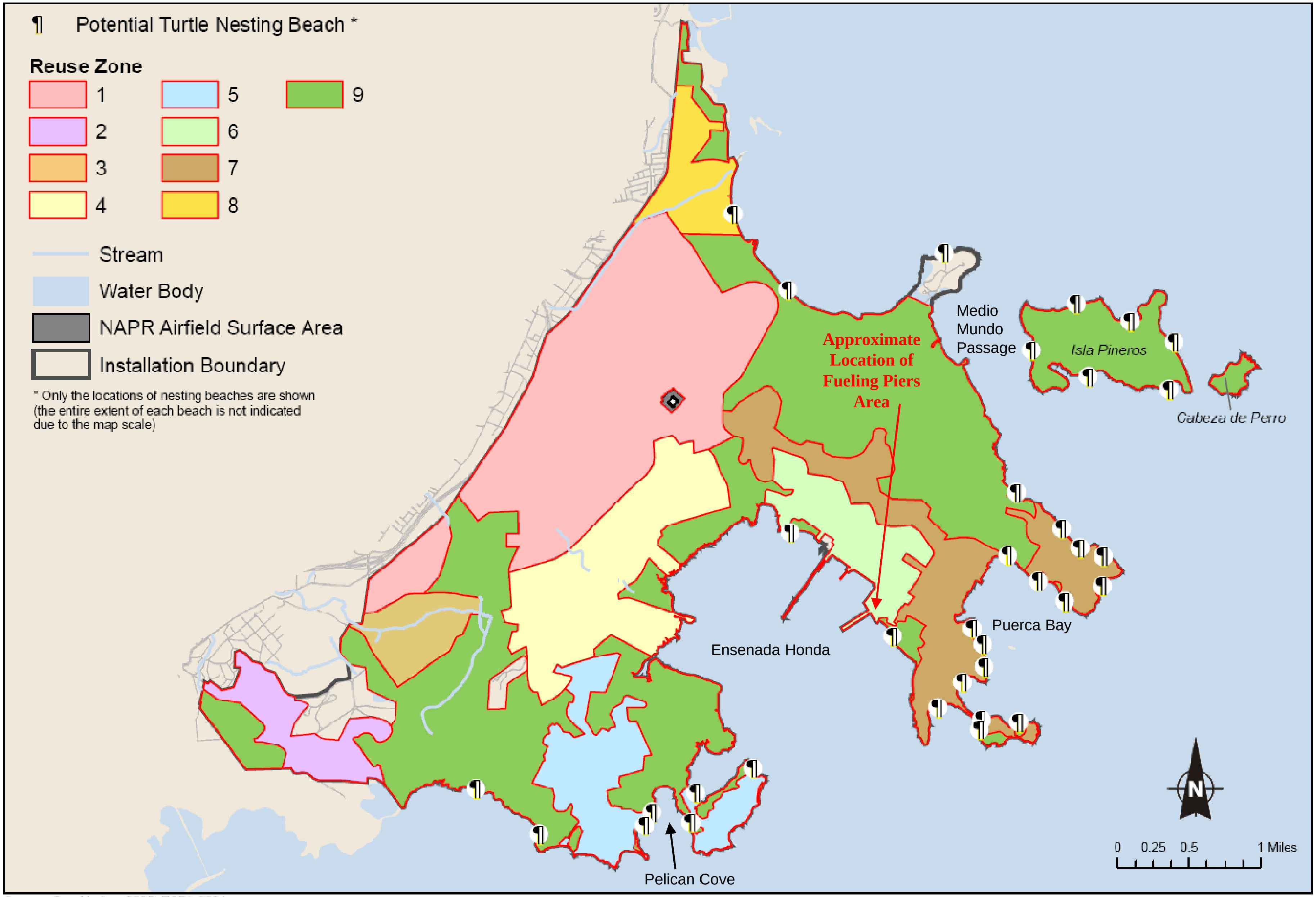


Source: Geo-Marine, 2005; ESRI, 2004; USFWS, 2005;

Cumulative sea turtle sightings from March 1984 through March 1995 obtained from weekly aerial surveys of the Former Naval Station Roosevelt Roads.

Figure from: Department of the Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads).* April 2007.

FIGURE 7-8
SEA TURTLE SIGHTINGS AT NAVAL ACTIVITY PUERTO RICO
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO



Source: Geo-Marine, 2005; ESRI, 2004;

Figure from: Department of Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads).* April 2007

FIGURE 7-9
POTENTIAL TURTLE NESTING SITES
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

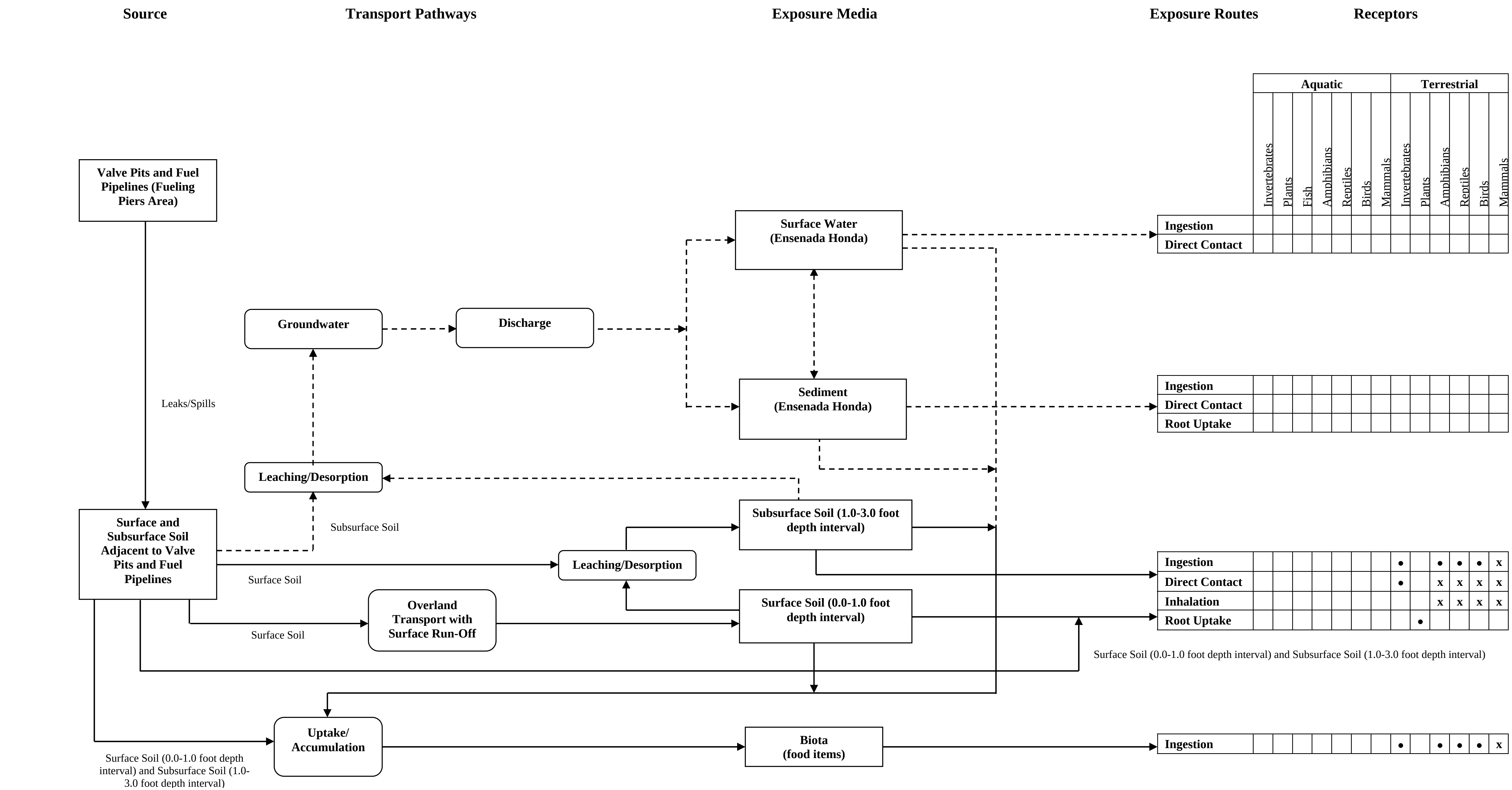
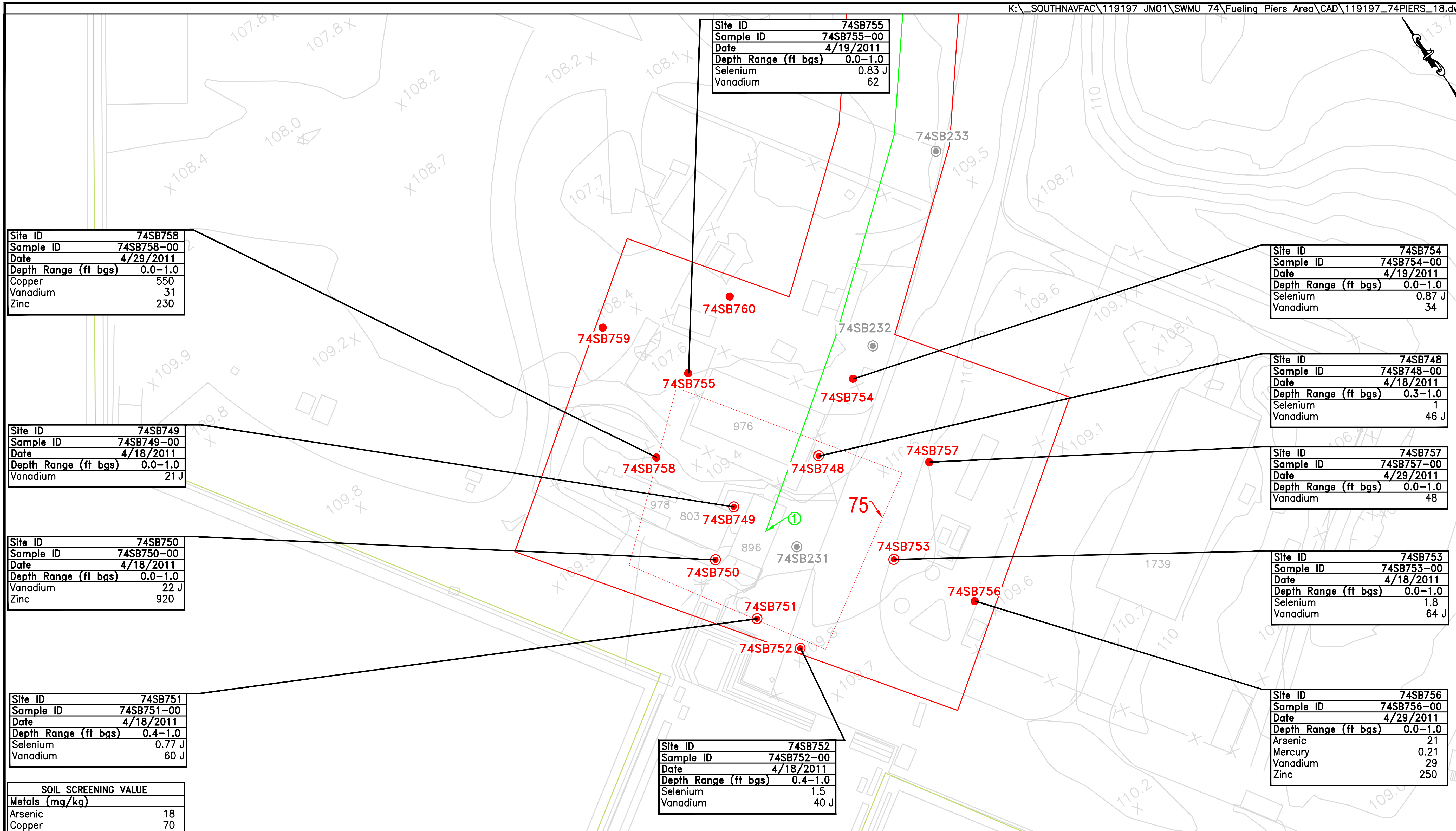


FIGURE 7-10
PRELIMINARY CONCEPTUAL MODEL
FUELING PIERS AREA, SWMU 74 –FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

→ Potentially complete and significant pathway evaluated
⇢ Potentially complete and insignificant pathway not evaluated

● - Receptor/pathway evaluated quantitatively or qualitatively evaluated
x - Receptor/pathway not evaluated

K:_SOUTHNAVFAC\111626 DO2\Task 15 - CMS Inv 56 61 69\69 CMS Report\Draft\ERA\Figures



Site ID	74SB755
Sample ID	74SB755-00
Date	4/19/2011
Depth Range (ft bgs)	0.0-1.0
Selenium	0.83 J
Vanadium	62

Site ID	74SB758
Sample ID	74SB758-00
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
Copper	550
Vanadium	31
Zinc	230

Site ID	74SB754
Sample ID	74SB754-00
Date	4/19/2011
Depth Range (ft bgs)	0.0-1.0
Selenium	0.87 J
Vanadium	34

Site ID	74SB748
Sample ID	74SB748-00
Date	4/18/2011
Depth Range (ft bgs)	0.3-1.0
Selenium	1
Vanadium	46 J

Site ID	74SB749
Sample ID	74SB749-00
Date	4/18/2011
Depth Range (ft bgs)	0.0-1.0
Vanadium	21 J

Site ID	74SB757
Sample ID	74SB757-00
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
Vanadium	48

Site ID	74SB750
Sample ID	74SB750-00
Date	4/18/2011
Depth Range (ft bgs)	0.0-1.0
Vanadium	22 J
Zinc	920

Site ID	74SB753
Sample ID	74SB753-00
Date	4/18/2011
Depth Range (ft bgs)	0.0-1.0
Selenium	1.8
Vanadium	64 J

Site ID	74SB751
Sample ID	74SB751-00
Date	4/18/2011
Depth Range (ft bgs)	0.4-1.0
Selenium	0.77 J
Vanadium	60 J

Site ID	74SB756
Sample ID	74SB756-00
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
Arsenic	21
Mercury	0.21
Vanadium	29
Zinc	250

Site ID	74SB752
Sample ID	74SB752-00
Date	4/18/2011
Depth Range (ft bgs)	0.4-1.0
Selenium	1.5
Vanadium	40 J

SOIL SCREENING VALUE	
Metals (mg/kg)	
Arsenic	18
Copper	70
Mercury	0.10
Selenium	0.52
Vanadium	20
Zinc	120

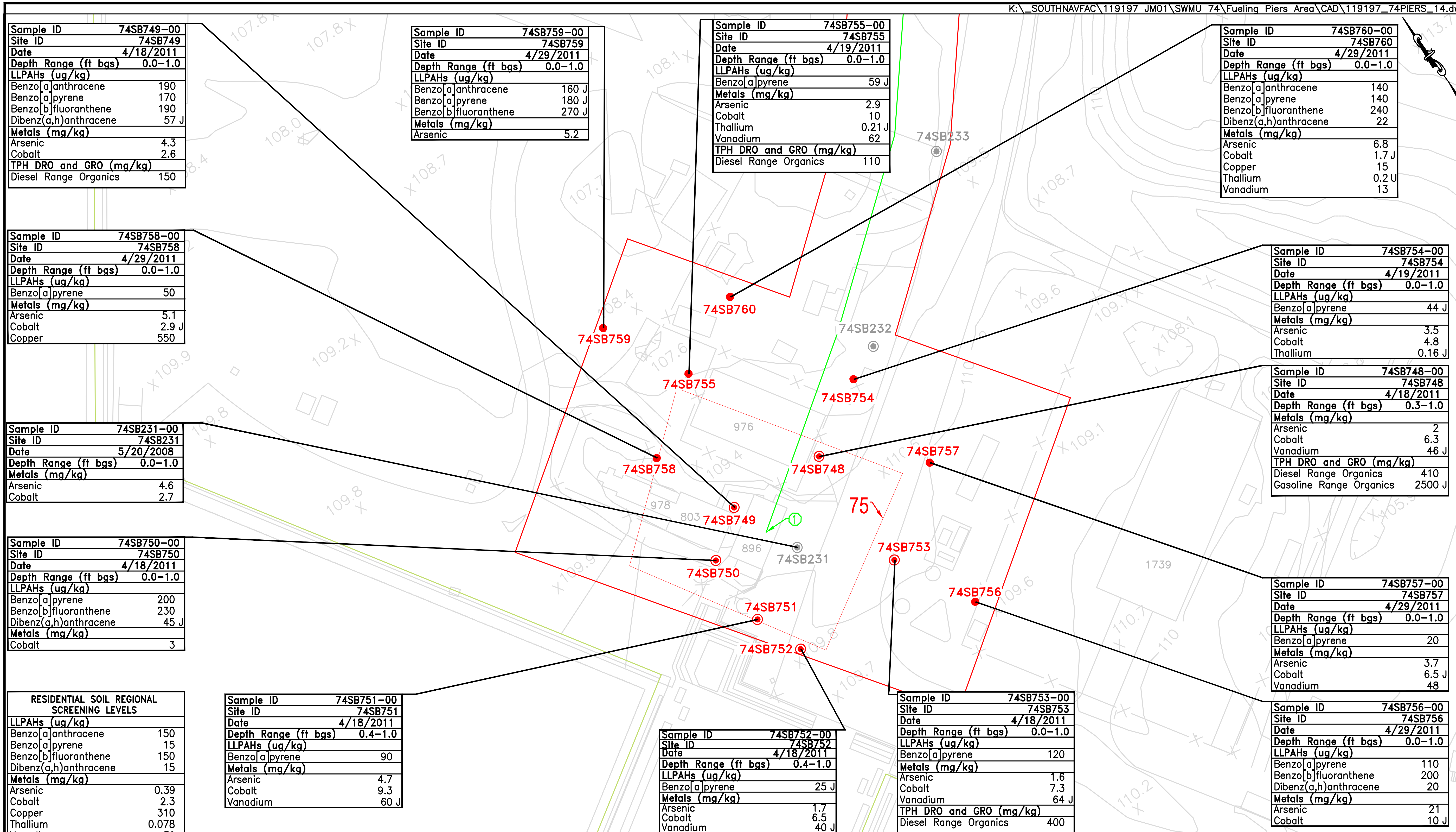
50 0 25 50
1 inch = 50 ft.

Baker

LEGEND
- SOIL BORING SAMPLE LOCATIONS (PHASE I 2008)
- SURFACE SOIL SAMPLE LOCATIONS (PHASE II 2011)
- SURFACE AND SUBSURFACE SOIL BORING SAMPLE LOCATIONS (PHASE II 2011)
- SWMU BOUNDARY
- WETLAND DELINEATION
- FUEL PIPELINE
- FUEL PIPELINE CONTINUED TO BERTHING PIER #3
- J - ESTIMATED: THE ANALYTE WAS POSITIVELY IDENTIFIED; THE QUANTITATION IS AN ESTIMATION.

FIGURE 7-11
DETECTED CONCENTRATIONS IN SURFACE SOIL EXCEEDING SOIL SCREENING VALUES
FUELING PIERS AREA
SWMU 74-FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO

K:_SOUTHNAVFAC\119197 JM01\SWMU 74\Fueling Piers Area\CAD\119197_74PIERS_14.dwg



Sample ID	74SB749-00
Site ID	74SB749
Date	4/18/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]anthracene	190
Benzo[a]pyrene	170
Benzo[b]fluoranthene	190
Dibenz(a,h)anthracene	57 J
Metals (mg/kg)	
Arsenic	4.3
Cobalt	2.6
TPH DRO and GRO (mg/kg)	
Diesel Range Organics	150

Sample ID	74SB759-00
Site ID	74SB759
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]anthracene	160 J
Benzo[a]pyrene	180 J
Benzo[b]fluoranthene	270 J
Metals (mg/kg)	
Arsenic	5.2

Sample ID	74SB755-00
Site ID	74SB755
Date	4/19/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	59 J
Metals (mg/kg)	
Arsenic	2.9
Cobalt	10
Thallium	0.21 J
Vanadium	62
TPH DRO and GRO (mg/kg)	
Diesel Range Organics	110

Sample ID	74SB760-00
Site ID	74SB760
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]anthracene	140
Benzo[a]pyrene	140
Benzo[b]fluoranthene	240
Dibenz(a,h)anthracene	22
Metals (mg/kg)	
Arsenic	6.8
Cobalt	1.7 J
Copper	15
Thallium	0.2 U
Vanadium	13

Sample ID	74SB758-00
Site ID	74SB758
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	50
Metals (mg/kg)	
Arsenic	5.1
Cobalt	2.9 J
Copper	550

Sample ID	74SB754-00
Site ID	74SB754
Date	4/19/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	44 J
Metals (mg/kg)	
Arsenic	3.5
Cobalt	4.8
Thallium	0.16 J

Sample ID	74SB748-00
Site ID	74SB748
Date	4/18/2011
Depth Range (ft bgs)	0.3-1.0
Metals (mg/kg)	
Arsenic	2
Cobalt	6.3
Vanadium	46 J
TPH DRO and GRO (mg/kg)	
Diesel Range Organics	410
Gasoline Range Organics	2500 J

Sample ID	74SB231-00
Site ID	74SB231
Date	5/20/2008
Depth Range (ft bgs)	0.0-1.0
Metals (mg/kg)	
Arsenic	4.6
Cobalt	2.7

Sample ID	74SB750-00
Site ID	74SB750
Date	4/18/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	200
Benzo[b]fluoranthene	230
Dibenz(a,h)anthracene	45 J
Metals (mg/kg)	
Cobalt	3

Sample ID	74SB757-00
Site ID	74SB757
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	20
Metals (mg/kg)	
Arsenic	3.7
Cobalt	6.5 J
Vanadium	48

RESIDENTIAL SOIL REGIONAL SCREENING LEVELS	
LLPAHs (ug/kg)	
Benzo[a]anthracene	150
Benzo[a]pyrene	15
Benzo[b]fluoranthene	150
Dibenz(a,h)anthracene	15
Metals (mg/kg)	
Arsenic	0.39
Cobalt	2.3
Copper	310
Thallium	0.078
Vanadium	39
TPH DRO and GRO (mg/kg)	
Diesel Range Organics	100
Gasoline Range Organics	100

Sample ID	74SB751-00
Site ID	74SB751
Date	4/18/2011
Depth Range (ft bgs)	0.4-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	90
Metals (mg/kg)	
Arsenic	4.7
Cobalt	9.3
Vanadium	60 J

Sample ID	74SB752-00
Site ID	74SB752
Date	4/18/2011
Depth Range (ft bgs)	0.4-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	25 J
Metals (mg/kg)	
Arsenic	1.7
Cobalt	6.5
Vanadium	40 J

Sample ID	74SB753-00
Site ID	74SB753
Date	4/18/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	120
Metals (mg/kg)	
Arsenic	1.6
Cobalt	7.3
Vanadium	64 J
TPH DRO and GRO (mg/kg)	
Diesel Range Organics	400

Sample ID	74SB756-00
Site ID	74SB756
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	110
Benzo[b]fluoranthene	200
Dibenz(a,h)anthracene	20
Metals (mg/kg)	
Arsenic	21
Cobalt	10 J

50 0 25 50

1 inch = 50 ft.

Baker

LEGEND

- -SOIL BORING SAMPLE LOCATIONS (PHASE I 2008)
- -SURFACE SOIL SAMPLE LOCATIONS (PHASE II 2011)
- -SURFACE AND SUBSURFACE SOIL BORING SAMPLE LOCATIONS (PHASE II 2011)
- -SWMU BOUNDARY
- -WETLAND DELINEATION
- -FUEL PIPELINE
- (1) -FUEL PIPELINE CONTINUED TO BERTHING PIER #3
- J -ESTIMATED: THE ANALYTE WAS POSITIVELY IDENTIFIED; THE QUANTITATION IS AN ESTIMATE

FIGURE 8-1

DETECTED CONCENTRATIONS IN SURFACE SOIL EXCEEDING RESIDENTIAL SOIL REGIONAL SCREENING LEVELS

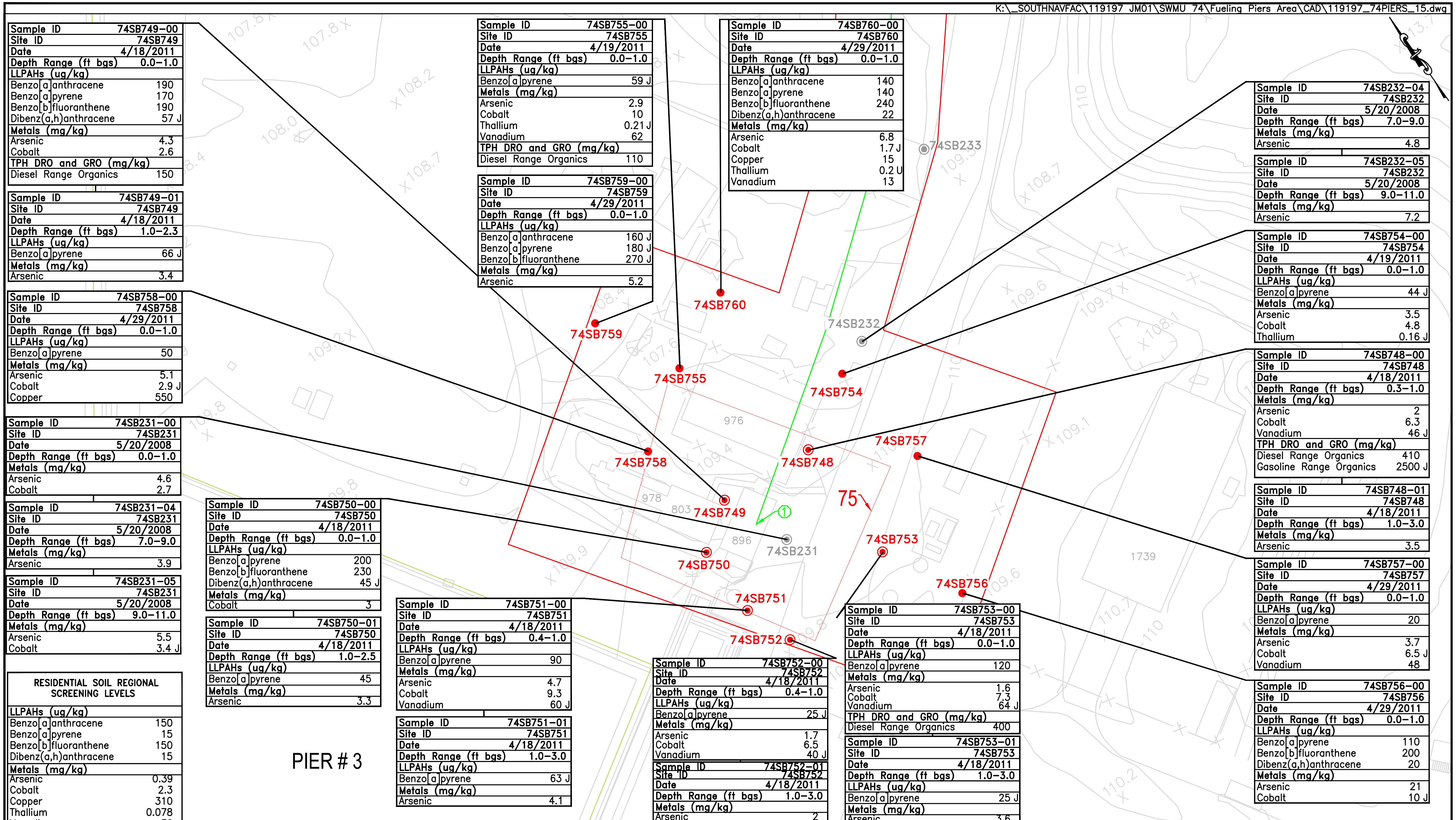
FUELING PIERS AREA

SWMU 74-FUEL PIPELINES AND HYDRANT PITS

PHASE II INVESTIGATION AND CMS REPORT

NAVAL ACTIVITY PUERTO RICO

K:_SOUTHNAVFAC\119197 JM01\SWMU 74\Fueling Piers Area\CAD\119197_74PIERS_15.dwg



Sample ID	74SB749-00
Site ID	74SB749
Date	4/18/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]anthracene	190
Benzo[a]pyrene	170
Benzo[b]fluoranthene	190
Dibenz(a,h)anthracene	57 J
Metals (mg/kg)	
Arsenic	4.3
Cobalt	2.6
TPH DRO and GRO (mg/kg)	
Diesel Range Organics	150

Sample ID	74SB749-01
Site ID	74SB749
Date	4/18/2011
Depth Range (ft bgs)	1.0-2.3
LLPAHs (ug/kg)	
Benzo[a]pyrene	66 J
Metals (mg/kg)	
Arsenic	3.4

Sample ID	74SB758-00
Site ID	74SB758
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	50
Metals (mg/kg)	
Arsenic	5.1
Cobalt	2.9 J
Copper	550

Sample ID	74SB231-00
Site ID	74SB231
Date	5/20/2008
Depth Range (ft bgs)	0.0-1.0
Metals (mg/kg)	
Arsenic	4.6
Cobalt	2.7

Sample ID	74SB231-04
Site ID	74SB231
Date	5/20/2008
Depth Range (ft bgs)	7.0-9.0
Metals (mg/kg)	
Arsenic	3.9

Sample ID	74SB231-05
Site ID	74SB231
Date	5/20/2008
Depth Range (ft bgs)	9.0-11.0
Metals (mg/kg)	
Arsenic	5.5
Cobalt	3.4 J

RESIDENTIAL SOIL REGIONAL SCREENING LEVELS	
LLPAHs (ug/kg)	
Benzo[a]anthracene	150
Benzo[a]pyrene	15
Benzo[b]fluoranthene	150
Dibenz(a,h)anthracene	15
Metals (mg/kg)	
Arsenic	0.39
Cobalt	2.3
Copper	310
Thallium	0.078
Vanadium	39
TPH DRO and GRO (mg/kg)	
Diesel Range Organics	100
Gasoline Range Organics	100

Sample ID	74SB755-00
Site ID	74SB755
Date	4/19/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	59 J
Metals (mg/kg)	
Arsenic	2.9
Cobalt	10
Thallium	0.21 J
Vanadium	62
TPH DRO and GRO (mg/kg)	
Diesel Range Organics	110

Sample ID	74SB759-00
Site ID	74SB759
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]anthracene	160 J
Benzo[a]pyrene	180 J
Benzo[b]fluoranthene	270 J
Metals (mg/kg)	
Arsenic	5.2

Sample ID	74SB760-00
Site ID	74SB760
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]anthracene	140
Benzo[a]pyrene	140
Benzo[b]fluoranthene	240
Dibenz(a,h)anthracene	22
Metals (mg/kg)	
Arsenic	6.8
Cobalt	1.7 J
Copper	15
Thallium	0.2 U
Vanadium	13

Sample ID	74SB750-00
Site ID	74SB750
Date	4/18/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	200
Benzo[b]fluoranthene	230
Dibenz(a,h)anthracene	45 J
Metals (mg/kg)	
Cobalt	3

Sample ID	74SB750-01
Site ID	74SB750
Date	4/18/2011
Depth Range (ft bgs)	1.0-2.5
LLPAHs (ug/kg)	
Benzo[a]pyrene	45
Metals (mg/kg)	
Arsenic	3.3

Sample ID	74SB751-00
Site ID	74SB751
Date	4/18/2011
Depth Range (ft bgs)	0.4-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	90
Metals (mg/kg)	
Arsenic	4.7
Cobalt	9.3
Vanadium	60 J

Sample ID	74SB751-01
Site ID	74SB751
Date	4/18/2011
Depth Range (ft bgs)	1.0-3.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	63 J
Metals (mg/kg)	
Arsenic	4.1

Sample ID	74SB752-00
Site ID	74SB752
Date	4/18/2011
Depth Range (ft bgs)	0.4-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	25 J
Metals (mg/kg)	
Arsenic	1.7
Cobalt	6.5
Vanadium	40 J

Sample ID	74SB752-01
Site ID	74SB752
Date	4/18/2011
Depth Range (ft bgs)	1.0-3.0
Metals (mg/kg)	
Arsenic	2

Sample ID	74SB753-00
Site ID	74SB753
Date	4/18/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	120
Metals (mg/kg)	
Arsenic	1.6
Cobalt	7.3
Vanadium	64 J
TPH DRO and GRO (mg/kg)	
Diesel Range Organics	400

Sample ID	74SB753-01
Site ID	74SB753
Date	4/18/2011
Depth Range (ft bgs)	1.0-3.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	25 J
Metals (mg/kg)	
Arsenic	3.6

Sample ID	74SB232-04
Site ID	74SB232
Date	5/20/2008
Depth Range (ft bgs)	7.0-9.0
Metals (mg/kg)	
Arsenic	4.8

Sample ID	74SB232-05
Site ID	74SB232
Date	5/20/2008
Depth Range (ft bgs)	9.0-11.0
Metals (mg/kg)	
Arsenic	7.2

Sample ID	74SB754-00
Site ID	74SB754
Date	4/19/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	44 J
Metals (mg/kg)	
Arsenic	3.5
Cobalt	4.8
Thallium	0.16 J

Sample ID	74SB748-00
Site ID	74SB748
Date	4/18/2011
Depth Range (ft bgs)	0.3-1.0
Metals (mg/kg)	
Arsenic	2
Cobalt	6.3
Vanadium	46 J
TPH DRO and GRO (mg/kg)	
Diesel Range Organics	410
Gasoline Range Organics	2500 J

Sample ID	74SB748-01
Site ID	74SB748
Date	4/18/2011
Depth Range (ft bgs)	1.0-3.0
Metals (mg/kg)	
Arsenic	3.5

Sample ID	74SB757-00
Site ID	74SB757
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	20
Metals (mg/kg)	
Arsenic	3.7
Cobalt	6.5 J
Vanadium	48

Sample ID	74SB756-00
Site ID	74SB756
Date	4/29/2011
Depth Range (ft bgs)	0.0-1.0
LLPAHs (ug/kg)	
Benzo[a]pyrene	110
Benzo[b]fluoranthene	200
Dibenz(a,h)anthracene	20
Metals (mg/kg)	
Arsenic	21
Cobalt	10 J

50 0 25 50
1 inch = 50 ft.

Baker

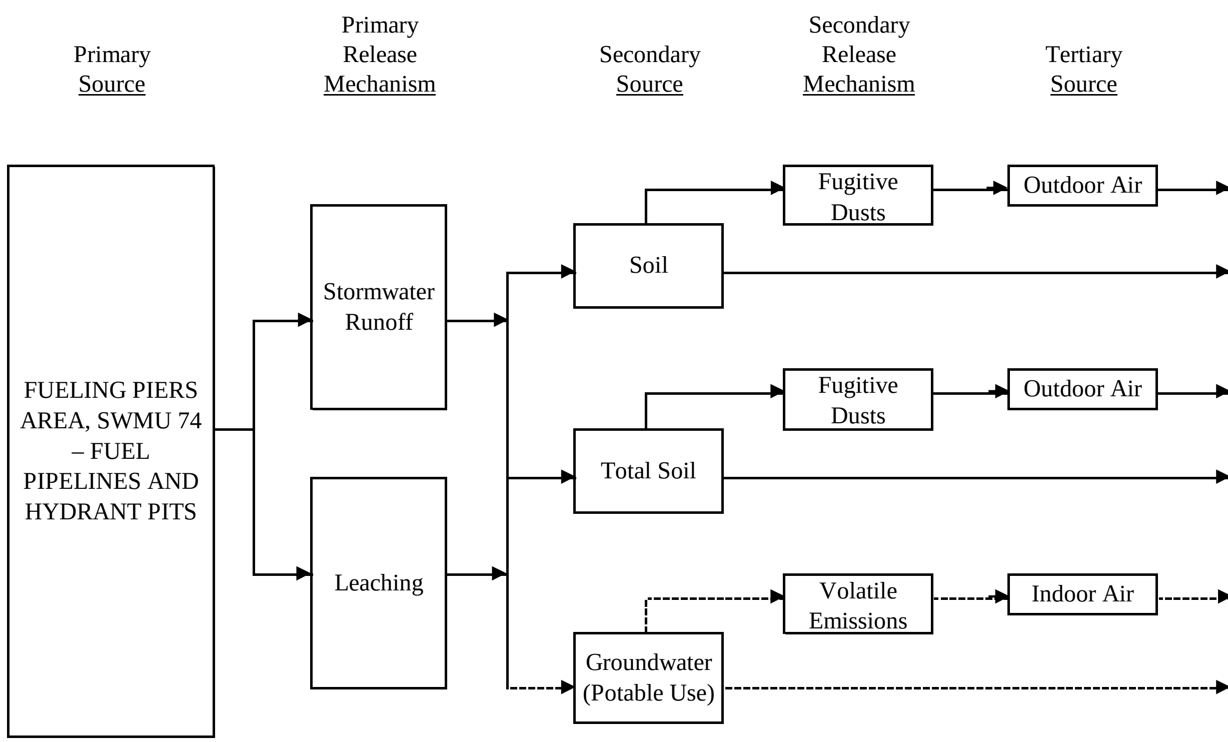
LEGEND

- -SOIL BORING SAMPLE LOCATIONS (PHASE I 2008)
- -SURFACE SOIL SAMPLE LOCATIONS (PHASE II 2011)
- -SURFACE AND SUBSURFACE SOIL BORING SAMPLE LOCATIONS (PHASE II 2011)
- -SWMU BOUNDARY
- -WETLAND DELINEATION
- -FUEL PIPELINE
- (1) -FUEL PIPELINE CONTINUED TO BERTHING PIER #3
- J -ESTIMATED: THE ANALYTE WAS POSITIVELY IDENTIFIED; THE QUANTITATION IS AN ESTIMATE

FIGURE 8-2
DETECTED CONCENTRATIONS IN TOTAL SOIL EXCEEDING RESIDENTIAL SOIL REGIONAL SCREENING LEVELS
FUELING PIERS AREA
SWMU 74-FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO

FIGURE 8-3

CONCEPTUAL SITE MODEL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO



Exposure Route	Current and Future Adult Trespassers	Current and Future Youth Trespassers	Current and Future Adult On-Site Workers	Future Adult Residents	Future Young Child Residents	Future Adult Industrial / Commercial Workers	Future Adult Construction Workers
	Potential Human Receptors						
Inhalation	***CF***	***CF***	***CF***	**F**	**F**	**F**	**F**
Ingestion	***CF***	***CF***	***CF***	**F**	**F**	**F**	**F**
Dermal Contact	***CF***	***CF***	***CF***	**F**	**F**	**F**	**F**
Inhalation	***CF***	***CF***	***CF***	**F**	**F**	**F**	**F**
Ingestion	***CF***	***CF***	***CF***	**F**	**F**	**F**	**F**
Dermal Contact	***CF***	***CF***	***CF***	**F**	**F**	**F**	**F**
Inhalation				**F**	**F**		**F**
Ingestion				**F**	**F**		**F**
Dermal Contact				**F**	**F**		**F**

Legend

F Future Exposure Pathway

CF Current and Future Exposure Pathway

→ Complete Exposure Pathway

-·-→ Potentially Complete but Insignificant Exposure Pathway

APPENDIX A
FIELD ACTIVITIES

SITE PHOTOGRAPHS

Fueling Piers area of SWMU 74

Boring 74SB748; Track-mounted Geoprobe® rig operated by GeoEnviroTech, Inc.

Boring 74SB750; Track-mounted Geoprobe® rig operated by GeoEnviroTech, Inc.

Soil sampling for VOCs and TPH GRO

Homogenizing soil for analyses other than VOCs and TPH GRO

Soil sampling for analyses other than VOCs and TPH GRO

FIELD LOGBOOK NOTES

Environmental Geologist – Scott Moffett (April 2011)

Sunday 4/17/11 NAPR SWMU 74 - Fueling Piers Area

0800 At Pittsburgh Airport to catch flight to San Juan

1530 Arrive in San Juan, pick up rental car and head for NAPR

1630 Arrive at NAPR and check to see if samples bottles and equipment arrived
sample bottles and equipment are locked in Pedros office - check with personnel in building to see if anyone has key to open office
No one can seem to locate key so we will have to wait until tomorrow morning to see if we can get in

1720 head over to Fueling piers area to collect Background sample for PetroFlag screening using Hand auger - soils in area are very rocky and can't Hand auger beyond 6-8" - will have GeoEnviroTech collect with Geoprobe tomorrow

1740 S Moffett and D Hope off site
weather today was partly cloudy with high temperatures in the mid 80's

[signature] 4/17/11

Monday 4/18/11 NAPR SWMU 74 - Fueling Piers Area

0700 Arrive on base of NAPR - Smother / D Hope
check with Elba to see if she has key to get
in Pedro's office - she does not but will check
with the commander

0715 Begin prep for sampling - Trip Blank 74TB114 VOC/GRO

0820 Meet Guys from GeoEnviratech
William Rodriguez and Nasser Castro
Head over to fueling piers area - layout
boring locations with GPS while Drillers unload
rig and get setup

0845 Conduct Health and Safety Briefing and
sign field site safety form

0900 Head over to Background area upgradient
of piers to collect sample for Background
PetroFlag screening - location selected
Based on conversation between Adam and
Rick Aschenbrenner

0905 Meet with surveyors from DJDC - They Get
set up running controls

0910 Collect Background Sample from Boring
74 Piers BG for PetroFlag Screening 3.5' recovery
0-0.8 fill material - silty sand, gravel, Brown, Dry
0.8-3.5' Sand, ~~Trace~~ Trace roots gravel and shell fragments
light brown / Buff, Dry - fine to medium grain
Background sample collected from 1-3'

Monday 4/18/11 NAPR SWMU 74 - Fueling Piers area

0917 set up on Boring 74SB753 and verify
clear of utilities - no utilities identified

74SB753

S-1 0-4' 3.6' recovery PID Readings - 0.0 6" intervals
0-2.5' fill material - silty sand, gravel, Brown
Dry, Trace roots
2.5-3.6' sand, ~~Trace~~ gravel and shell fragments
light brown / buff, Dry - fine to medium sand

0930 74SB753-00 0-1'
0940 74SB753-01 1-3'
VOCs, LLPAHs, metals, TPH-GRO/DRO

1000 Move to 74SB752
S-1 0-4' 3.3' recovery PID readings - 0.0 6" intervals
0-0.3 Asphalt
0.3-1.3' fill material - silty sand gravel, Brown, Dry
1.3-3.3' sand, ~~Trace~~ gravel and shell fragments
light brown / buff Dry - sand is fine - medium
grained

1015 74SB752-00 0.4'-1.0'
1025 74SB752-01 1-3'
VOCs, LLPAHs, metals, TPH GRO/DRO

Monday 4/18/11 NAPR SWMU 74 - Fueling Piers Area

1045 Move to Boring 74SB751 - Boring location moved 4-5' southwest towards ocean due to utility

S-1 0-4' 3.4' recovery PID readings -0.0 6" intervals

0-0.3' Asphalt

0.3'-1.9 Fill material - silty sand gravel, Brown, Dry

1.9-3.4 Sand, ~~trace~~ gravel and shell fragments light Brown/Buff, Dry - Sand is fine to med grain

1100 | 74SB751-00 | 0.4 - 1.0'

1110 | 74SB751-01 | 1.0'-3.0'

VOCs, LLPAHs, metals, TPH GRO/DRO

1125 Surveyors offsite - will come back and shoot locations tomorrow

Move to Boring 74SB750

S-1 0-4' 2.5' recovery PID readings - 0.0 6" intervals

0-0.8' fill material - silty sand gravel, Brown, Dry

0.8-2.5' Sand, ~~trace~~ trace roots Gravel and shell fragments white/Buff, Dry - sand is fine to medium grain

1140 | 74SB750-00 | 0-1.0'

1150 | 74SB750-01 | ~~1.0-3.0'~~ 1.0-2.5' [initials] 4/18/11

VOCs, LLPAHs, metals, TPH GRO/DRO

Monday 4/18/11 NAPR SWMU 74 - Fueling Piers Area

1200 Move to Boring 74SB749 - location moved a few feet to the west due to belowgrade pipeline pit

S-1 0-4' 2.3' Recovery PID readings 0.0 6" intervals

0.0-0.4' Fill material - silty sand gravel Brown, Dry

0.4'-2.3' Sand, ~~trace~~ trace roots gravel and shell fragments light Brown/Buff, Dry - Sand is fine to medium grain

1215 | 74SB749-00 | 0-1.0'

1225 | 74SB749-01 | 1.0'-2.3'

VOCs, LLPAHs, metals, TPH GRO/DRO

0735 Move to Boring 74SB748 - location moved a few feet to the east due to locked gate and pavillion type structure

S-1 0-4' 3.0' recovery PID = 10.5/0/0/0/0/0

0-1.6' fill material - silty sand gravel, Brown, Dry Black staining and petroleum odor from 0-0.6', 0.2' weathered asphalt at surface

1.6-3.0' sand, ~~trace~~ gravel and shell fragments light Brown/Buff - sand is fine to medium grain

1240 | 74SB748-00 | 0-1' (MS/MSD)

| 74SB748-00D | 0-1' Duplicate

1250 | 74SB748-01 | 1-3' (MS/MSD)

| 74SB748-01D | 1-3' Duplicate

VOCs, LLPAHs, metals, TPH GRO/DRO

Monday 4/18/11 NAPR SWMU 74 - Fueling Piers Area

1350 completed sampling the six initial borings
All Borings Backfilled with respective
excess soil cuttings and cement/bentonite grout
GeoEnviroTech loads up equipment and
stages rig/trailer in parking area on base

1420 Heads back to office to pack up samples
and complete chain of custody forms
GeoEnviroTech offsite

1510 completed packing samples - head back
out to Fueling Piers Area to collect field
Blank and Equipment Rinsate Blank

1530 collect [74FB01] from lab supplied
DI water - VOCs, LLPAHs, Tot Metals, TPH-GRO/DRO

1545 collect [74ER114] - Equipment Rinsate using
lab supplied DI water run through Acetate
liner and over stainless steel spoon/pie pan
VOCs, LLPAHs, Tot Metals, TPH-GRO/DRO
will not test for Dis metals as outlined in
summary of sampling and analytical
Program because no environmental samples
are to be tested for Dis Metals

Monday 4/18/11 NAPR SWMU 74 - Fueling Piers Area

1650 Fed ex did not come to pick up samples
DHope called and they did not have us
scheduled for pickup - Fed ex dropped the ball
internally - run samples to Fed ex in San Juan

1800 drop samples off at fed ex in San Juan
2 coolers

weather today was mostly sunny with low
temperatures in the mid 70s and high
temperatures in the mid 80s

[signature] 4/18/11

Tuesday 4/19/11 NAPR SWMU 74 - fueling Piers Area

0700 Arrive on Base at NAPR - S Moffett / D Hupe run up to see if JP-5 Hill Area Gate is unlocked - Gate is open and unlocked Go to office and get equipment to collect water levels from existing wells at JP5 Hill

water level readings

		SWL (ft below PVC)	
0728	74VP9a/JP5	22.50	TD = 22.67
0736	74SB137	22.14	TD = 22.28
0738	74VP10a/JP5	no protective casing PVC is Bent over/snapped off	
0740	74VP11a/JP5	21.45	TD = 21.58
0742	74VP11b/JP5	22.37	TD: 22.50
0745	74SB273	16.22	TD: 22.93
0748	74SB285	DRY	TD: 23.12
0800	74SB246	9.36	TD = 14.06 (Piers Area)
0803	803 - MW 2	8.83	

* NO free phase product detected in any of the wells - 803-MW2 cover broken and well filled in

Head back to office to prepare for Groundwater sampling - Trip Blank [74TB115]

0840 Collect [74ER115] equipment rinsate collected from bladder pump using lab supplied DI water only analyze for LLPAHs since well 74SB246 is only being analyzed for LLPAHs will not test for other parameters listed on sample summary

Tuesday 4/19/11 NAPR SWMU 74 - Fueling Pier Area

0850 Talk with Mark Kimes back at office and discuss Petroflag screening results suggest getting expedited turn on TPH from lab so we can have a comparative data set - Mark will review data and get back to me

0915 Meet with surveyors and show Team the locations that need to be surveyed

0930 Talk with Mark Kimes and Rick Aschenbrener Back at office will do some additional hand auger borings northand west of 74SB246 to delineate petroleum observed in surface soil - can not sample to east due to road - Mark will have lab analyze select samples from yesterday on a quick Turn - will sample additional borings (surface soil) for full parameter list but Mark may instruct lab to only analyze a subset

1010 Head over to piers area to sample additional Borings while D Hupe samples well 74SB246

(10)

Tuesday 4/19/11 NAPR SWMU 74-Fueling Piers Area

1015 lay out 2 additional Borings around
7458748 to Delineate observed petroleum
impact in surface soil
74SB754 - Approximately 40' north of
Boring SB748
74SB755 - west of Boring SB748 on other
side of fenced/locked hose storage pavilion

1025 Begin advancing Boring 74SB754 using
Hand auger
S-1 0-1.3' PID=0.0 refusal at 1.3'
0.0-0.7' - fill material - silty sand gravel,
Brown to light Brown, Dry, trace roots
0.7-1.3' - sand, some gravel and shell
fragments, light Brown/Buff, Dry - fine gravel

1045 74SB754-00 0-1'
VOCs, LLPAHs, metals, TPH-GRO/DRO
Hand auger refusal at 1.3' - tried to advance
a second boring to get deeper but
encountered refusal at 0.8' - difficult augering
Due to gravel/rocks

1105 Surveyors off site - Had them survey
2 additional Borings

(11)

Tuesday 4/19/11 NAPR SWMU 74 - fueling Piers Area

1115 Move to Boring 74SB755
S-1 0-1.2' PID=0.0 Refusal at 1.2'
0.0-0.4' - fill material - silty sand gravel
Brown, Dry, trace roots
0.4-1.2' sand some gravel and shell fragments
light Brown/Buff, Dry - fine to medium gravel

1135 74SB755-00 0-1'
VOCs, LLPAHs, metals, TPH-GRO/DRO

1150 Move to Background area to collect sample
from 0-1' for surface soil Background
PetroFlag field screening since this material
was notably different from buff sand material
Background area is about 120' north of SB748
west of road and north of old gravel
access road to west

1230 collect 74ER118 Equipment rinsate from
Hand auger Then run Back to office to
Help Darrin pack up samples/equipment and
clean out work office - Test sample for VOCs,
LLPAHs, metals, TPH-GRO/DRO
Haul bunch of trash to Dumpster and
test remaining soil samples using PetroFlag kit
see D. Hupe's notes

(12)

Tuesday 4/19/11 NAPR SWMU 74 - Fueling Pier Area

1600 Go around and view rest of Base including DFM Area and SWMU 9 - Area C

1700 Sundfett / D Hope leave NAPR

Weather today was mostly sunny with low temperatures in the mid 70s and high temperatures in the mid 80s

4/19/11

Environmental Technician – Darrin Hupe (April 2011)

4/17/11

0900 - Fly to Island, pick up car & drive to base.

[Event: SWMU74 - Piers
Crew: Scott Moffett, Darrin Hupe]

1630: Arrive @ NAPR
• All our supplies & equip. that were shipped down someone placed in Pedro Ruiz's office which we do not have a key for. Asked the watch commander if he had a key which he did not. Will talk to ~~key~~ people in office tomorrow.

1730: Depart NAPR

DNH
①

4/18/11

0700. Arrive C NAPR to prep for the day. Inquired about key to Pedro's office. Elba (Armorer) obtained from Commanders office.

0820. Met w/ Drillers (William + Nasser w/ Geoenviro tech) & went to site to locate borings & begin.

0900. Collect background sample for use w/ PetroFlag Kit - composite of Carc

0903 - Surveyors called & are heading to site (PSDC)

0925. Setup PetroFlag Test Kit & cal. borate

Reading SC 4 @ 25.8 C

BL = 0

CSD = 1000

ID	Time	ppm
Background	1026	80
753-00	1027	"Flashing over range error message"

Will re-do with 1 gram per Manual instructions

753-00	1100	12,210 * (1gm sample. Initial reading of 1,221 multiplied by 10)
752-01	1102	117

DNH

Weather: Sunny, breezy, ~82°F

4/18/11

1125. Surveyors depart site. Have finished running controls only. Since we are not yet sure of remaining SB's, they will complete survey tomorrow.

PetroFlag Kit

ID	Time	PPM
750-00	1222	755
751-00	1223	792

1352 - Back to Bld. 1205 to process/pack samples for shipment

1500. Coolers ready for Fed-X

1510 - Setup PetroFlag Kit for Add! Tests. (Perform tests in Bld. 1205)

1530. At Piers to obtain Field Blank (74FB01)

1545. Obtain Equip. Rinsate (74ER114) from Soil Sampling Equip.

DNH

4/18/11

Calibration of Petroflag kit.

1600 - Reading SC4 @ 21.8°C (in Bld. 1205)
BL = 0   CSD = 1000

ID	PPM	Time
748-00	2,253	1635
748-01	0	1636
749.00	704	1637
749.01	234	1638
750.01	72	1639
751.01	227	1640
752.00	952	1641
753.01	273	1642

1650. Depart NAPR to take samples coolers to Fed-X in Carolina, PR. I called Fed-X dispatch & they said no pickup was scheduled & courier is too far away.

1800. Dropped off at Fed-X in San Juan.

DNH

4/19/11

0700. Arrive @ NAPR to prep for the day. Drive to well 74SB24C & some IPSHill wells to gauge. - See S. Moffet's Logbook for Details.
0810 - At Bld. 1205 to perform Daily Decon. on groundwater pump & calibrate meters

0840 - Meter Calibration

	Reading	Adj.
Temp.	19.42	—
Sp. Cond. (1.409)	1.503	1.409
pH 4	4.04	4.00
7	6.96	7.00
10	9.91	10.00
ORP (231)	242	231.0
D.O. (760 baro.)	9.20	9.01
Turb. (10 NTU)	13.25	10.00

DNH

4/19/11

0905 - Meeting w/ Surveyors to show them borings/Well's that need shot
0940 - Back @ Bld. 1205
1017 - Drop Scott off @ Piers area to obtain 2 add. Soil Borings by hand that M. Kimes requests, while I set up on Well 74SB246B
(See Field Data Sheets for Purge/Sample Details)

1123 - Sample Taken (74GW246B)
+ Dup (74GW246BD)
+ MS & MSD
1217 - Well complete. Head to Bld. 1205 to process samples, re-ice & pack for Fed-x pickup.
1400 - Packages ready for Fed-X Pickup
1455 - Prepare 3 add. Samples for PetroFlag
- Meter calibrated yesterday PM & stayed in Bld. 1205 overnight

~~BT~~ ID	PPM	Time
(0-1') Background	238	1528
754-00	863	1529
755-00	850	1530

DHH

4/19/11

1540 - Found out that Fed-X picked up sample coolers & rental items ~ 1/2 hr. ago

1550 - Drive S. Moffet around the base to orient himself w/ the SWMU's, etc.

1700 - Depart NAPR

~~4/20/11~~ 4/20/11

Depart San Juan for PIT

DHH

Sunny, breezy, ~87°F

4/28/11

0700. Arrive @ NAPR. prep for the day.

0810. At SWMU 74 DFM Area to assist Jay w/ Borings - See Jay's Fieldbook for most details

1745 - Depart NAPR

4/29/11

0705 - Arrive @ NAPR

* I've been tasked with obtaining 5 additional samples @ the Piers area.

0730. Deconned 5 Hand Auger Buckets as follows:

- Liquinox wash
- Tap water rinse
- Methanol
- Tap rinse
- Lab grade DI rinse.

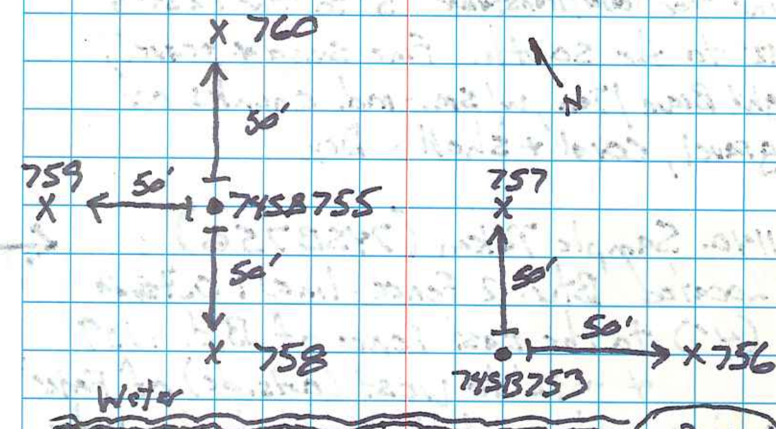
0800. Obtained Equipment rinsate from Auger Bucket (74ER117).

DNH

Weather: Sunny, breezy, ~85°F

4/29/11

0920 - Arrive @ SWMU 74 Pier area to lay out additional Borings & sample.



1000. Sample Taken (74SB759) + Dup. + MS/MSD

- Located in open grassy area

Fine sand, light Brown/Tan w/ sm. gravel & some sm. pieces of coral & shell - Dry.

1050. Sample Taken (74SB760). Located in open, grassy area. Fine sand & gravel, light Brown/Tan w/ sm.-med. chunks of gravel, coral & shells - Dry.

DNH

4/29/11
(Piers Sampling Cont.)

1115. Sample Taken (74SB758)
Located in open space, little grass. Fence-line for Power/Transformer Area 5' to the east & 12' to the south. Fine sand & gravel, light Brown/Tan, w/ sm.-md. chunks of gravel, coral & shell - Dry.

1140. Sample Taken (74SB756) ←
Located Btw. 2 Fence-lines! Outside (4') to the East Fence of Bld. 1739 & ~12' to west (outside) of Fence enclosure to a dual-Tank cluster, under tree canopy w/ leaf litter on ground surface.

1200. Sample Taken (74SB757) Located 5' to the east of Access Road, under light tree canopy w/ leaf litter & some vines on ground. Fine sand & gravel, some silt, light Brown/Tan, w/ large amt. of sm-md. gravel, coral & shell - Dry.

4/29/11

(Fine Sand & gravel, ~~some silt~~ light Tan, w/a large amt. of sm.-md. chunks of gravel, coral & shell & a sm. amt. of roots - Dry)

1240. Back at Bld. 1205 to process samples for shipping.

1435. At Well 74GW655 to Develope. (1 Well Vol. = 1.5 gal.)
SWL = 10.23 TD = 19.44 (Bottom Med. Soft.)
SWL = 11.13 after ~2.5 gals. purged
Recharge = 1/10 ft in 13 sec.
1530. Back @ Well after obtaining a 55 gal. Drum for IDW.
* Will Harris to complete development while I go to Well 696
* Water has moderate Fuel Odor.

DAILY METER CALIBRATION RECORDS

DAILY METER CALIBRATION RECORD

Date: 4/19/11 Time: 0840

Model: YSI 556 MPS
Serial #:

Model: RAE 2000
Serial #:

		Initial	Adjusted
pH (Std. Units)			
Buffer:	4	4.04	4.00
Buffer:	7	6.96	7.00
Buffer:	10	9.91	10.00
ORP (mV's)			
Std.:	231	242	231
Sp.Cond. (mS/cm)			
Std.:	1.409	1.503	1.409
D.O. (mg/l)			
Baro. Pressure (mm/Hg):	760	9.20	9.01
Temp. (Celsius)		19.42	N/A

	Initial	Adjusted
Isobutylene (100ppm)	—	

Model:
Serial #:

		Initial	Adjusted
Turbidity (NTU's)			
Std.:	10	13.25	10

SOIL BORING LOGS

Baker

Michael Baker Jr., Inc.

TEST BORING RECORD

PROJECT: Naval Activity Puerto Rico - SWMU 74 Fueling Piers Area
SO NO.: 119197 BORING NO.: 74SB748
COORDINATES: EAST: 939657.38 NORTH: 798971.43
ELEVATION: SURFACE: 109.56

Rig: Geoprobe 6610DT Track Rig	MC Sampler	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	2.5"				4/18/11	0.0 - 4.0	Mid 80s, Mostly Sunny	
Length	4'							
Type	Acetate							
Hammer Wt.								
Fall								

Remarks: Borehole backfilled with remaining soil and bentonite grout.

SAMPLE TYPE

S = Split Spoon; A = Auger
T = Shelby Tube; W = Wash
R = Air Rotary; C = Core
D = Direct Push; P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D1586)
PID = Photoionization Detector Measurement
MSL = Mean Sea Level
BG/PS = Background/Point Source
ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm)	Visual Description	Elevation (Ft. MSL)
1		D-1	3.0 75%		74SB748-00 (MS/MSD) 74SB748-00D (0.3-1.0')	10.5	Weathered Asphalt	
2					74SB748-01 (MS/MSD) 74SB748-01D (1.0-3.0')	<1	Silty Sand and Gravel Fill Material; brown; dry, black staining and petroleum odor from 0.2-0.5'	
3							Fine to Medium Sand with some gravel and shell fragments; light brown/buff; dry	
4	4.0							
5							END OF BORING at 4.0'	
6								
7								
8								
9								
10								

DRILLING CO.: GeoEnviroTech, Inc. BAKER REP.: Scott Moffett
DRILLER: William Rodriguez BORING NO.: 74SB748 SHEET 1 OF 1

Baker

Michael Baker Jr., Inc.

TEST BORING RECORD

PROJECT: Naval Activity Puerto Rico - SWMU 74 Fueling Piers Area
SO NO.: 119197 BORING NO.: 74SB749
COORDINATES: EAST: 939607.96 NORTH: 798975.12
ELEVATION: SURFACE: 110.05

Rig: Geoprobe 6610DT Track Rig	MC Sampler	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	2.5"				4/18/11	0.0 - 4.0	Mid 80s, Mostly Sunny	
Length	4'							
Type	Acetate							
Hammer Wt.								
Fall								

Remarks: Borehole backfilled with remaining soil and bentonite grout.

SAMPLE TYPE

S = Split Spoon; A = Auger
T = Shelby Tube; W = Wash
R = Air Rotary; C = Core
D = Direct Push; P = Piston
N = No Sample

DEFINITIONS

SPT = Standard Penetration Test (ASTM D1586)
PID = Photoionization Detector Measurement
MSL = Mean Sea Level
BG/PS = Background/Point Source
ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm)	Visual Description	Elevation (Ft. MSL)
1					74SB749-00 (0.0-1.0')		Silty Sand and Gravel Fill Material; brown; dry, trace roots	
2		D-1	2.3 58%		74SB749-01 (1.0-2.3')	<1	Fine to Medium Sand with some gravel and shell fragments; light brown/buff; dry	
3								
4	4.0							
5							END OF BORING at 4.0'	
6								
7								
8								
9								
10								

DRILLING CO.: GeoEnviroTech, Inc. BAKER REP.: Scott Moffett
DRILLER: William Rodriguez BORING NO.: 74SB749 SHEET 1 OF 1

Baker

Michael Baker Jr., Inc.

TEST BORING RECORD

PROJECT: Naval Activity Puerto Rico - SWMU 74 Fueling Piers Area
SO NO.: 119197 BORING NO.: 74SB750
COORDINATES: EAST: 939585.15 NORTH: 798958.78
ELEVATION: SURFACE: 110.23

Rig: Geoprobe 6610DT Track Rig	MC Sampler	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	2.5"				4/18/11	0.0 - 4.0	Mid 80s, Mostly Sunny	
Length	4'							
Type	Acetate							
Hammer Wt.								
Fall								

Remarks: Borehole backfilled with remaining soil and bentonite grout.

SAMPLE TYPE
S = Split Spoon; A = Auger
T = Shelby Tube; W = Wash
R = Air Rotary; C = Core
D = Direct Push; P = Piston
N = No Sample

DEFINITIONS
SPT = Standard Penetration Test (ASTM D1586)
PID = Photoionization Detector Measurement
MSL = Mean Sea Level
BG/PS = Background/Point Source
ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm)	Visual Description	Elevation (Ft. MSL)
1					74SB750-00 (0.0-1.0')		Silty Sand and Gravel Fill Material; brown; dry, trace roots	
2		D-1	2.5 63%		74SB750-01 (1.0-2.5')	<1	Fine to Medium Sand with some gravel and shell fragments; white/buff; dry	
3								
4	4.0							
5							END OF BORING at 4.0'	
6								
7								
8								
9								
10								

DRILLING CO.: GeoEnviroTech, Inc. BAKER REP.: Scott Moffett
DRILLER: William Rodriguez BORING NO.: 74SB750 SHEET 1 OF 1

Baker

Michael Baker Jr., Inc.

TEST BORING RECORD

PROJECT:	Naval Activity Puerto Rico - SWMU 74 Fueling Piers Area		
SO NO.:	119197	BORING NO.:	74SB751
COORDINATES:	EAST: 939585.13	NORTH:	798922.68
ELEVATION:	SURFACE: 109.98		

Rig: Geoprobe 6610DT Track Rig	MC Sampler	Casing	Augers	Core Barrel	Date	Progress (Ft.)	Weather	Depth to Water (Ft.)
Size (ID)	2.5"				4/18/11	0.0 - 4.0	Mid 80s, Mostly Sunny	
Length	4'							
Type	Acetate							
Hammer Wt.								
Fall								

Remarks: Borehole backfilled with remaining soil and bentonite grout.

SAMPLE TYPE	DEFINITIONS
S = Split Spoon; A = Auger	SPT = Standard Penetration Test (ASTM D1586)
T = Shelby Tube; W = Wash	PID = Photoionization Detector Measurement
R = Air Rotary; C = Core	MSL = Mean Sea Level
D = Direct Push; P = Piston	BG/PS = Background/Point Source
N = No Sample	ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm)	Visual Description	Elevation (Ft. MSL)
					74SB751-00 (0.4-1.0')		Asphalt	
1							Silty Sand and Gravel Fill Material; brown; dry	
2		D-1	3.4 85%		74SB751-01 (1.0-3.0')	<1		
3							Fine to Medium Sand with some gravel and shel fragments; light brown/buff; dry	
4	4.0							
5							END OF BORING at 4.0'	
6								
7								
8								
9								
10								

DRILLING CO.:	GeoEnviroTech, Inc.	BAKER REP.:	Scott Moffett
DRILLER:	William Rodriguez	BORING NO.:	74SB751 SHEET 1 OF 1

Baker

Michael Baker Jr., Inc.

TEST BORING RECORD

PROJECT:	Naval Activity Puerto Rico - SWMU 74 Fueling Piers Area		
SO NO.:	119197	BORING NO.:	74SB752
COORDINATES:	EAST: 939594.15	NORTH:	798898.10
ELEVATION:	SURFACE: 110.01		

Rig: Geoprobe 6610DT Track Rig	**MC Sampler**	**Casing**	**Augers**	**Core Barrel**	**Date**	**Progress (Ft.)**	**Weather**	**Depth to Water (Ft.)**
Size (ID)	2.5"				4/18/11	0.0 - 4.0	Mid 80s, Mostly Sunny	
Length	4'							
Type	Acetate							
Hammer Wt.								
Fall								

Remarks: Borehole backfilled with remaining soil and bentonite grout.

SAMPLE TYPE	**DEFINITIONS**
S = Split Spoon; A = Auger	SPT = Standard Penetration Test (ASTM D1586)
T = Shelby Tube; W = Wash	PID = Photoionization Detector Measurement
R = Air Rotary; C = Core	MSL = Mean Sea Level
D = Direct Push; P = Piston	BG/PS = Background/Point Source
N = No Sample	ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm)	Visual Description	Elevation (Ft. MSL)
1					74SB752-00 (0.4-1.0')		Asphalt Silty Sand and Gravel Fill Material; brown; dry	
2		D-1	3.3 83%		74SB752-01 (1.0-3.0')	<1	Fine to Medium Sand with some gravel and shell fragments; light brown/buff; dry	
3								
4	4.0							
5							END OF BORING at 4.0'	
6								
7								
8								
9								
10								

DRILLING CO.:	GeoEnviroTech, Inc.	BAKER REP.:	Scott Moffett
DRILLER:	William Rodriguez	BORING NO.:	74SB752 SHEET 1 OF 1

Baker

Michael Baker Jr., Inc.

TEST BORING RECORD

PROJECT: Naval Activity Puerto Rico - SWMU 74 Fueling Piers Area

SO NO.: 119197 | BORING NO.: 74SB753

COORDINATES: EAST: 939658.22 | NORTH: 798907.35

ELEVATION: SURFACE: 110.21

Rig: Geoprobe 6610DT Track Rig					**Date**	**Progress (Ft.)**	**Weather**	**Depth to Water (Ft.)**
	MC Sampler	**Casing**	**Augers**	**Core Barrel**				
Size (ID)	2.5"				4/18/11	0.0 - 4.0	Mid 80s, Mostly Sunny	
Length	4'							
Type	Acetate							
Hammer Wt.								
Fall								

Remarks: Borehole backfilled with remaining soil and bentonite grout.

SAMPLE TYPE	**DEFINITIONS**
S = Split Spoon; A = Auger	SPT = Standard Penetration Test (ASTM D1586)
T = Shelby Tube; W = Wash	PID = Photoionization Detector Measurement
R = Air Rotary; C = Core	MSL = Mean Sea Level
D = Direct Push; P = Piston	BG/PS = Background/Point Source
N = No Sample	ppm = parts per million

Depth (Ft.)		Sample Type & No.	Sample Rec. (Ft.,%)	SPT	Lab ID	PID (ppm)	Visual Description	Elevation (Ft. MSL)
1					74SB753-00 (0.0-1.0')		Silty Sand and Gravel Fill Material; brown; dry, trace roots	
2		D-1	3.6 90%		74SB753-01 (1.0-3.0')	<1		
3							Fine to Medium Sand with some gravel and shell fragments; light brown/buff; dry	
4	4.0							
5							END OF BORING at 4.0'	
6								
7								
8								
9								
10								

DRILLING CO.: GeoEnviroTech, Inc. | BAKER REP.: Scott Moffett

DRILLER: William Rodriguez | BORING NO.: 74SB753 | SHEET 1 OF 1

GROUNDWATER SAMPLING FORMS

WELL DETAIL AND SAMPLING LOG

Well ID #: 74GW246B DATE: 4/19/11

PROJECT: SWMU74 Piers WEATHER: Sunny, breezy, ~85°F

WELL DATA

(CONDITIONS): (G = Good, F = Fair, P = Poor)

Pad ______ Well Cap G PVC Locking Cap/Plug G

Cap Lock G Cover Bolts NA Water over PVC? Y / (N)

Casing (outer) G Casing (inner) G SWL Reference Mark G Reference Mark Location? PVC

Casing Dia.: 1.5 Casing Material: PVC Flushmount / (Stickup)

Comments: Had to cut Lock off

(OTHER): Static Water Level (ft.): 9.36 Time: ______ (Pre-Pump Installation)

Depth to Product (ft.): ______

Water Level (ft.): 9.12 Time: 10:50 (Post-Pump Installation, Pre-Purge)

Total Well Depth (ft.) - Post Sampling: 14.04 Time: ______

PID Reading (PPM) - Unopened: ______ Opened: ______

PURGE DATA

Pump Type: Geotech .88 portable Bladder (Teflon)

From Boring Log: Total Depth (ft.): ______ Screened Interval (ft.): ______

Pump Intake Set @ (ft.): 12 Controller Settings / Pressure: CPM6 7/3 p = ~15 psi.

Comments: ______

SAMPLE DATA

Sample ID #: 74GW246B Dup (Y) N - (ID#: 74GW246BD)

Sample Time: 1123 MS / MSD: (Y) N Field Filtered: Y / (N)

Sampled By: D. Hope Signature: [signature]

Sample Description: clear, w/ No apparent odors

SAMPLE CONTAINERS

Bottle Type	Qty.	Preservative	Analysis
1L Amber	8	None	LL PAH'S

GENERAL COMMENTS

LOW FLOW PURGE DATA SHEET

WELL ID: 74GW246B
DATE: 4/19/11
PROJECT: SWMU74- Piers

SAMPLER (s): D. Hope
SAMPLE ID: 74GW246B

TIME [3-5 min.]	DEPTH TO WATER (ft) [<0.3 ft.]	VOL. (ml)	PURGE RATE (ml/min) [250-500 ml/min]	TEMP. (°C)	SP. COND. (mS/cm) [+/- 3%]	D.O. (mg/l) [+/- 10%]	pH (S.U.) [+/- 0.1]	ORP (mV) [+/- 10]	TURBIDITY (NTU) [+/- 10%]	COMMENTS (Sample descrip.: color, clarity, odor - issues and adjustments, etc.)
1050	9.12	- (Water Level : Post-Pump Installation, Pre-Start)								
10.57	- (Start of Purging)	—	—							
1102	9.10	800	160	31.78	1.754	5.76	7.44	107.8	1.4	clear, No odor.
1107	9.10	600	120	31.65	1.750	5.76	7.42	111.0	1.2	
1112	9.10	600	120	31.72	1.747	5.77	7.42	112.8	1.1	Bump press. up slightly
1117	9.10	750	150	31.67	1.742	5.85	7.44	114.4	1.0	
1122	9.10	750	150	31.66	1.741	5.87	7.45	114.9	1.0	
1123	- **Sample Time** (Note: Flow rate to be btwn. 100 - 250 ml/min.)									**Sampler Signature:**

Note: Stability achieved when 3 consecutive readings fall within specific parameter ranges shown in the above header.

CHAIN-OF-CUSTODY FORMS

Baker

Michael Baker Jr., Inc.
Airside Office Park
100 Airside Drive
Moon Township, PA 15108
412-269-6300
412-375-3996 (fax)

CHAIN OF CUSTODY RECORD

Lab and BOA No.: TEST AMERICA-SAVANNAH
Delivery Order No.:
Project No.: 119197
Project Name: NAPR SWMU 74-Fueling Piers Area
Field Team: SMoffett/DHupE
SEND RESULTS TO:

Sample Number	2011 Date	Time	Sample Location	Matrix Type (1) GB (2)	Matrix Type (1) COM (2)	App IX VOCs (MeOH) 8260 (DI water)	TPH-GRO (MeOH) 8015 (DI water)	Moisture Cont.	Low Level PAHs 8270 LL-PAHs	TPH-DRO 8015	App IX Metals 6020/7470						General Comments / Remarks
Type of Container(s) (3)						40ml G	40ml G	2oz P	16oz G	→	8oz P						
74SB748-00	4/18	1240	MS/MSD	SS		9	9	3	2	→	2						
74SB748-00D		1240		SS		3	3	2	1	→	1						
74SB748-01		1250	MS/MSD	SB		9	9	3	2	→	2						
74SB748-01D		1250		SB		3	3	2	1	→	1						
74SB749-00		1215		SS		3	3	1	1	→	1						
74SB749-01		1225		SB		3	3	1	1	→	1						
74SB750-00		1140		SS		3	3	1	1	→	1						
74SB750-01		1150		SB		3	3	1	1	→	1						
74SB751-00		1100		SS		3	3	1	1	→	1						680 67512
74SB751-01	↓	1110		SB		3	3	1	1	→	1						Temp 1.2°C/1.6°C

Relinquished by: [signature] Date: 4/18/11 Time: 1600
Received by: Beth O Daughtry Date: 04-19-11 Time: 0937
Shipped by: (*check one*) ☐ Hand ☒ Overnight ☐ Other:

Relinquished by: Date: Time:
Received by: Date: Time:
Shipped by: (*check one*) ☐ Hand ☐ Overnight ☐ Other:

Relinquished by: Date: Time:
Received by: Date: Time:
Shipped by: (*check one*) ☐ Hand ☐ Overnight ☐ Other:

Sample stored at 4 degrees C: ☒ Yes ☐ No
Chain-of-custody seal on cooler: ☐ Yes (Number:) ☐ No
Analysis turnaround: ☐ Priority (Hours:) ☒ Regular
See Work Order ☒
See Analysis Request Form ☐
Sample Disposal: ☐ Return to Baker - archive until: (*date*)
☒ Lab Disposal

NOTES:
(1) A - Air, GW - Groundwater, L - Leachate, S - Spring, SS - Surface Soil, SB - Subsurface soil, SW - Surface Water, W - Waste, WP - Wipe, WW - Wastewater
(2) GB - Grab, COM - Composite
(3) P - Plastic, G - Glass

White copy: Return with analytical results
Yellow copy: Laboratory copy
Pink copy: Field copy

Courier Name: Federal Express
Courier Pickup Number: 8617 8652 7330
File Name:

Page 130 of 13

Baker

Michael Baker Jr., Inc.
Airside Office Park
100 Airside Drive
Moon Township, PA 15108
412-269-6300
412-375-3996 (fax)

CHAIN OF CUSTODY RECORD

Lab and BOA No.: TEST AMERICA-SAVANNAH
Delivery Order No.:
Project No.: 119197
Project Name: NAPR SWMU 74- Fueling Piers Area
Field Team: SMoffett/DHupe
SEND RESULTS TO:

Sample Number	2011 Date	Time	Sample Location	Matrix Type (1) GB (2)	COM (2)	App IX VOCs (MeOH) 8260 (DI water)	TPH-GRO (MeOH) 8015 (DI water)	Moisture Cont.	Low Level PAHs 8270 LL-PAHs	TPH-DRO 8015	App IX Metals 6020/7470	App IX VOCs 8260	TPH-GRO 8015 (HCl)	Low Level PAHs 8270 LL-PAHs	TPH-DRO 8015 (HCl)	App IX Metals (Total) 6020/7470 (HNO3)	
Type of Container(s) (3)						40ml G	40ml G	2oz P	16oz G	→	8oz P	40ml G	40ml G	1L G	1L G	250ml P	
74SB752-00	4/18	1015		SS		3	3	2	1 →	→	1						
74SB752-01	↓	1025		SB		3	3	2	1 →	→	1						
74SB753-00	↓	0930		SS		3	3	2	1 →	→	1						
74SB753-01	↓	0940		SB		3	3	2	1 →	→	1						
74TB114	↓	/		/								2	2				

General Comments

Remarks
680-67512
Temp 1.2°C/1.6°C

Relinquished by: [signature] Date: 4/18/11 Time: 1600
Received by: Beth A Daughtry Date: 04-19-11 Time: 0937
Shipped by: (*check one*) ☐ Hand ☑ Overnight ☐ Other:

Relinquished by: Date: Time:
Received by: Date: Time:
Shipped by: (*check one*) ☐ Hand ☐ Overnight ☐ Other:

Relinquished by: Date: Time:
Received by: Date: Time:
Shipped by: (*check one*) ☐ Hand ☐ Overnight ☐ Other:

Sample stored at 4 degrees C: ☑ Yes ☐ No
Chain-of-custody seal on cooler: ☐ Yes (Number: ______) ☐ No
Analysis turnaround: ☐ Priority (Hours: ______) ☑ Regular
See Work Order ☑
See Analysis Request Form ☐
Sample Disposal: ☐ Return to Baker - archive until: ______ (*date*)
☑ Lab Disposal

NOTES:
(1) A - Air, GW - Groundwater, L - Leachate, S - Spring, SS - Surface Soil, SB - Subsurface soil, SW - Surface Water, W - Waste, WP - Wipe, WW - Wastewater
(2) GB - Grab, COM - Composite
(3) P - Plastic, G - Glass

White copy: Return with analytical results
Yellow copy: Laboratory copy
Pink copy: Field copy

Courier Name: FEDERAL Express
Courier Pickup Number: 8617 8652 7330
File Name:

Baker

Michael Baker Jr., Inc.
Airside Office Park
100 Airside Drive
Moon Township, PA 15108
412-269-6300
412-375-3996 (fax)

CHAIN OF CUSTODY RECORD

Lab and BOA No.: TEST America-SAVANNAH
Delivery Order No.:
Project No.: 119197
Project Name: NAPR SNMU 74-Fueling Piers Area
Field Team: SMUFFETT/D HOPE
SEND RESULTS TO:

Sample Number	2011 Date	Time	Sample Location	Matrix Type (1) GB (2)	COM (2)	App IX VOCs 8260 (40ml G)	TPH-GRO 8015 (HCl) (40ml G)	Low Level PAHs 8270 LL-PAHs (1L G)	TPH-DRO 8015 (HCl) (1L G)	App IX Metals (Total) 6020/7470 (HNO3) (250ml P)	App IX Metals (Dis) 6020/7470 (HNO3) (250ml P)	App IX VOCs (MeOH) (DI water) 8260 (40ml G)	TPH-GRO (MeOH) 8015 (DI water) (40ml G)	Moisture Cont. (2oz P)	Low Level PAHs 8270 LL-PAHs (16oz G)	TPH-DRO 8015 (→)	App IX Metals 6020/7470 (8oz P)	Remarks
74GW246B	4/19/11	1123	MS/MSD	GW				6										
74GW246BD	↓	1123		GW				2										
74FB01	4/18/11	1530		/		3	3	2	2	1								
74ER114	↓	1545		/		3	3	2	2	1								
74ER115	4/19/11	0840		/		~~3~~	~~3~~	2										
74ER116		1230		/		3	3	2	2	1								
74SB754-00		1045		SS								3	3	2	1 →		1	
74SB755-00		1135		SS								3	3	2	1 →		1	680-67543
74TB115	↓	/		/		2	2											1.8°C
																		Temp 0.2°C/1.6°C

General Comments

Relinquished by: [signature] Date: 4/19/11 Time: 1500
Received by: Beth A Daugherty Date: 04-20-11 Time: ~~1103~~ 1057
Shipped by: (*check one*) ☐ Hand ☒ Overnight ☒ Other:

Relinquished by: Date: Time:
Received by: Date: Time:
Shipped by: (*check one*) ☐ Hand ☐ Overnight ☐ Other:

Relinquished by: Date: Time:
Received by: Date: Time:
Shipped by: (*check one*) ☐ Hand ☐ Overnight ☐ Other:

Sample stored at 4 degrees C: ☒ Yes ☐ No
Chain-of-custody seal on cooler: ☐ Yes (Number: ______) ☐ No
Analysis turnaround: ☐ Priority (Hours: ______) ☒ Regular
See Work Order ☒
See Analysis Request Form ☐
Sample Disposal: ☐ Return to Baker - archive until: ______ (*date*)
☒ Lab Disposal

NOTES:
(1) A - Air, GW - Groundwater, L - Leachate, S - Spring, SS - Surface Soil, SB - Subsurface soil, SW - Surface Water, W - Waste, WP - Wipe, WW - Wastewater
(2) GB - Grab, COM - Composite
(3) P - Plastic, G - Glass

Courier Name: FEDERAL Express
Courier Pickup Number: 8617 8652 7329
File Name:

White copy: Return with analytical results
Yellow copy: Laboratory copy
Pink copy: Field copy

Test America, Inc.
[redacted] Savannah, GA 31404

CHAIN OF CUSTODY

74-Pier-4/29/11 22620

Page 1 of 1

501 Madison Ave.
Cary, NC 27513
Phone: 919-379-4100 Fax 919-379-4040

Courier FEDEX
Airbill No. 8617 8652 7318
Sampling Complete? (Y) or N

Client/Reporting Information	Project Information
Company Name: Michael Baker Jr., Inc.	Project Name: NAPR
Address: 100 Airside Drive	Sampling Location: Puerto Rico
City: Moon Twp State: PA Zip: 15108	Turnaround time: Standard
Project Contact: Mark Kimes	Batch QC or Project Specific? If Specific, which Sample ID?
Phone #: 412-269-2009	Are aqueous samples field filtered for metals? Y or N
Sampler's Name:	Are high concentrations expected? Y or N? If yes, which ID(s)?

Matrices: GW - Ground water; WW - Waste water; SW - Surface water; SO - Soil/Sediment; TB - Trip Blank; RI - Rinsate; WP - Wipe; O - Other

Requested Analysis (include method and bottle type)

CompuChem No (Lab Use)	Field ID	Collection Date	Collection Time	Matrix	# of bottles	HCl	NaOH	HNO3	H2SO4	MEOH	Other	APP IX VOCs	Low Level PAHs	TPH DRO	TPH GRO	APP IX Metals	APP IX Metals (Dissolved)					pH / Sample Info (Lab Use)
	74ER117	4/29/11	0800	RI	10	5		1				X	X	X	X	X						
	74TB117	4/29/11	N/A	TB	5	5						X			X							
	74SB756-00	↓	1140	So	8	3				2		X	X	X	X	X						
	74SB757-00	↓	1200	↓	8	3				2		↓	↓	↓	↓	↓						
	74SB758-00	↓	1115	↓	8	3				2		↓	↓	↓	↓	↓						
	74SB759-00	↓	1000	↓	8	3				2		↓	↓	↓	↓	↓						
	74SB759-00D	↓	1000	↓	8	3				2		↓	↓	↓	↓	↓						
	74SB759-00MS/MSD	↓	1000	↓	14					4		↓	↓	↓	↓	↓						
	74SB760-00	↓	1050	↓	8	3				2		↓	↓	↓	↓	↓						

Page 82 of 82

Lab Use Only

Sample Unpacked By:
Sample Order Entry By:
Samples Received in Good Condition? Y or N
If no, explain:

Cyanide samples checked for sulfide & chlorine? Y or NA
625 & Phenol samples checked for chlorine? Y or NA
608 samples checked for pH between 5.0-9.0? Y or NA

Comments

Rinsate - hand auger (74ER117)

680-67897

Sample Custody

Relinquished by: Katie Perkins	Date/Time: 4/29/11 1300	Received by:	Date/Time:
Relinquished by:	Date/Time:	Received by: Francis Swafford	Date/Time: 04/30/11 10:50
Subcontact? Y or N If yes, where?		Custody Seal(s) intact? Y or N / On Ice? Y or N	Cooler Temp: 1.6°C, 1.8°C °C

Samples stored 60 days after date report mailed at no extra charge.

White & Yellow copy to lab • Pink copy for customer

APPENDIX B
LABORATORY ANALYTICAL RESULTS

SURFACE SOIL DATA

APPENDIX B-1

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748		74SB748		74SB749		74SB750		74SB751		74SB752		74SB753		74SB754	
Sample ID	74SB748-00		74SB748-00D		74SB749-00		74SB750-00		74SB751-00		74SB752-00		74SB753-00		74SB754-00	
Date	4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/19/2011	
Depth Range (ft bgs)	0.3-1.0		0.3-1.0		0.0-1.0		0.0-1.0		0.4-1.0		0.4-1.0		0.0-1.0		0.0-1.0	
Volatile Organics (µg/kg)																
1,1,1,2-Tetrachloroethane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
1,1,1-Trichloroethane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
1,1,2-Trichloroethane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
1,1-Dichloroethane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
1,1-Dichloroethene	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
1,2,3-Trichloropropane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
1,2-Dibromo-3-Chloropropane	9.8	U	9.3	U	11	U	10	U	10	U	8	U	8.2	U	11	U
1,2-Dibromoethane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
1,2-Dichloroethane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
1,2-Dichloropropane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
2-Butanone (MEK)	24	U	23	U	27	U	26	U	25	U	20	U	21	U	28	U
2-Hexanone	24	U	23	U	27	U	26	U	25	U	20	U	21	U	28	U
3-Chloro-1-propene	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
4-Methyl-2-pentanone (MIBK)	24	U	23	U	27	U	26	U	25	U	20	U	21	U	28	U
Acetone	49	U	47	U	55	U	51	U	50	U	40	U	41	U	56	U
Acetonitrile	200	U	190	U	220	U	210	U	200	U	160	U	160	U	220	U
Acrolein	98	UJ	93	UJ	110	UJ	100	UJ	100	UJ	80	UJ	82	UJ	110	U
Acrylonitrile	98	U	93	U	110	U	100	U	100	U	80	U	82	U	110	U
Benzene	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
Bromodichloromethane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
Bromoform	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
Bromomethane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
Carbon disulfide	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.9	
Carbon tetrachloride	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
Chlorobenzene	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
Chloroethane	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U
Chloroform	4.9	U	4.7	U	5.5	U	5.1	U	5	U	4	U	4.1	U	5.6	U

APPENDIX B-1

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753	74SB754
Sample ID	74SB748-00	74SB748-00D	74SB749-00	74SB750-00	74SB751-00	74SB752-00	74SB753-00	74SB754-00
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/19/2011
Depth Range (ft bgs)	0.3-1.0	0.3-1.0	0.0-1.0	0.0-1.0	0.4-1.0	0.4-1.0	0.0-1.0	0.0-1.0
Volatile Organics (µg/kg) (cont.)								
Chloromethane	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Chloroprene	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
cis-1,3-Dichloropropene	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Dibromochloromethane	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Dibromomethane	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Dichlorodifluoromethane	4.9 UJ	4.7 UJ	5.5 UJ	5.1 UJ	5 UJ	4 UJ	4.1 UJ	5.6 UJ
Ethyl methacrylate	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Ethylbenzene	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Iodomethane	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Isobutyl alcohol	200 U	190 U	220 U	210 U	200 U	160 U	160 U	220 U
Methacrylonitrile	98 U	93 U	110 U	100 U	100 U	80 U	82 U	110 U
Methyl methacrylate	9.8 U	9.3 U	11 U	10 U	10 U	8 U	8.2 U	11 U
Methylene Chloride	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Pentachloroethane	24 U	23 U	27 U	26 U	25 U	20 U	21 U	28 U
Propionitrile	98 U	93 U	110 U	100 U	100 U	80 U	82 U	110 U
Styrene	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Tetrachloroethene	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Toluene	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
trans-1,2-Dichloroethene	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
trans-1,3-Dichloropropene	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
trans-1,4-Dichloro-2-butene	9.8 U	9.3 U	11 U	10 U	10 U	8 U	8.2 U	11 U
Trichloroethene	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Trichlorofluoromethane	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Vinyl acetate	9.8 U	9.3 U	11 U	10 U	10 U	8 U	8.2 U	11 U
Vinyl chloride	4.9 U	4.7 U	5.5 U	5.1 U	5 U	4 U	4.1 U	5.6 U
Xylenes, Total	9.8 U	9.3 U	11 U	10 U	10 U	8 U	8.2 U	11 U

APPENDIX B-1

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753	74SB754
Sample ID	74SB748-00	74SB748-00D	74SB749-00	74SB750-00	74SB751-00	74SB752-00	74SB753-00	74SB754-00
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/19/2011
Depth Range (ft bgs)	0.3-1.0	0.3-1.0	0.0-1.0	0.0-1.0	0.4-1.0	0.4-1.0	0.0-1.0	0.0-1.0
LLPAHs (µg/kg)								
2-Methylnaphthalene	71 U	71 U	72 U	69 U	74 U	72 U	69 U	71 U
Acenaphthene	71 U	71 U	72 U	69 U	74 U	72 U	69 U	71 U
Acenaphthylene	71 U	71 U	72 U	69 U	74 U	72 U	69 U	71 U
Anthracene	71 U	71 U	51 J	69 U	74 U	72 U	69 U	71 U
Benzo[a]anthracene	71 U	71 U	190	140	78	72 U	69 U	71 U
Benzo[a]pyrene	71 U	71 U	170	200	90	25 J	120	44 J
Benzo[b]fluoranthene	71 U	71 U	190	230	74 U	72 U	69 U	73
Benzo[g,h,i]perylene	43 J	71 U	170	92	52 J	72 U	69 U	36 J
Benzo[k]fluoranthene	71 U	71 U	160	170	130	72 U	69 U	71 U
Chrysene	71 U	39 J	210	160	100	72 U	74	71 U
Dibenz(a,h)anthracene	71 U	71 U	57 J	45 J	74 U	72 U	69 U	71 U
Fluoranthene	71 U	71 U	330	120	110	72 U	69 U	71 U
Fluorene	71 U	71 U	72 U	69 U	74 U	72 U	69 U	71 U
Indeno[1,2,3-cd]pyrene	71 U	71 U	110	84	38 J	72 U	69 U	71 U
Naphthalene	71 U	71 U	72 U	69 U	74 U	72 U	69 U	71 U
Phenanthrene	71 U	71 U	100	69 U	35 J	26 J	26 J	71 U
Pyrene	71 U	71 U	320	160	140	72 U	52 J	71 U
LLPAH Totals (µg/kg)								
Low molecular weight PAHs	568	568	841	603	589	530	509	568
High molecular weight PAHs	611	607	1577	1281	776	601	660	579

APPENDIX B-1

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753	74SB754
Sample ID	74SB748-00	74SB748-00D	74SB749-00	74SB750-00	74SB751-00	74SB752-00	74SB753-00	74SB754-00
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/19/2011
Depth Range (ft bgs)	0.3-1.0	0.3-1.0	0.0-1.0	0.0-1.0	0.4-1.0	0.4-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)								
Antimony	2 U	1.9 U	2.9	2 U	2.1 U	2 U	2 U	2 U
Arsenic	2	1.5	4.3	4.2	4.7	1.7	1.6	3.5
Barium	150 J	190 J	29 J	44 J	55 J	150 J	110 J	65 J
Beryllium	0.17	0.14	0.064 J	0.078 J	0.093 J	0.14	0.25	0.079 J
Cadmium	0.062 J	0.046 J	1.3	0.18	0.086 J	0.047 J	0.12	0.73
Chromium	7.3	3.9	20	13	15	4.2	9.5	11
Cobalt	6.3	5.7	2.6	3	9.3	6.5	7.3	4.8
Copper	12	9.9	45	16	49	17	22	22
Lead	4.6	3.5	120	32	7.6	3.5	8.8	25 R
Mercury	0.021 U	0.02 U	0.022	0.02	0.014 J	0.0092 J	0.016 J	0.0093 J
Nickel	4.8 J	2.7 J	4.3	3.2	8	3.7	6.9	4
Selenium	1	1	0.97 U	0.98 U	0.77 J	1.5	1.8	0.87 J
Silver	0.2 U	0.19 U	0.84	0.2 U	0.21 U	0.2 U	0.2 U	0.2 U
Thallium	0.2 U	0.19 U	0.054 J	0.068 J	0.21 U	0.2 U	0.2 U	0.16 J
Tin	20 U	19 U	19 U	20 U	21 U	20 U	20 U	20 U
Vanadium	46 J	37 J	21 J	22 J	60 J	40 J	64 J	34
Zinc	34	32	110	920	36	37	49	40
TPH DRO and GRO (mg/kg)								
Diesel Range Organics	290	410	150	47	44	78	400	56
Gasoline Range Organics	2500 J	170 J	35 J	26 J	26 J	12 J	16 J	0.12 J
TPH Total	2790 J	580 J	185 J	73 J	70 J	90 J	416 J	56.12 J

APPENDIX B-1

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB755		74SB756		74SB757		74SB758		74SB759		74SB759		74SB760	
Sample ID	74SB755-00		74SB756-00		74SB757-00		74SB758-00		74SB759-00		74SB759-00D		74SB760-00	
Date	4/19/2011		4/29/2011		4/29/2011		4/29/2011		4/29/2011		4/29/2011		4/29/2011	
Depth Range (ft bgs)	0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0	
Volatile Organics (µg/kg)														
1,1,1,2-Tetrachloroethane	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
1,1,1-Trichloroethane	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
1,1,2-Trichloroethane	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
1,1-Dichloroethane	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
1,1-Dichloroethene	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
1,2,3-Trichloropropane	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
1,2-Dibromo-3-Chloropropane	12	U	13	U	12	U	11	U	11	U	11	U	11	U
1,2-Dibromoethane	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
1,2-Dichloroethane	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
1,2-Dichloropropane	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
2-Butanone (MEK)	30	U	31	U	31	U	27	U	28	U	27	U	27	U
2-Hexanone	30	U	31	U	31	U	27	U	28	U	27	U	27	U
3-Chloro-1-propene	6	U	6.3	UJ	6.1	UJ	5.3	UJ	5.6	UJ	5.4	UJ	5.4	UJ
4-Methyl-2-pentanone (MIBK)	30	U	31	U	31	U	27	U	28	U	27	U	27	U
Acetone	60	U	63	U	61	U	53	U	56	U	54	U	54	U
Acetonitrile	240	U	250	U	240	U	210	U	220	U	220	U	220	U
Acrolein	120	U	130	UJ	120	UJ	110	UJ	110	UJ	110	UJ	110	UJ
Acrylonitrile	120	U	130	U	120	U	110	U	110	U	110	U	110	U
Benzene	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
Bromodichloromethane	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
Bromoform	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
Bromomethane	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
Carbon disulfide	5.5	J	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
Carbon tetrachloride	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
Chlorobenzene	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U
Chloroethane	6	U	6.3	UJ	6.1	UJ	5.3	UJ	5.6	UJ	5.4	UJ	5.4	UJ
Chloroform	6	U	6.3	U	6.1	U	5.3	U	5.6	U	5.4	U	5.4	U

APPENDIX B-1

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB755	74SB756	74SB757	74SB758	74SB759	74SB759	74SB760
Sample ID	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB759-00D	74SB760-00
Date	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Volatile Organics (µg/kg) (cont.)							
Chloromethane	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Chloroprene	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
cis-1,3-Dichloropropene	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Dibromochloromethane	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Dibromomethane	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Dichlorodifluoromethane	6 UJ	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Ethyl methacrylate	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Ethylbenzene	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Iodomethane	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Isobutyl alcohol	240 U	250 U	240 U	210 U	220 U	220 U	220 U
Methacrylonitrile	120 U	130 U	120 U	110 U	110 U	110 U	110 U
Methyl methacrylate	12 U	13 U	12 U	11 U	11 U	11 U	11 U
Methylene Chloride	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Pentachloroethane	30 U	31 U	31 U	27 U	28 U	27 U	27 U
Propionitrile	120 U	130 U	120 U	110 U	110 U	110 U	110 U
Styrene	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Tetrachloroethene	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Toluene	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
trans-1,2-Dichloroethene	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
trans-1,3-Dichloropropene	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
trans-1,4-Dichloro-2-butene	12 U	13 U	12 U	11 U	11 U	11 U	11 U
Trichloroethene	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Trichlorofluoromethane	6 U	6.3 UJ	6.1 UJ	5.3 UJ	5.6 UJ	5.4 UJ	5.4 UJ
Vinyl acetate	12 U	13 U	12 U	11 U	11 UJ	11 UJ	11 U
Vinyl chloride	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U	5.4 U
Xylenes, Total	12 U	13 U	12 U	11 U	11 U	11 U	11 U

APPENDIX B-1

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB755	74SB756	74SB757	74SB758	74SB759	74SB759	74SB760
Sample ID	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB759-00D	74SB760-00
Date	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
LLPAHs (µg/kg)							
2-Methylnaphthalene	75 U	4.2 J	7.4 U	7.2 U	7.2 U	7.1 U	7.2 U
Acenaphthene	75 U	7.2 U	7.4 U	7.2 U	3.8 J	7.1 U	9.4
Acenaphthylene	75 U	11	7.4 U	7.2 U	17	14	17
Anthracene	75 U	25	4 J	4.5 J	26	12	52
Benzo[a]anthracene	75 U	63	13	37	160 J	50 J	140
Benzo[a]pyrene	59 J	110	20	50	180 J	68 J	140
Benzo[b]fluoranthene	68 J	200	36	89	270 J	120 J	240
Benzo[g,h,i]perylene	76	53	7.4 U	24	52	23	66
Benzo[k]fluoranthene	56 J	180	33	73	230 J	94 J	210
Chrysene	46 J	110	31	50	200 J	96 J	250
Dibenz(a,h)anthracene	75 U	20	7.4 U	7.2 U	7.2 U	7.1 U	22
Fluoranthene	43 J	97	32	50	300 J	170 J	400
Fluorene	75 U	7.2 U	7.4 U	7.2 U	3.6 J	7.1 U	7.6
Indeno[1,2,3-cd]pyrene	44 J	26	5 J	12	26	14	36
Naphthalene	75 U	7.2 U	7.4 U	7.2 U	7.2 U	7.1 U	7.2 U
Phenanthrene	75 U	40	6.2 J	8.6	78 J	32 J	180
Pyrene	51 J	110	33	58	350 J	190 J	430
LLPAH Totals (µg/kg)							
Low molecular weight PAHs	568	198.8	79.2	99.1	442.8	256.4	680.4
High molecular weight PAHs	550	872	185.8	400.2	1475.2	662.1	1534

APPENDIX B-1

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB755	74SB756	74SB757	74SB758	74SB759	74SB759	74SB760
Sample ID	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB759-00D	74SB760-00
Date	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg)							
Antimony	2.2 U	1.8 J	2.1 U	2.1 U	2.1 U	2.1 U	2 U
Arsenic	2.9	21	3.7	5.1	5.2	4.3	6.8
Barium	54 J	38 J	44 J	17 J	15 J	13 J	20 J
Beryllium	0.095 J	0.059 J	0.099 J	0.06 J	0.11 U	0.1 U	0.099 U
Cadmium	1.8	0.7	0.11	0.51	0.11	0.079 J	0.18
Chromium	18	27	19	11	9.4	8.5	7.8
Cobalt	10	10 J	6.5 J	2.9 J	1.9 J	1.8 J	1.7 J
Copper	48	59	39	550	9.3	7.1	15
Lead	50 R	58	35	71	6.7	5.4	7.3
Mercury	0.012 J	0.21	0.021 U	0.015 J	0.02 U	0.0085 J	0.02 U
Nickel	8.5	27	9.1	3.9	4.2	2.6	2.2
Selenium	0.83 J	0.97 U	1.1 U	1.1 U	1.1 U	1 U	0.99 U
Silver	0.16 J	0.1 J	0.21 U	0.83	0.21 U	0.21 U	0.2 U
Thallium	0.21 J	0.061 J	0.21 U	0.21 U	0.21 U	0.21 U	0.2 U
Tin	22 U	19 U	21 U	21 U	21 U	21 U	20 U
Vanadium	62	29	48	31	15	18	13
Zinc	100	250	33	230	12	10	28
TPH DRO and GRO (mg/kg)							
Diesel Range Organics	110	36	24	25	32 J	19 J	71
Gasoline Range Organics	0.26 J	0.31 U	0.31 U	0.3 U	0.27 UJ	0.32 UJ	0.3 U
TPH Total	110.26 J	36	24	25	32 J	19 J	71

APPENDIX B-1

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes/Qualifiers

J - Estimated: The analyte was positively identified; the quantitation is an estimation
R - Rejected data; data is not usable
U - Not detected at the Limit of Detection
UJ - Reported quantitation limit is qualified as estimated
ft bgs - feet below ground surface
LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons
μg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
TPH - Total Petroleum Hydrocarbons

SUBSURFACE SOIL DATA

APPENDIX B-2

SUMMARY OF ANALYTICAL RESULTS, SUBSURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748		74SB748		74SB749		74SB750		74SB751		74SB752		74SB753	
Sample ID	74SB748-01		74SB748-01D		74SB749-01		74SB750-01		74SB751-01		74SB752-01		74SB753-01	
Date	4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011	
Depth Range (ft bgs)	1.0-3.0		1.0-3.0		1.0-2.3		1.0-2.5		1.0-3.0		1.0-3.0		1.0-3.0	
Volatile Organics (µg/kg)														
1,1,1,2-Tetrachloroethane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
1,1,1-Trichloroethane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
1,1,2-Trichloroethane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
1,1-Dichloroethane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
1,1-Dichloroethene	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
1,2,3-Trichloropropane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
1,2-Dibromo-3-Chloropropane	14	U	13	U	12	U	13	U	9.7	U	9.6	U	10	U
1,2-Dibromoethane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
1,2-Dichloroethane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
1,2-Dichloropropane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
2-Butanone (MEK)	34	U	34	U	31	U	33	U	24	U	24	U	25	U
2-Hexanone	34	U	34	U	31	U	33	U	24	U	24	U	25	U
3-Chloro-1-propene	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
4-Methyl-2-pentanone (MIBK)	34	U	34	U	31	U	33	U	24	U	24	U	25	U
Acetone	69	U	67	U	62	U	66	U	48	U	48	U	50	U
Acetonitrile	280	U	270	U	250	U	260	U	190	U	190	U	200	U
Acrolein	140	UJ	130	UJ	120	UJ	130	UJ	97	UJ	96	UJ	100	UJ
Acrylonitrile	140	U	130	U	120	U	130	U	97	U	96	U	100	U
Benzene	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Bromodichloromethane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Bromoform	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Bromomethane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Carbon disulfide	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Carbon tetrachloride	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Chlorobenzene	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Chloroethane	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Chloroform	6.9	U	6.7	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U

APPENDIX B-2

SUMMARY OF ANALYTICAL RESULTS, SUBSURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID	74SB748-01	74SB748-01D	74SB749-01	74SB750-01	74SB751-01	74SB752-01	74SB753-01
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	1.0-3.0	1.0-3.0	1.0-2.3	1.0-2.5	1.0-3.0	1.0-3.0	1.0-3.0
Volatile Organics (µg/kg) (cont.)							
Chloromethane	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Chloroprene	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
cis-1,3-Dichloropropene	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Dibromochloromethane	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Dibromomethane	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Dichlorodifluoromethane	6.9 UJ	6.7 UJ	6.2 UJ	6.6 UJ	4.8 UJ	4.8 UJ	5 UJ
Ethyl methacrylate	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Ethylbenzene	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Iodomethane	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Isobutyl alcohol	280 U	270 U	250 U	260 U	190 U	190 U	200 U
Methacrylonitrile	140 U	130 U	120 U	130 U	97 U	96 U	100 U
Methyl methacrylate	14 U	13 U	12 U	13 U	9.7 U	9.6 U	10 U
Methylene Chloride	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Pentachloroethane	34 U	34 U	31 U	33 U	24 U	24 U	25 U
Propionitrile	140 U	130 U	120 U	130 U	97 U	96 U	100 U
Styrene	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Tetrachloroethene	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Toluene	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
trans-1,2-Dichloroethene	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
trans-1,3-Dichloropropene	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
trans-1,4-Dichloro-2-butene	14 U	13 U	12 U	13 U	9.7 U	9.6 U	10 U
Trichloroethene	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Trichlorofluoromethane	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Vinyl acetate	14 U	13 U	12 U	13 U	9.7 U	9.6 U	10 U
Vinyl chloride	6.9 U	6.7 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Xylenes, Total	14 U	13 U	12 U	13 U	9.7 U	9.6 U	10 U

APPENDIX B-2

SUMMARY OF ANALYTICAL RESULTS, SUBSURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID	74SB748-01	74SB748-01D	74SB749-01	74SB750-01	74SB751-01	74SB752-01	74SB753-01
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	1.0-3.0	1.0-3.0	1.0-2.3	1.0-2.5	1.0-3.0	1.0-3.0	1.0-3.0
LLPAHs (µg/kg)							
2-Methylnaphthalene	7.5 U	7.4 U	72 U	7.1 U	74 U	7.3 U	72 U
Acenaphthene	7.5 U	7.4 U	72 U	7.1 U	74 U	7.3 U	72 U
Acenaphthylene	7.5 U	7.4 U	72 U	7.1 U	74 U	7.3 U	72 U
Anthracene	7.5 U	7.4 U	72 U	6.1 J	74 U	7.3 U	72 U
Benzo[a]anthracene	7.5 U	7.4 U	72 U	23	72 J	7.3 U	72 U
Benzo[a]pyrene	7.5 U	7.4 U	66 J	45	63 J	7.3 U	25 J
Benzo[b]fluoranthene	7.5 U	7.4 U	110	45	74 U	4.7 J	72 U
Benzo[g,h,i]perylene	7.5 U	7.4 U	62 J	30	74 U	7.3 U	72 U
Benzo[k]fluoranthene	7.5 U	7.4 U	41 J	36	83	2.3 J	72 U
Chrysene	7.5 U	7.4 U	42 J	24	62 J	7.3 U	72 U
Dibenz(a,h)anthracene	7.5 U	7.4 U	72 U	10	74 U	7.3 U	72 U
Fluoranthene	7.5 U	7.4 U	72 U	10	110	7.3 U	72 U
Fluorene	7.5 U	7.4 U	72 U	7.1 U	74 U	7.3 U	72 U
Indeno[1,2,3-cd]pyrene	7.5 U	7.4 U	46 J	27	74 U	7.3 U	72 U
Naphthalene	7.5 U	7.4 U	72 U	7.1 U	74 U	7.3 U	72 U
Phenanthrene	7.5 U	7.4 U	72 U	7.1 U	32 J	7.3 U	72 U
Pyrene	7.5 U	7.4 U	72 U	15	110	7.3 U	72 U
LLPAH Totals (µg/kg)							
Low molecular weight PAHs	60	59.2	576	58.7	586	58.4	576
High molecular weight PAHs	67.5	66.6	583	255	686	58.1	601

APPENDIX B-2

SUMMARY OF ANALYTICAL RESULTS, SUBSURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748		74SB748		74SB749		74SB750		74SB751		74SB752		74SB753	
Sample ID	74SB748-01		74SB748-01D		74SB749-01		74SB750-01		74SB751-01		74SB752-01		74SB753-01	
Date	4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011	
Depth Range (ft bgs)	1.0-3.0		1.0-3.0		1.0-2.3		1.0-2.5		1.0-3.0		1.0-3.0		1.0-3.0	
Metals (mg/kg)														
Antimony	2.1	U	2.2	U	2.9		2.1	U	2.1	U	2.1	U	2.1	U
Arsenic	3.5		2.6		3.4		3.3		4.1		2		3.6	
Barium	11	J	9.7	J	21	J	34	J	56	J	9.7	J	35	J
Beryllium	0.11	U	0.11	U	0.11	U	0.11	U	0.054	J	0.11	U	0.072	J
Cadmium	0.11	U	0.11	U	2.8		0.029	J	0.044	J	0.11	U	0.11	U
Chromium	3.5		2.4		13		4.7		10		11		5.1	
Cobalt	0.37		0.22		1.7		0.97		2		0.57		2.2	
Copper	1.9		1.5		53		4.5		7.7		2.2		28	
Lead	0.32	J	0.28	J	110		3.8		3.7		0.97		6.4	
Mercury	0.021	U	0.021	U	0.027		0.0098	J	0.016	J	0.011	J	0.012	J
Nickel	1.2		0.82	J	4.2		1.7		2.6		1.9		2.9	
Selenium	1.1	U	1.1	U	1.1	U	1.1	U	1	U	1.1	U	1.1	U
Silver	0.21	U	0.22	U	0.4		0.21	U	0.21	U	0.21	U	0.21	U
Thallium	0.057	J	0.22	U	0.22	U	0.21	U	0.21	U	0.21	U	0.21	U
Tin	21	U	22	U	22	U	21	U	21	U	21	U	21	U
Vanadium	5.1	J	3.3	J	14	J	11	J	20	J	5.5	J	20	J
Zinc	1.9	J	4.3	U	110		39		16		2.4	J	11	
TPH DRO and GRO (mg/kg)														
Diesel Range Organics	3.7	U	3.6	U	37		15		32		20		31	
Gasoline Range Organics	26	J	28	J	31	J	14	J	11	J	23	J	19	J
TPH Total	26	J	28	J	68	J	29	J	43	J	43	J	50	J

APPENDIX B-2

SUMMARY OF ANALYTICAL RESULTS, SUBSURFACE SOIL
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes/Qualifiers

J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Not detected at the Limit of Detection
UJ - Reported quantitation limit is qualified as estimated
ft bgs - feet below ground surface
LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons
μg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
TPH - Total Petroleum Hydrocarbons

GROUNDWATER DATA

APPENDIX B-3

SUMMARY OF ANALYTICAL RESULTS, GROUNDWATER
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB246B		74SB246B	
Sample ID	74GW246B		74GW246BD	
Date	4/19/2011		4/19/2011	
LLPAHs (µg/L)				
2-Methylnaphthalene	0.21	U	0.2	U
Acenaphthene	0.21	U	0.2	U
Acenaphthylene	0.21	U	0.2	U
Anthracene	0.21	U	0.2	U
Benzo[a]anthracene	0.21	U	0.2	U
Benzo[a]pyrene	0.21	U	0.2	U
Benzo[b]fluoranthene	0.21	U	0.2	U
Benzo[g,h,i]perylene	0.21	U	0.2	U
Benzo[k]fluoranthene	0.21	U	0.2	U
Chrysene	0.21	U	0.2	U
Dibenz(a,h)anthracene	0.21	U	0.2	U
Fluoranthene	0.21	U	0.2	U
Fluorene	0.21	U	0.2	U
Indeno[1,2,3-cd]pyrene	0.21	U	0.2	U
Naphthalene	0.21	U	0.2	U
Phenanthrene	0.21	U	0.2	U
Pyrene	0.21	U	0.2	U

Notes/Qualifiers

U - Not detected at the Limit of Detection
ft bgs - feet below ground surface
LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons
µg/L - micrograms per liter

QA/QC DATA

APPENDIX B-4

SUMMARY OF ANALYTICAL RESULTS, QA/QC SAMPLES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	74ER114	74ER115	74ER116	74ER117	74FB01	74TB114	74TB115	74TB117
Date	4/18/2011	4/19/2011	4/19/2011	4/29/2011	4/18/2011	4/18/2011	4/19/2011	4/29/2011
Volatile Organics (µg/L)								
1,1,1,2-Tetrachloroethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-Chloropropane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromoethane (EDB)	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone (MEK)	10 U	NA	10 U	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10 U	NA	10 U	10 U	10 U	10 U	10 U	10 U
3-Chloro-1-propene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
4-Methyl-2-pentanone (MIBK)	10 U	NA	10 U	10 U	10 U	10 U	10 U	10 U
Acetone	25 U	NA	25 U	41	25 U	25 U	25 U	25 U
Acetonitrile	40 U	NA	40 U	40 U	40 U	40 U	40 U	40 U
Acrolein	20 U	NA	20 U	20 U	20 U	20 U	20 U	20 U
Acrylonitrile	20 U	NA	20 U	20 U	20 U	20 U	20 U	20 U
Benzene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	1 UJ	NA	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ	1 UJ
Carbon disulfide	2 U	NA	2 U	2 U	2 U	2 U	2 U	2 U
Carbon tetrachloride	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1 U	NA	1 U	0.72 J	1 U	1 U	1 U	1 U
Chloromethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U

APPENDIX B-4

SUMMARY OF ANALYTICAL RESULTS, QA/QC SAMPLES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	74ER114	74ER115	74ER116	74ER117	74FB01	74TB114	74TB115	74TB117
Date	4/18/2011	4/19/2011	4/19/2011	4/29/2011	4/18/2011	4/18/2011	4/19/2011	4/29/2011
Volatile Organics (µg/L) (cont.)								
Chloroprene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Dibromomethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Ethyl methacrylate	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Iodomethane	5 U	NA	5 U	5 UJ	5 U	5 UJ	5 U	5 UJ
Isobutanol	40 U	NA	40 U	40 U	40 U	40 U	40 U	40 U
Methacrylonitrile	20 U	NA	20 U	20 U	20 U	20 U	20 U	20 U
Methyl methacrylate	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Methylene Chloride	5 U	NA	5 U	74	5 U	5 U	5 U	5 U
Pentachloroethane	5 U	NA	5 U	5 U	5 U	5 U	5 U	5 U
Propionitrile	20 U	NA	20 U	20 U	20 U	20 U	20 U	20 U
Styrene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	NA	1 U	0.52 J	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,4-Dichloro-2-butene	2 U	NA	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Vinyl acetate	2 U	NA	2 U	2 U	2 U	2 U	2 U	2 U
Vinyl chloride	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U
Xylenes, Total	2 U	NA	2 U	2 U	2 U	2 U	2 U	2 U

APPENDIX B-4

SUMMARY OF ANALYTICAL RESULTS, QA/QC SAMPLES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	74ER114	74ER115	74ER116	74ER117	74FB01	74TB114	74TB115	74TB117
Date	4/18/2011	4/19/2011	4/19/2011	4/29/2011	4/18/2011	4/18/2011	4/19/2011	4/29/2011
LLPAHs (µg/L)								
1-Methylnaphthalene	NA	NA	NA	0.39 U	NA	NA	NA	NA
2-Methylnaphthalene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Acenaphthene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Acenaphthylene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Anthracene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Benzo[a]anthracene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Benzo[a]pyrene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Benzo[b]fluoranthene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Benzo[g,h,i]perylene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Benzo[k]fluoranthene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Chrysene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Dibenz(a,h)anthracene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Fluoranthene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Fluorene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Indeno[1,2,3-cd]pyrene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Naphthalene	0.19 U	0.19 U	0.19 U	0.3	0.19 U	NA	NA	NA
Phenanthrene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
Pyrene	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	NA	NA	NA
LLPAH Totals (µg/L)								
Low molecular weight PAHs	1.52	1.52	1.52	2.09	1.52	NA	NA	NA
High molecular weight PAHs	1.71	1.71	1.71	1.8	1.71	NA	NA	NA

APPENDIX B-4

SUMMARY OF ANALYTICAL RESULTS, QA/QC SAMPLES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Sample ID	74ER114	74ER115	74ER116	74ER117	74FB01	74TB114	74TB115	74TB117
Date	4/18/2011	4/19/2011	4/19/2011	4/29/2011	4/18/2011	4/18/2011	4/19/2011	4/29/2011
Metals (µg/L)								
Antimony	5 U	NA	5 U	5 U	5 U	NA	NA	NA
Arsenic	2.5 U	NA	2.5 U	2.5 U	2.5 U	NA	NA	NA
Barium	11	NA	5 U	5 U	9.1	NA	NA	NA
Beryllium	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	NA	NA
Cadmium	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	NA	NA
Chromium	5 U	NA	5 U	5 U	5 U	NA	NA	NA
Cobalt	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	NA	NA
Copper	1.6 J	NA	5 U	5 U	5 U	NA	NA	NA
Lead	1.5 U	NA	1.5 U	1.5 U	1.5 U	NA	NA	NA
Mercury	0.2 U	NA	0.2 U	0.2 U	0.2 U	NA	NA	NA
Nickel	5 U	NA	5 U	5 U	5 U	NA	NA	NA
Selenium	2.5 U	NA	2.5 U	2.5 U	2.5 U	NA	NA	NA
Silver	1 U	NA	1 U	1 U	1 U	NA	NA	NA
Thallium	1 U	NA	1 U	1 U	1 U	NA	NA	NA
Tin	5 U	NA	5 U	5 U	5 U	NA	NA	NA
Vanadium	10 U	NA	10 U	10 U	10 U	NA	NA	NA
Zinc	20 U	NA	20 U	20 U	20 U	NA	NA	NA
TPH DRO and GRO (µg/L)								
Diesel Range Organics	0.024 J	NA	0.12	0.036 J	0.034 J	NA	NA	NA
Gasoline Range Organics	0.05 U	NA	0.05 U	0.013 J	0.05 U	50 U	0.05 U	0.05 U
TPH Total	0.024 J	NA	0.12	0.049 J	0.034 J	50 U	0.05 U	0.05 U

APPENDIX B-4

SUMMARY OF ANALYTICAL RESULTS, QA/QC SAMPLES
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes/Qualifiers

J - Estimated: The analyte was positively identified; the quantitation is an estimation

U - Not detected at the Limit of Detection

UJ - Reported quantitation limit is qualified as estimated

ft bgs - feet below ground surface

LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons

μg/L - micrograms per liter

NA - Not Analyzed

TPH - Total Petroleum Hydrocarbons

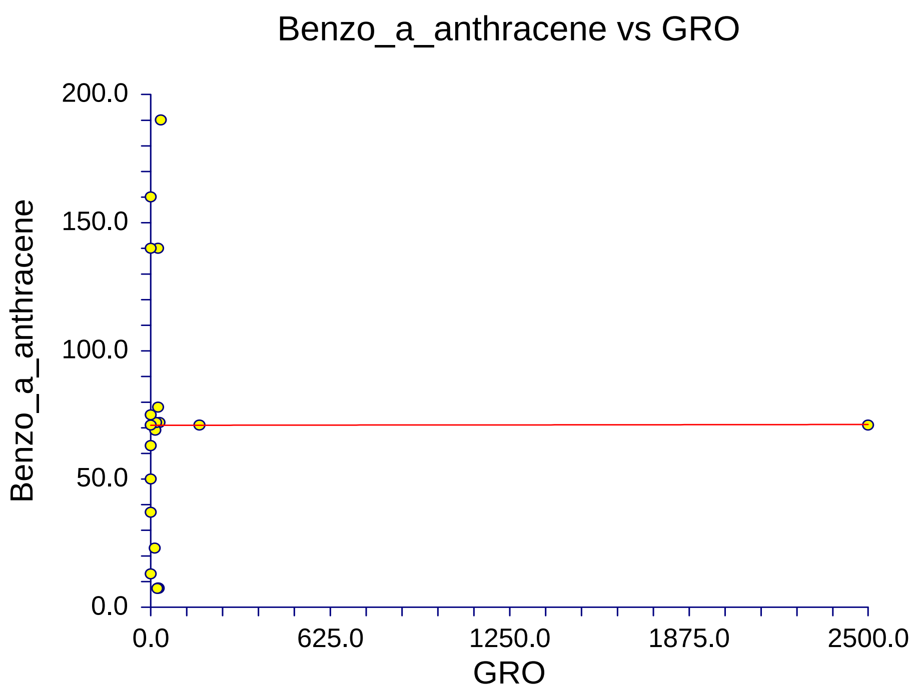
LINEAR REGRESSION RESULTS

LLPAHs vs. TPH GRO

Linear Regression Report

Page/Date/Time 1 6/21/2011 1:56:21 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_a_anthracene X = GRO

Linear Regression Plot Section



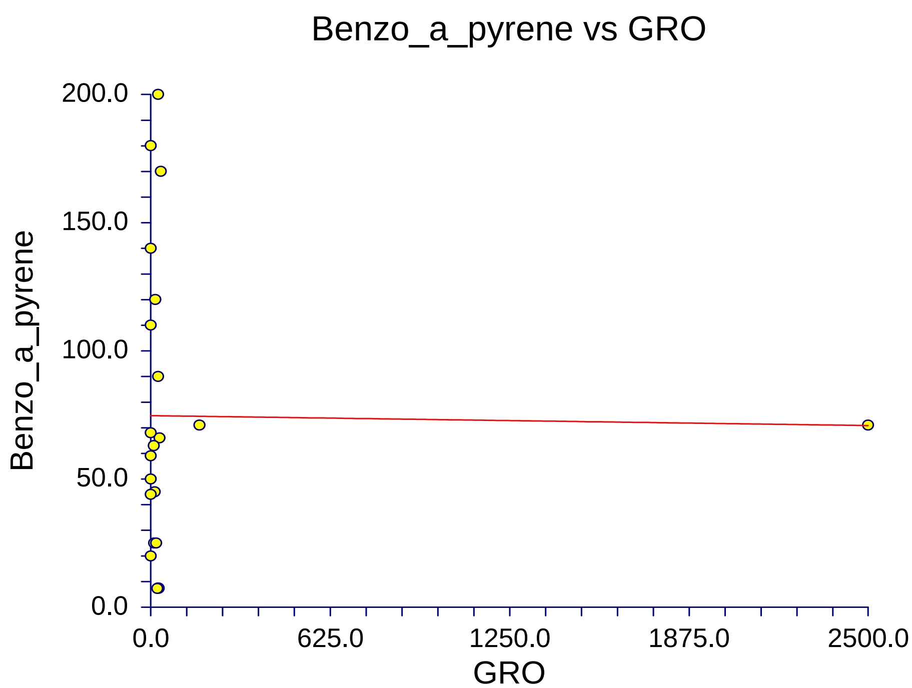
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_a_anthracene	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	70.9471	Rows Prediction Only	6
Slope	0.0001	Sum of Frequencies	22
R-Squared	0.0000	Sum of Weights	22.0000
Correlation	0.0013	Coefficient of Variation	0.7126
Mean Square Error	2557.039	Square Root of MSE	50.56717

Linear Regression Report

Page/Date/Time 1 6/21/2011 1:57:20 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_a_pyrene X = GRO

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Benzo_a_pyrene	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	74.7157	Rows Prediction Only	6
Slope	-0.0015	Sum of Frequencies	22
R-Squared	0.0002	Sum of Weights	22.0000
Correlation	-0.0144	Coefficient of Variation	0.7834
Mean Square Error	3406.895	Square Root of MSE	58.36861

Linear Regression Report

Page/Date/Time 1 6/21/2011 1:58:44 PM
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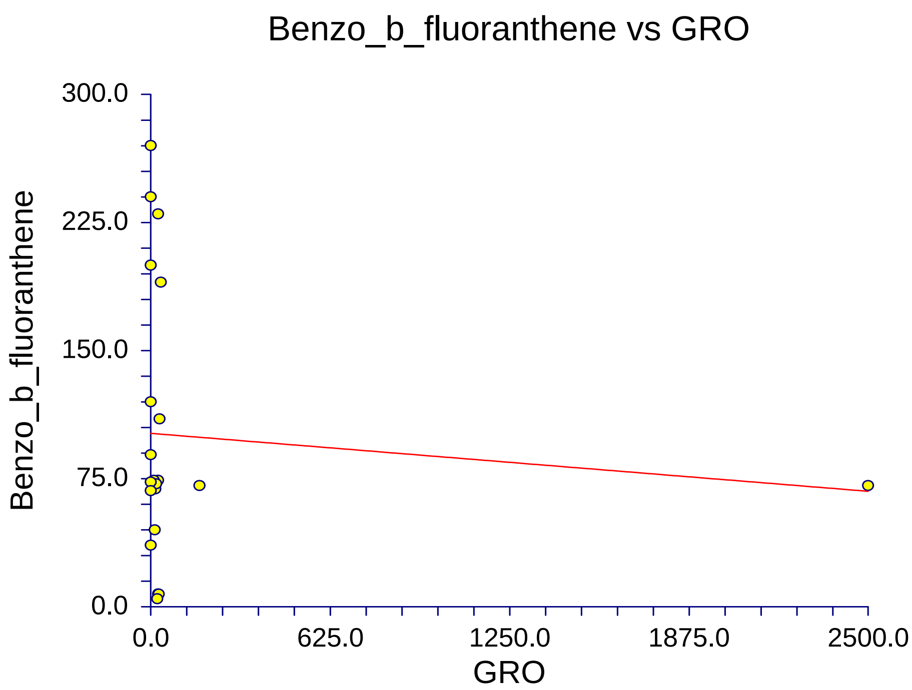
Y = Benzo_b_fluoranthene X = GRO

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_b_fluoranthene	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	101.5212	Rows Prediction Only	6
Slope	-0.0136	Sum of Frequencies	22
R-Squared	0.0087	Sum of Weights	22.0000
Correlation	-0.0932	Coefficient of Variation	0.7887
Mean Square Error	6184.253	Square Root of MSE	78.64002

Linear Regression Report

Page/Date/Time 1 6/21/2011 1:59:55 PM
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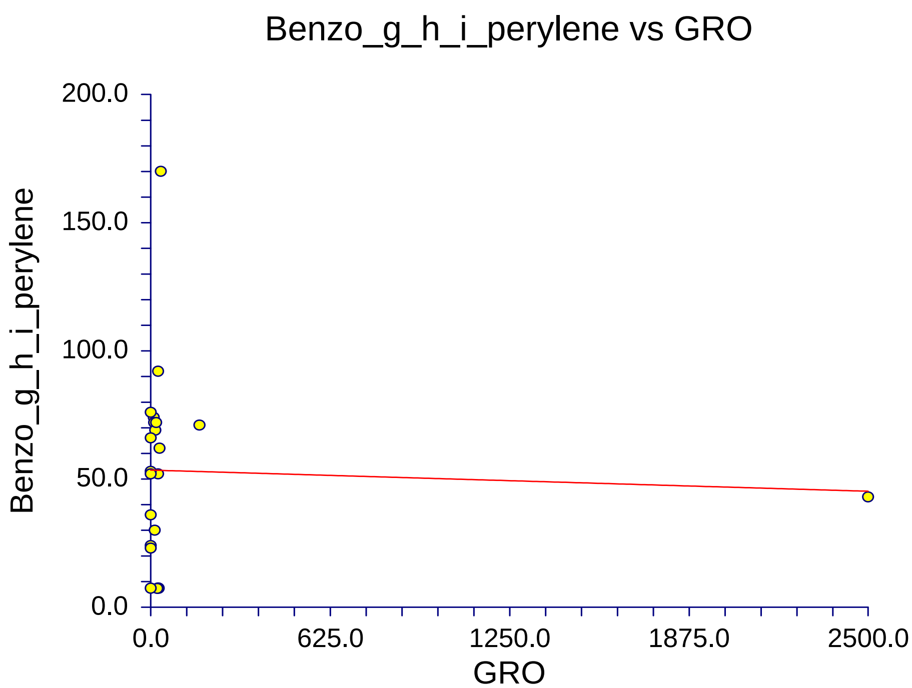
Y = Benzo_g_h_i_perylene X = GRO

Linear Regression Plot Section



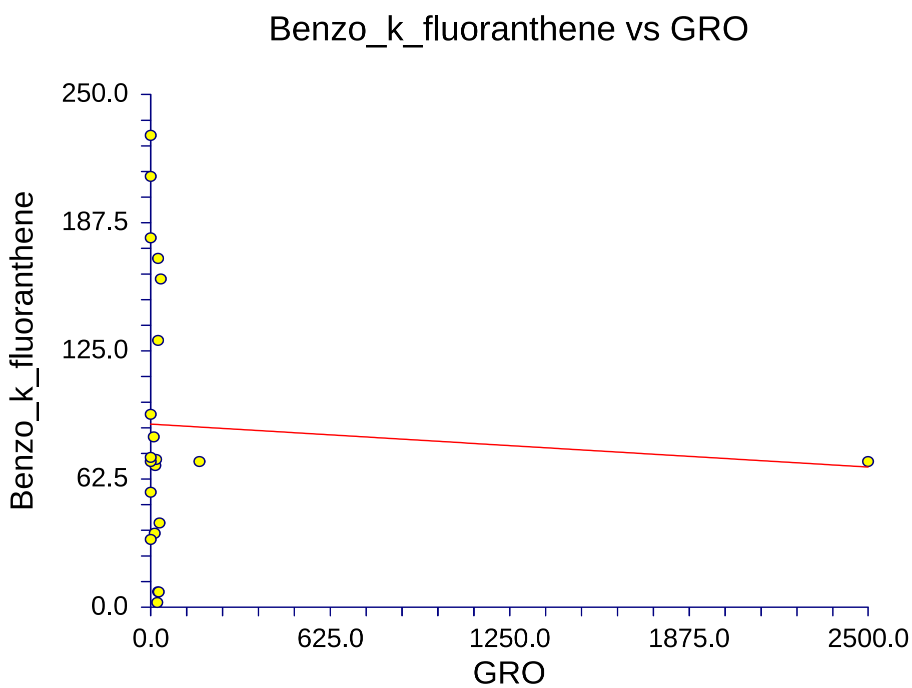
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_g_h_i_perylene	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	53.4680	Rows Prediction Only	6
Slope	-0.0033	Sum of Frequencies	22
R-Squared	0.0022	Sum of Weights	22.0000
Correlation	-0.0473	Coefficient of Variation	0.7137
Mean Square Error	1432.316	Square Root of MSE	37.84595

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:01:27 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_k_fluoranthene X = GRO

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_k_fluoranthene	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	89.2645	Rows Prediction Only	6
Slope	-0.0084	Sum of Frequencies	22
R-Squared	0.0047	Sum of Weights	22.0000
Correlation	-0.0684	Coefficient of Variation	0.7529
Mean Square Error	4403.958	Square Root of MSE	66.36233

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:02:39 PM
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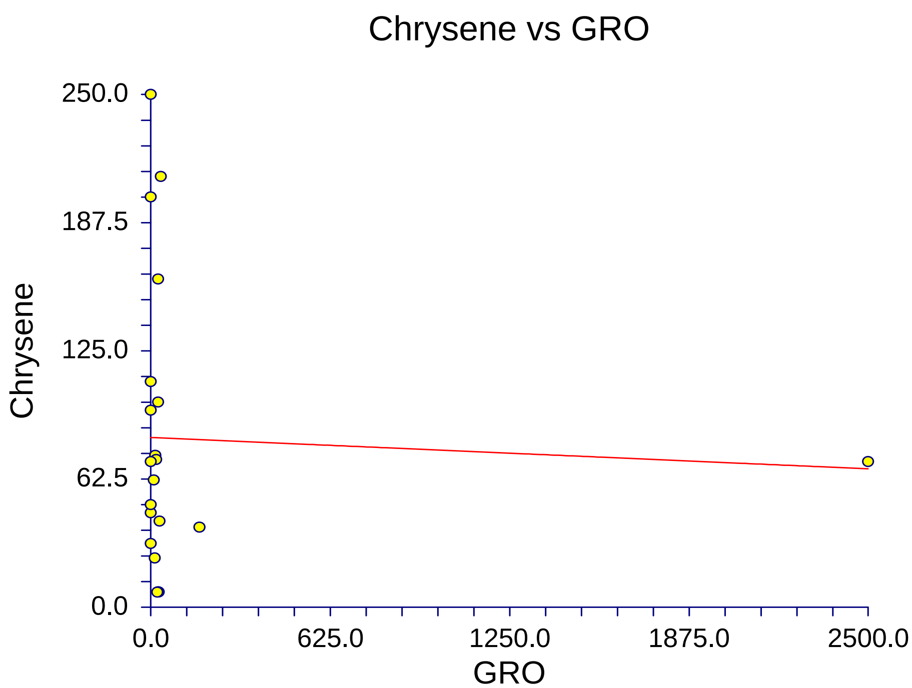
Y = Chrysene X = GRO

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Chrysene	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	82.7341	Rows Prediction Only	6
Slope	-0.0061	Sum of Frequencies	22
R-Squared	0.0023	Sum of Weights	22.0000
Correlation	-0.0480	Coefficient of Variation	0.8415
Mean Square Error	4751.778	Square Root of MSE	68.93314

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:28:47 PM
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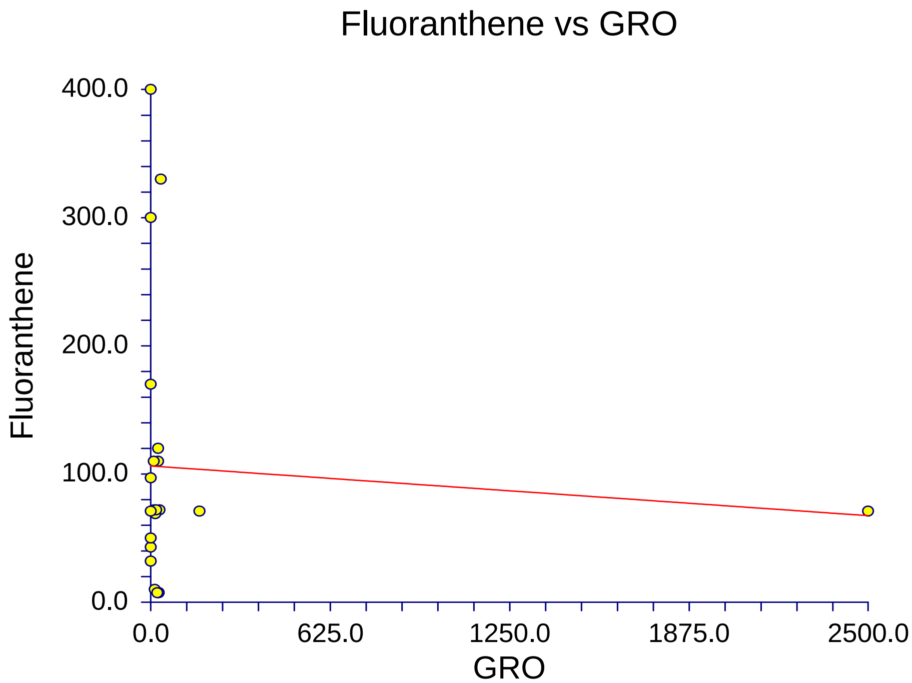
Y = Fluoranthene X = GRO

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Fluoranthene	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	106.2612	Rows Prediction Only	6
Slope	-0.0155	Sum of Frequencies	22
R-Squared	0.0059	Sum of Weights	22.0000
Correlation	-0.0771	Coefficient of Variation	1.0440
Mean Square Error	11832.04	Square Root of MSE	108.7752

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:31:37 PM
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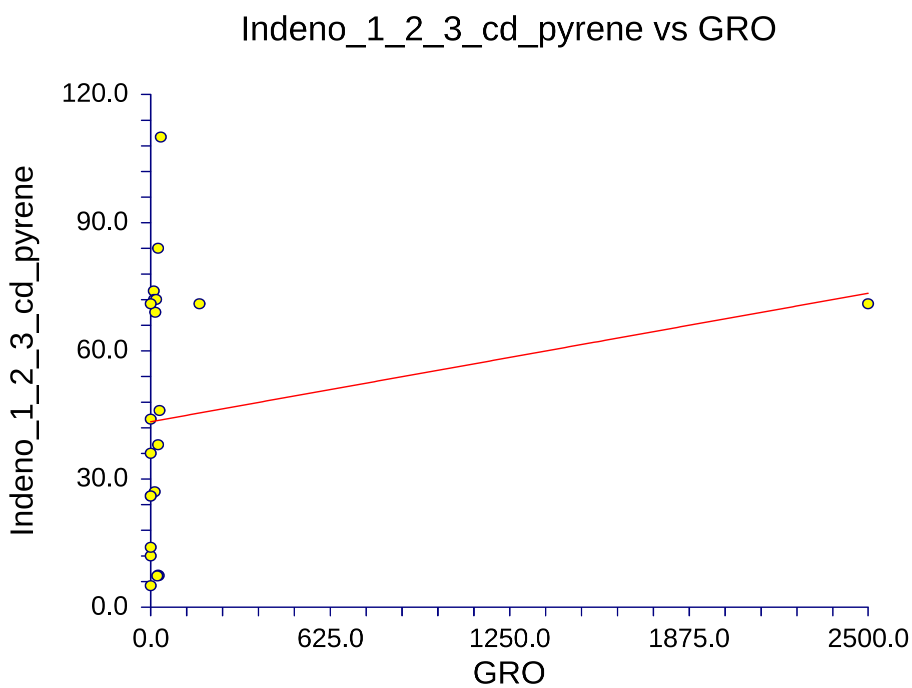
Y = Indeno_1_2_3_cd_pyrene X = GRO

Linear Regression Plot Section



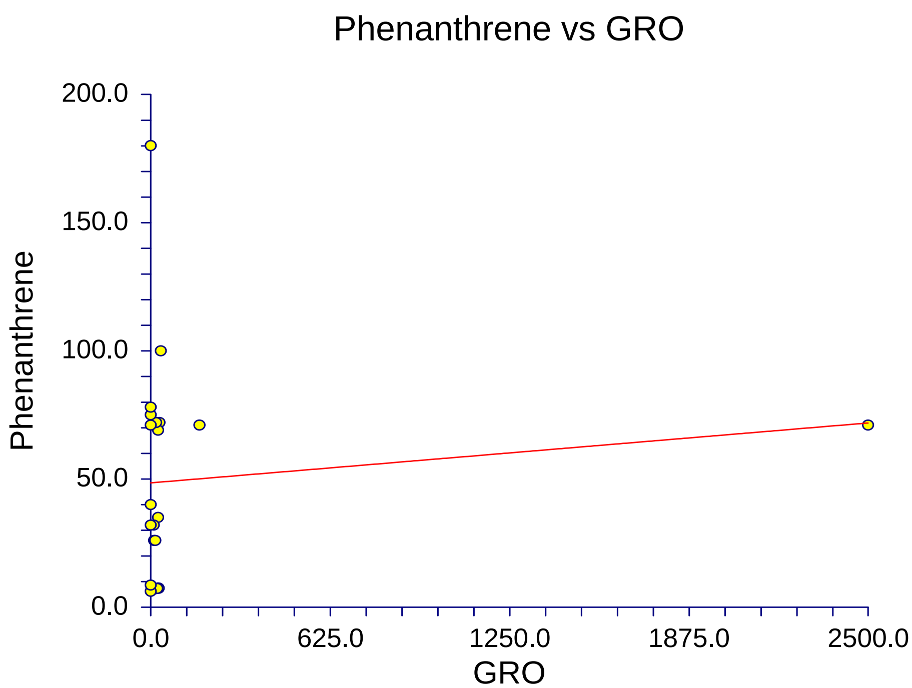
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Indeno_1_2_3_cd_pyrene	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	43.4021	Rows Prediction Only	6
Slope	0.0120	Sum of Frequencies	22
R-Squared	0.0432	Sum of Weights	22.0000
Correlation	0.2079	Coefficient of Variation	0.6824
Mean Square Error	943.2855	Square Root of MSE	30.71295

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:33:51 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Phenanthrene X = GRO

Linear Regression Plot Section



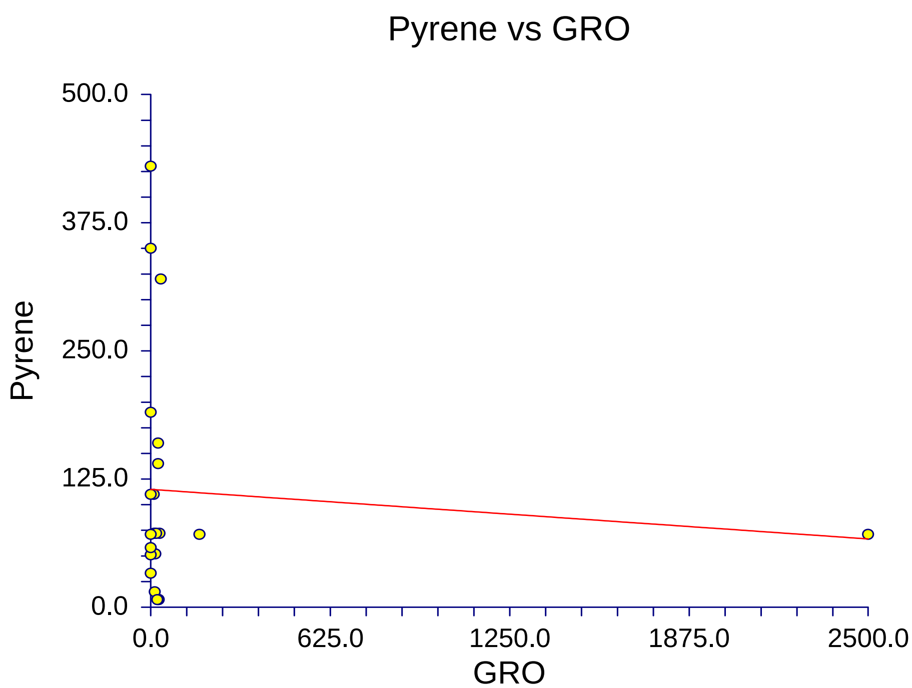
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Phenanthrene	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	48.4830	Rows Prediction Only	6
Slope	0.0093	Sum of Frequencies	22
R-Squared	0.0141	Sum of Weights	22.0000
Correlation	0.1188	Coefficient of Variation	0.8529
Mean Square Error	1799.333	Square Root of MSE	42.41854

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:34:53 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Pyrene X = GRO

Linear Regression Plot Section



Run Summary Section

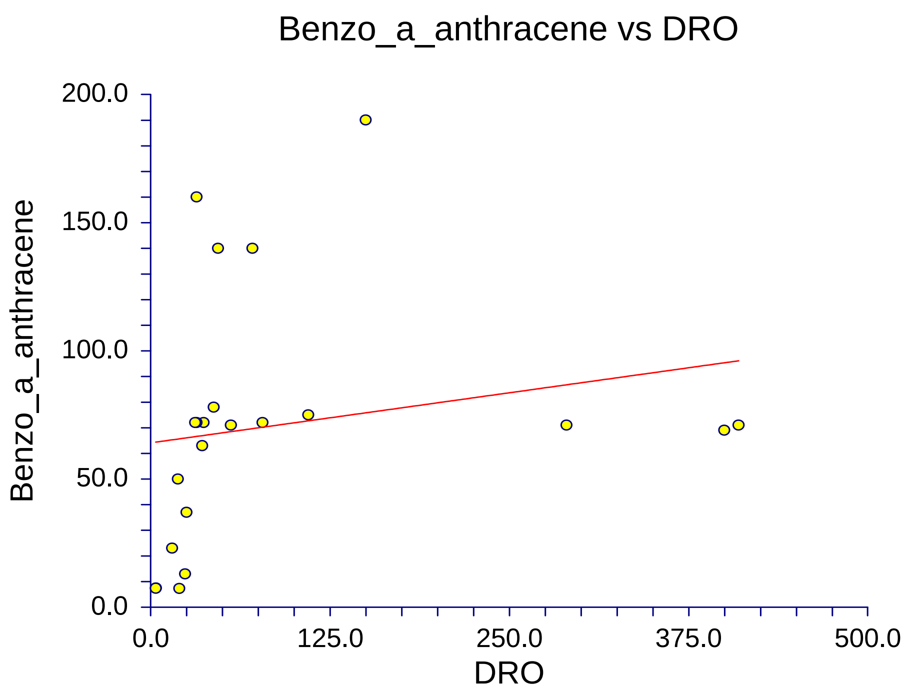
Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Pyrene	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	114.8617	Rows Prediction Only	6
Slope	-0.0193	Sum of Frequencies	22
R-Squared	0.0079	Sum of Weights	22.0000
Correlation	-0.0888	Coefficient of Variation	1.0473
Mean Square Error	13828.32	Square Root of MSE	117.5939

LLPAHs vs. TPH DRO

Linear Regression Report

Page/Date/Time 1 6/21/2011 1:56:02 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_a_anthracene X = DRO

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_a_anthracene	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	64.1017	Rows Prediction Only	6
Slope	0.0780	Sum of Frequencies	22
R-Squared	0.0361	Sum of Weights	22.0000
Correlation	0.1900	Coefficient of Variation	0.6996
Mean Square Error	2464.758	Square Root of MSE	49.64633

[redacted]Report

Page/Date/Time 1 6/21/2011 1:56:59 PM
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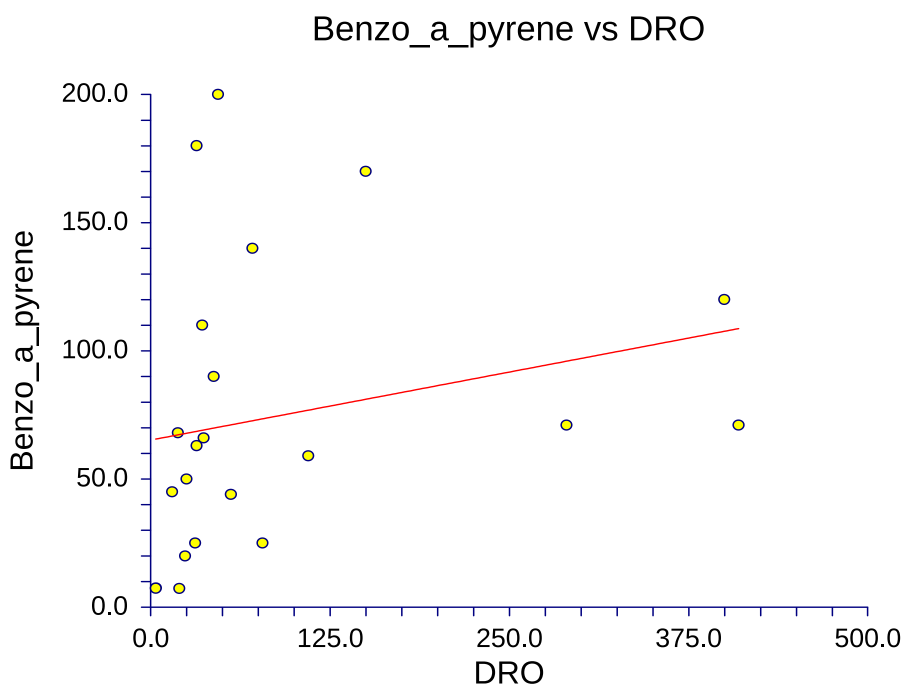
Y = Benzo_a_pyrene X = DRO

Linear Regression Plot Section



Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_a_pyrene	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	65.1861	Rows Prediction Only	6
Slope	0.1060	Sum of Frequencies	22
R-Squared	0.0500	Sum of Weights	22.0000
Correlation	0.2236	Coefficient of Variation	0.7636
Mean Square Error	3237.246	Square Root of MSE	56.8968

[redacted]

Page/Date/Time 1 6/21/2011 1:58:25 PM
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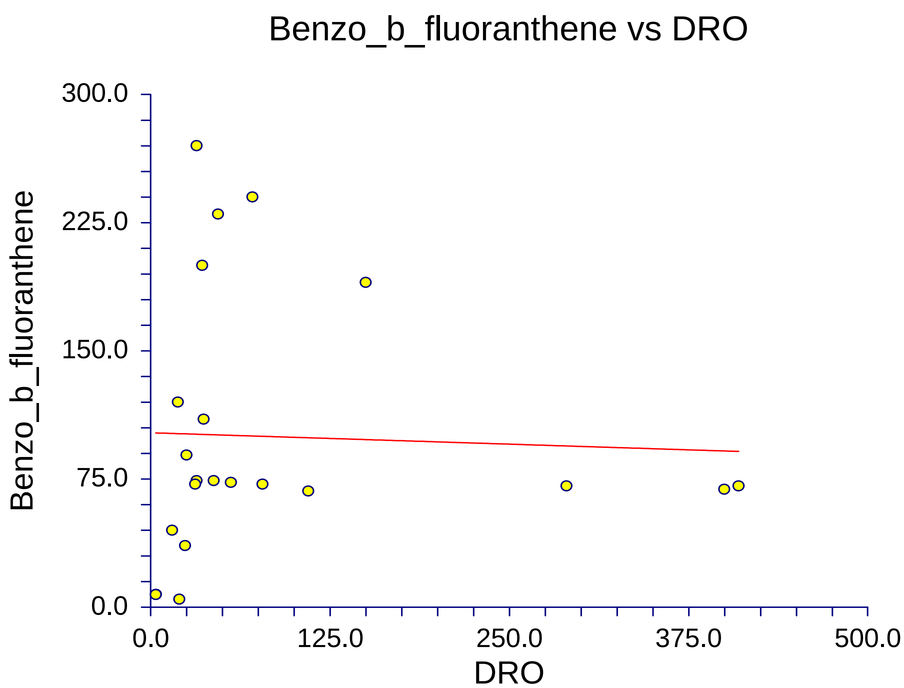
Y = Benzo_b_fluoranthene X = DRO

Linear Regression Plot Section



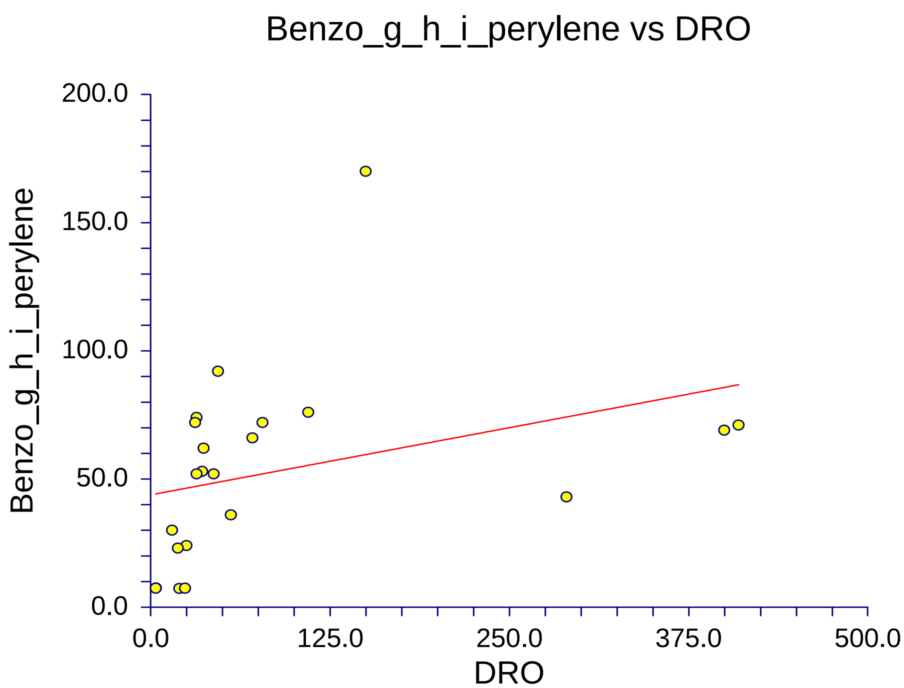
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_b_fluoranthene	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	102.0520	Rows Prediction Only	6
Slope	-0.0266	Sum of Frequencies	22
R-Squared	0.0017	Sum of Weights	22.0000
Correlation	-0.0415	Coefficient of Variation	0.7915
Mean Square Error	6227.703	Square Root of MSE	78.91579

Report

Page/Date/Time 1 6/21/2011 1:59:35 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_g_h_i_perylene X = DRO

Linear Regression Plot Section



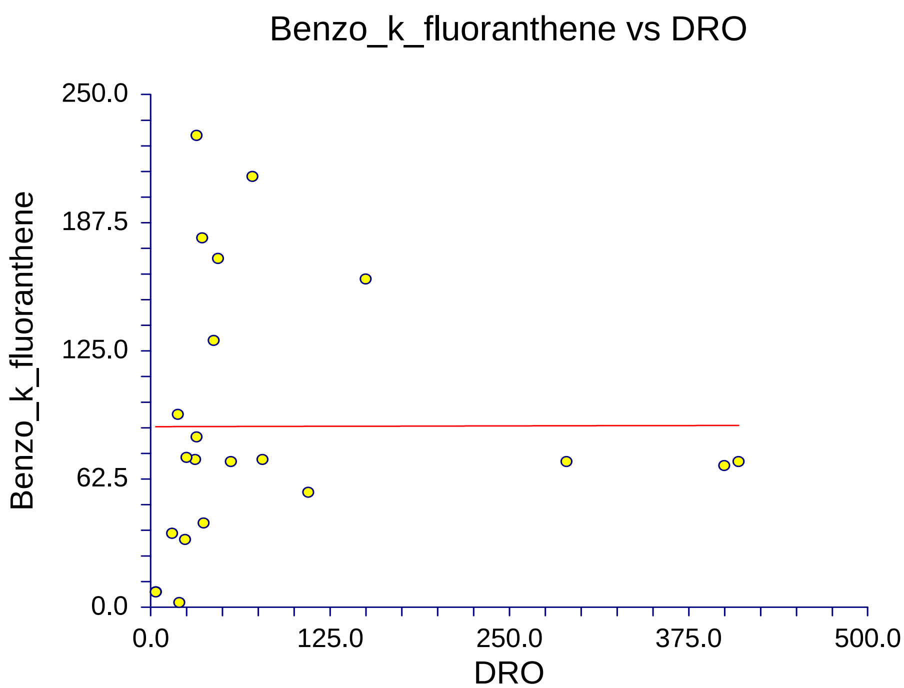
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Benzo_g_h_i_perylene	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	43.8207	Rows Prediction Only	6
Slope	0.1047	Sum of Frequencies	22
R-Squared	0.1157	Sum of Weights	22.0000
Correlation	0.3402	Coefficient of Variation	0.6719
Mean Square Error	1269.395	Square Root of MSE	35.62857

[redacted]

Page/Date/Time 1 6/21/2011 2:01:10 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_k_fluoranthene X = DRO

Linear Regression Plot Section



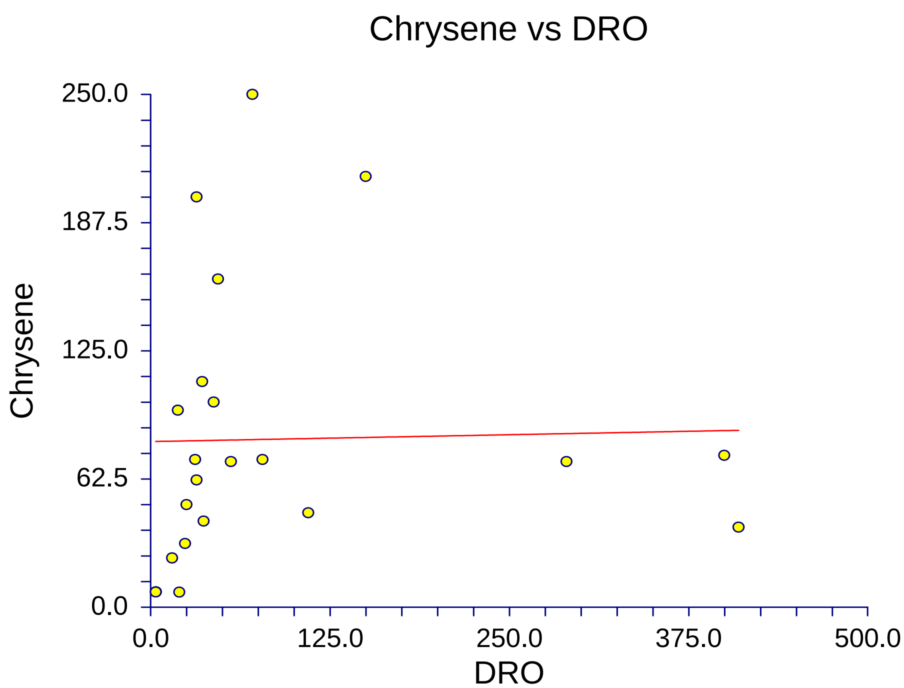
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_k_fluoranthene	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	88.0118	Rows Prediction Only	6
Slope	0.0015	Sum of Frequencies	22
R-Squared	0.0000	Sum of Weights	22.0000
Correlation	0.0028	Coefficient of Variation	0.7546
Mean Square Error	4424.597	Square Root of MSE	66.51764

[redacted]

Page/Date/Time 1 6/21/2011 2:02:22 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Chrysene X = DRO

Linear Regression Plot Section



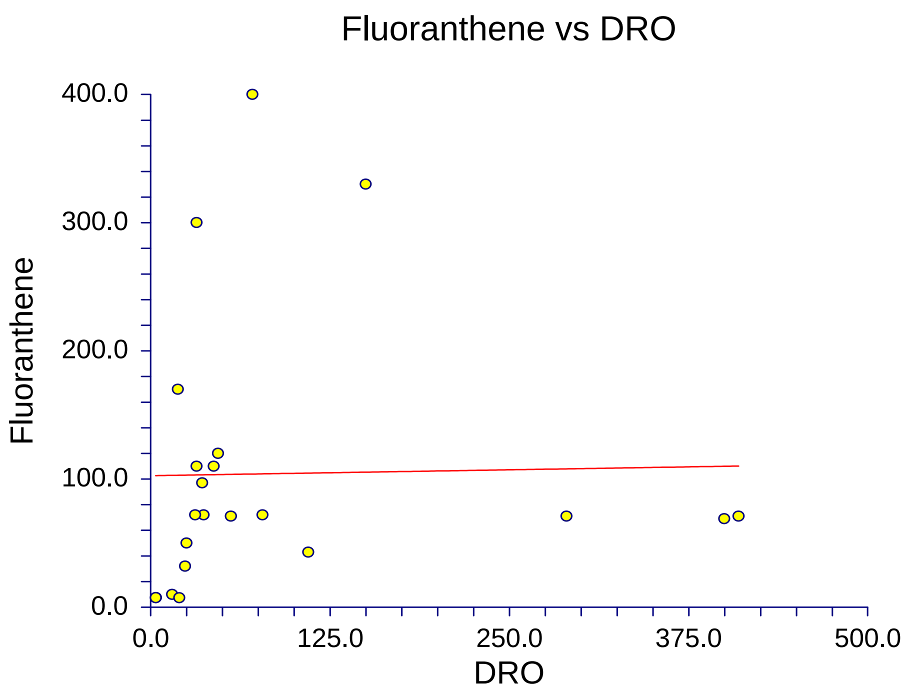
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Chrysene	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	80.7413	Rows Prediction Only	6
Slope	0.0134	Sum of Frequencies	22
R-Squared	0.0006	Sum of Weights	22.0000
Correlation	0.0239	Coefficient of Variation	0.8422
Mean Square Error	4760.053	Square Root of MSE	68.99314

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:28:28 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Fluoranthene X = DRO

Linear Regression Plot Section



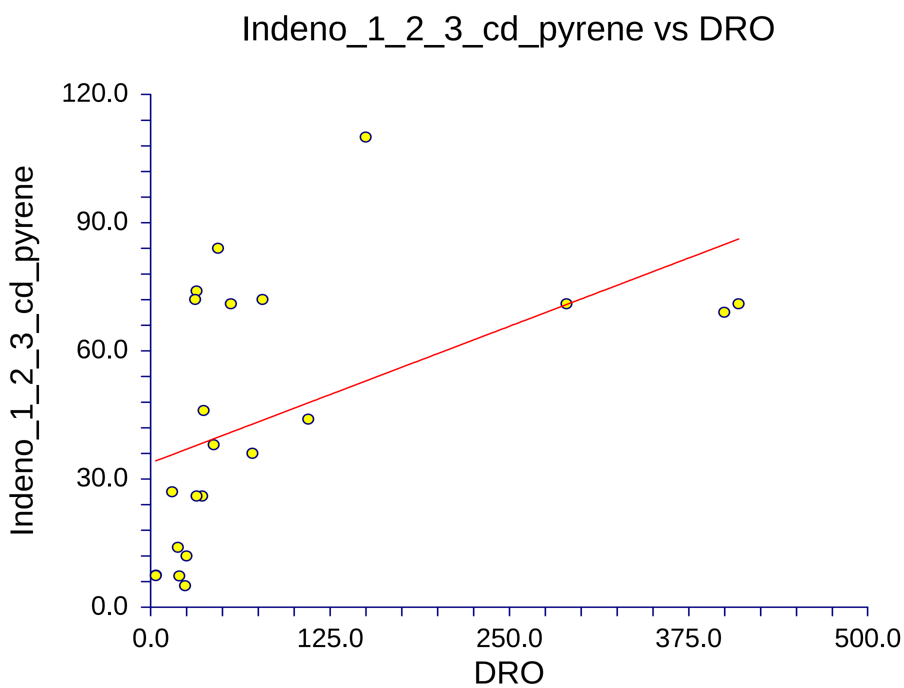
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Fluoranthene	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	102.5742	Rows Prediction Only	6
Slope	0.0184	Sum of Frequencies	22
R-Squared	0.0004	Sum of Weights	22.0000
Correlation	0.0207	Coefficient of Variation	1.0469
Mean Square Error	11897.67	Square Root of MSE	109.0765

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:31:07 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Indeno_1_2_3_cd_pyrene X = DRO

Linear Regression Plot Section



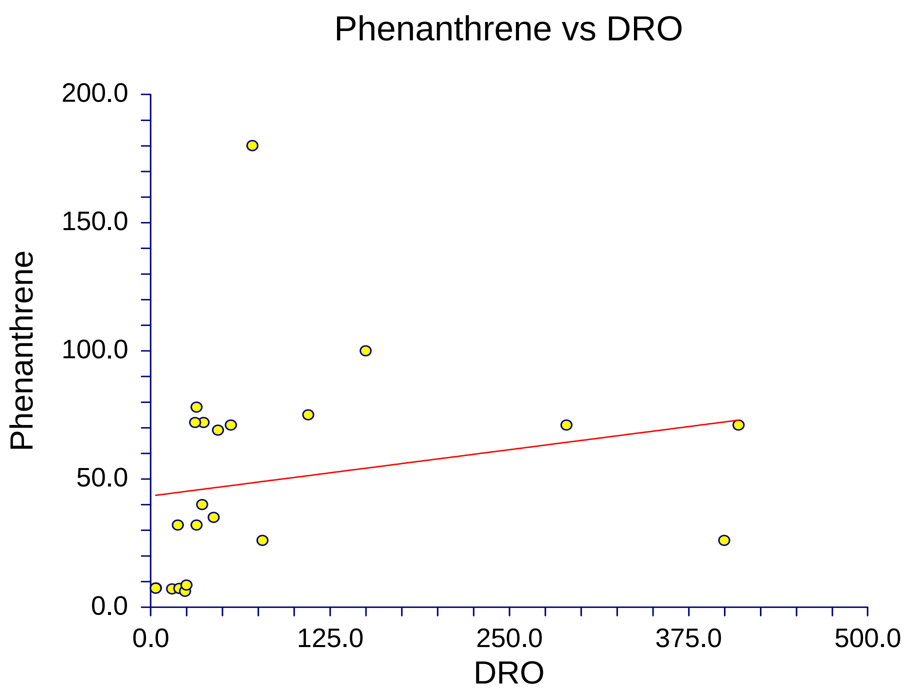
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Indeno_1_2_3_cd_pyrene	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	33.7779	Rows Prediction Only	6
Slope	0.1277	Sum of Frequencies	22
R-Squared	0.2508	Sum of Weights	22.0000
Correlation	0.5008	Coefficient of Variation	0.6039
Mean Square Error	738.6854	Square Root of MSE	27.17877

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:33:32 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Phenanthrene X = DRO

Linear Regression Plot Section



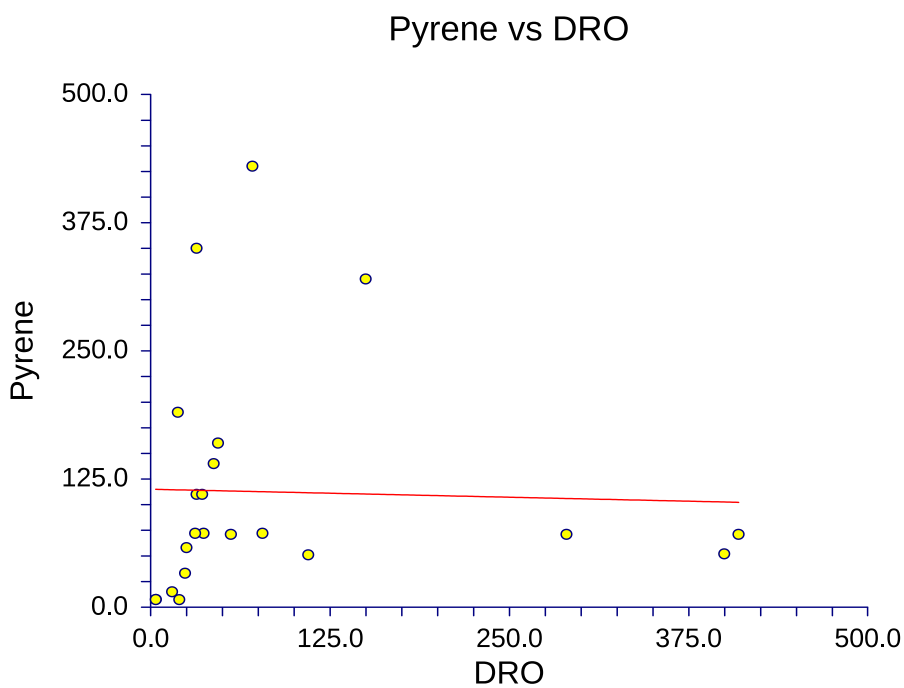
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Phenanthrene	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	43.3905	Rows Prediction Only	6
Slope	0.0721	Sum of Frequencies	22
R-Squared	0.0432	Sum of Weights	22.0000
Correlation	0.2078	Coefficient of Variation	0.8403
Mean Square Error	1746.261	Square Root of MSE	41.78829

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:34:36 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Pyrene X = DRO

Linear Regression Plot Section



Run Summary Section

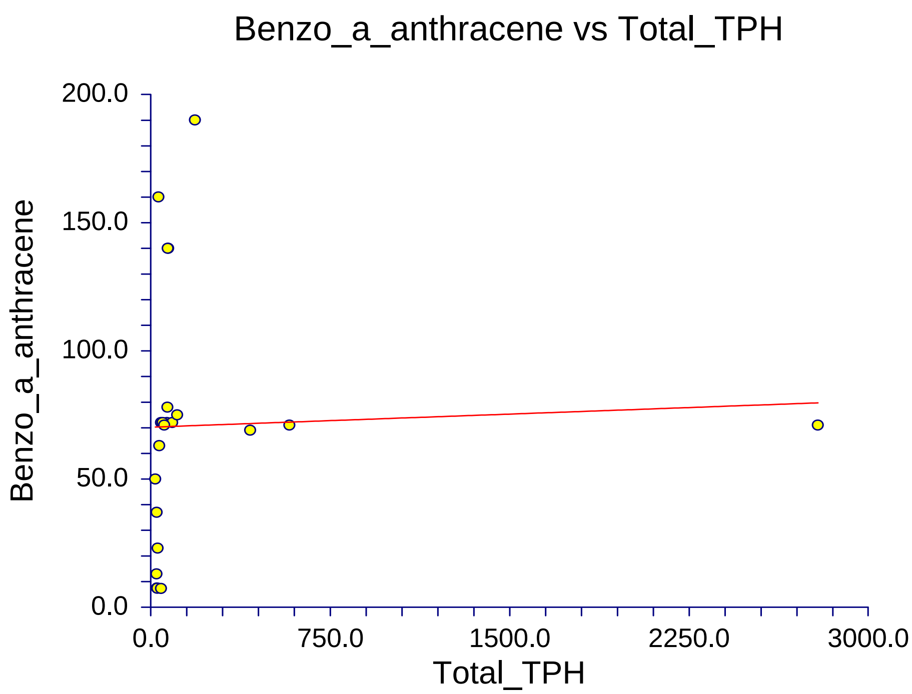
Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Pyrene	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	115.0154	Rows Prediction Only	6
Slope	-0.0311	Sum of Frequencies	22
R-Squared	0.0011	Sum of Weights	22.0000
Correlation	-0.0324	Coefficient of Variation	1.0509
Mean Square Error	13923.54	Square Root of MSE	117.9981

LLPAHs vs. Total TPH

Linear Regression Report

Page/Date/Time 1 6/21/2011 1:56:38 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_a_anthracene X = Total_TPH

Linear Regression Plot Section



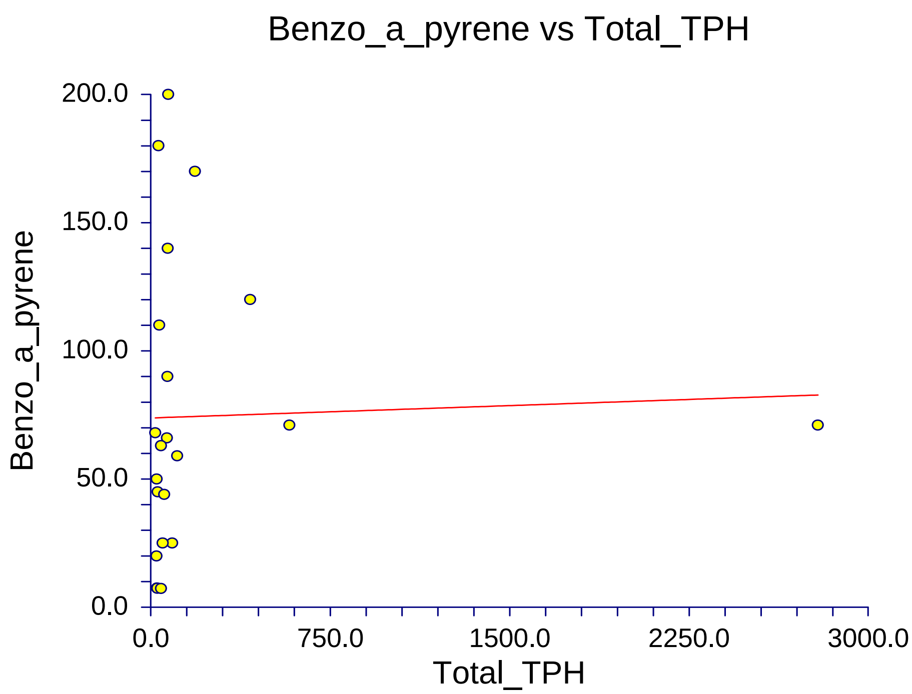
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_a_anthracene	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	70.2123	Rows Prediction Only	6
Slope	0.0034	Sum of Frequencies	22
R-Squared	0.0017	Sum of Weights	22.0000
Correlation	0.0406	Coefficient of Variation	0.7120
Mean Square Error	2552.824	Square Root of MSE	50.52548

Linear Regression Report

Page/Date/Time 1 6/21/2011 1:57:38 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_a_pyrene X = Total_TPH

Linear Regression Plot Section



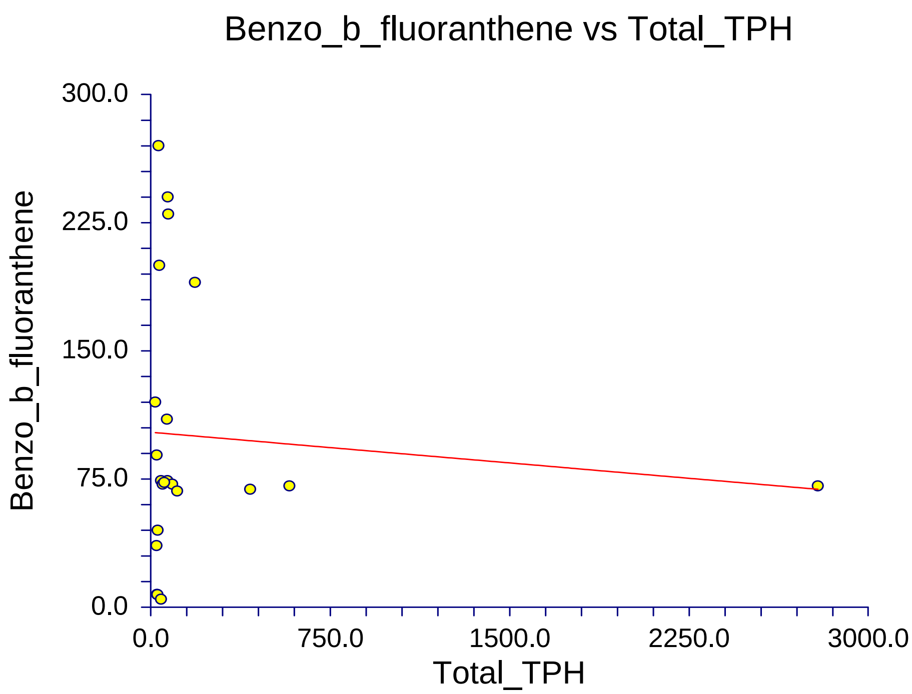
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_a_pyrene	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	73.7989	Rows Prediction Only	6
Slope	0.0032	Sum of Frequencies	22
R-Squared	0.0011	Sum of Weights	22.0000
Correlation	0.0333	Coefficient of Variation	0.7830
Mean Square Error	3403.83	Square Root of MSE	58.34235

Linear Regression Report

Page/Date/Time 1 6/21/2011 1:58:59 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_b_fluoranthene X = Total_TPH

Linear Regression Plot Section



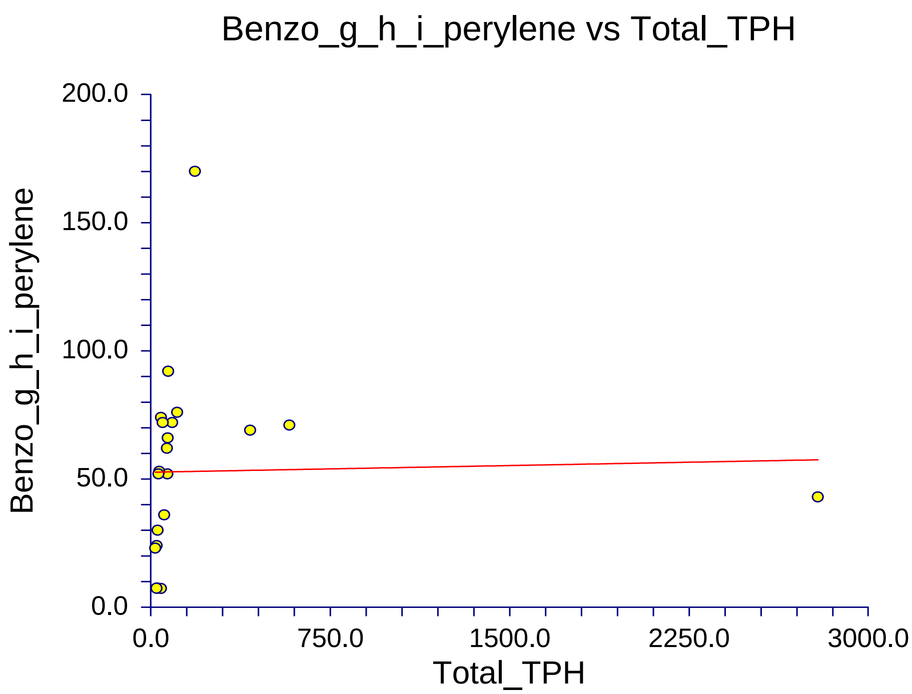
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_b_fluoranthene	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	102.3545	Rows Prediction Only	6
Slope	-0.0120	Sum of Frequencies	22
R-Squared	0.0084	Sum of Weights	22.0000
Correlation	-0.0916	Coefficient of Variation	0.7888
Mean Square Error	6186.157	Square Root of MSE	78.65213

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:00:14 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_g_h_i_perylene X = Total_TPH

Linear Regression Plot Section



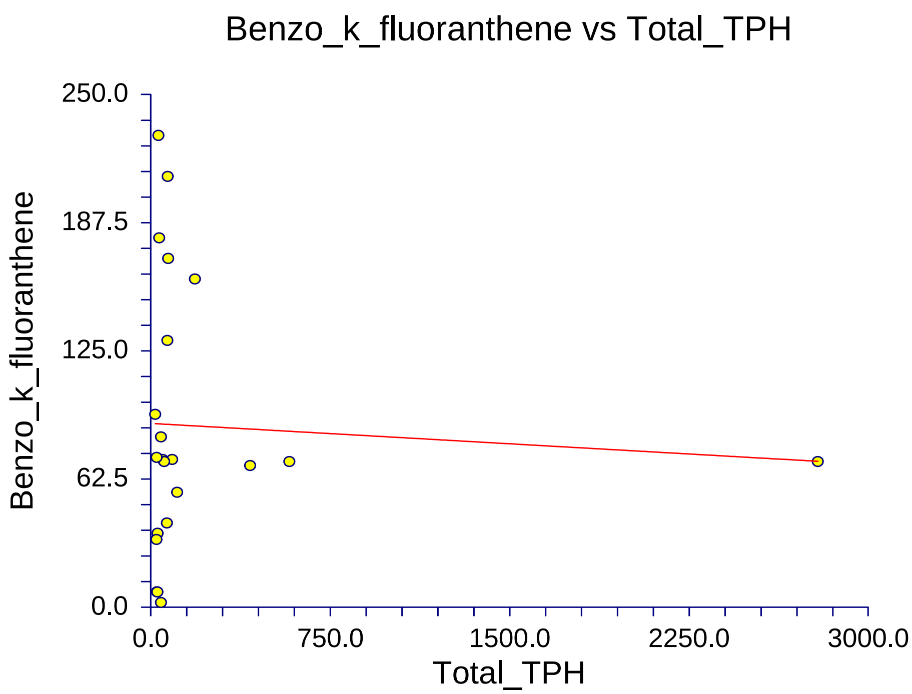
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_g_h_i_perylene	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	52.6445	Rows Prediction Only	6
Slope	0.0017	Sum of Frequencies	22
R-Squared	0.0008	Sum of Weights	22.0000
Correlation	0.0276	Coefficient of Variation	0.7142
Mean Square Error	1434.427	Square Root of MSE	37.87383

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:01:49 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Benzo_k_fluoranthene X = Total_TPH

Linear Regression Plot Section



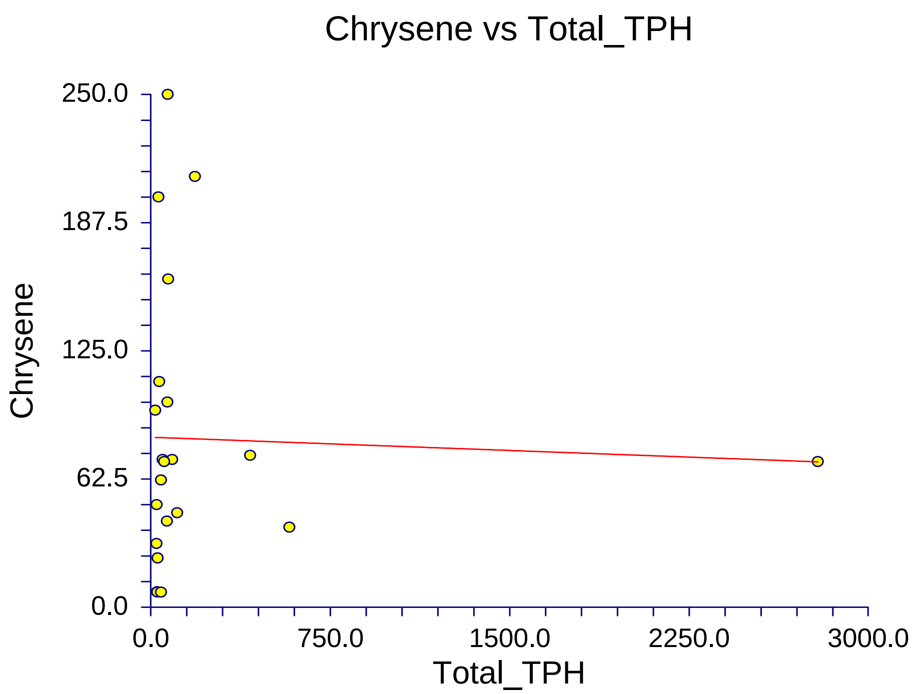
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Benzo_k_fluoranthene	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	89.6097	Rows Prediction Only	6
Slope	-0.0066	Sum of Frequencies	22
R-Squared	0.0036	Sum of Weights	22.0000
Correlation	-0.0602	Coefficient of Variation	0.7533
Mean Square Error	4408.607	Square Root of MSE	66.39735

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:02:55 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Chrysene X = Total_TPH

Linear Regression Plot Section



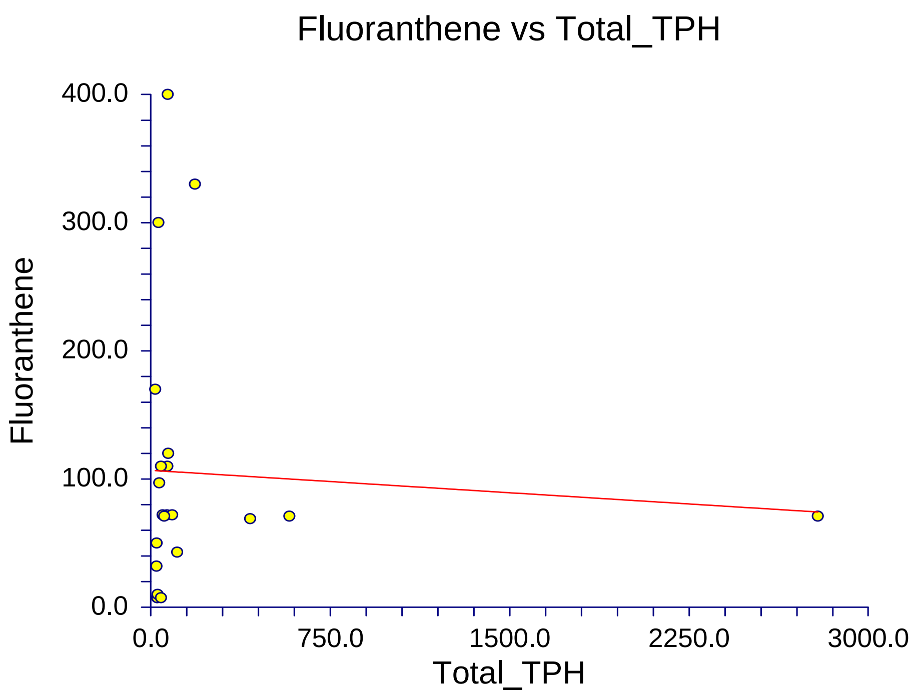
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Chrysene	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	82.8700	Rows Prediction Only	6
Slope	-0.0043	Sum of Frequencies	22
R-Squared	0.0014	Sum of Weights	22.0000
Correlation	-0.0377	Coefficient of Variation	0.8419
Mean Square Error	4755.997	Square Root of MSE	68.96374

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:29:06 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Fluoranthene X = Total_TPH

Linear Regression Plot Section



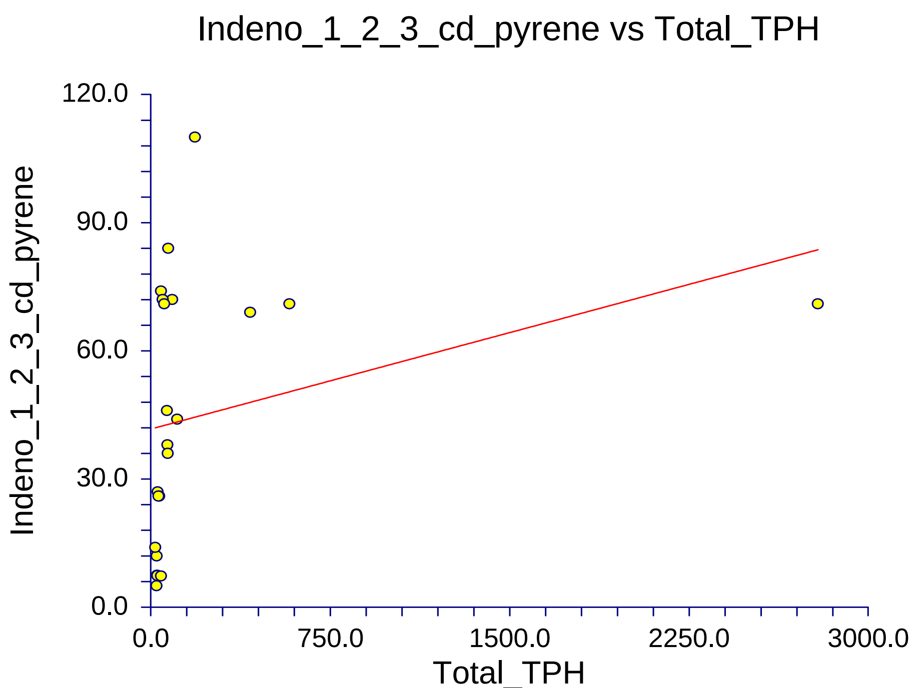
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Fluoranthene	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	106.7676	Rows Prediction Only	6
Slope	-0.0117	Sum of Frequencies	22
R-Squared	0.0042	Sum of Weights	22.0000
Correlation	-0.0646	Coefficient of Variation	1.0449
Mean Square Error	11853.17	Square Root of MSE	108.8723

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:32:12 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Indeno_1_2_3_cd_pyrene X = Total_TPH

Linear Regression Plot Section



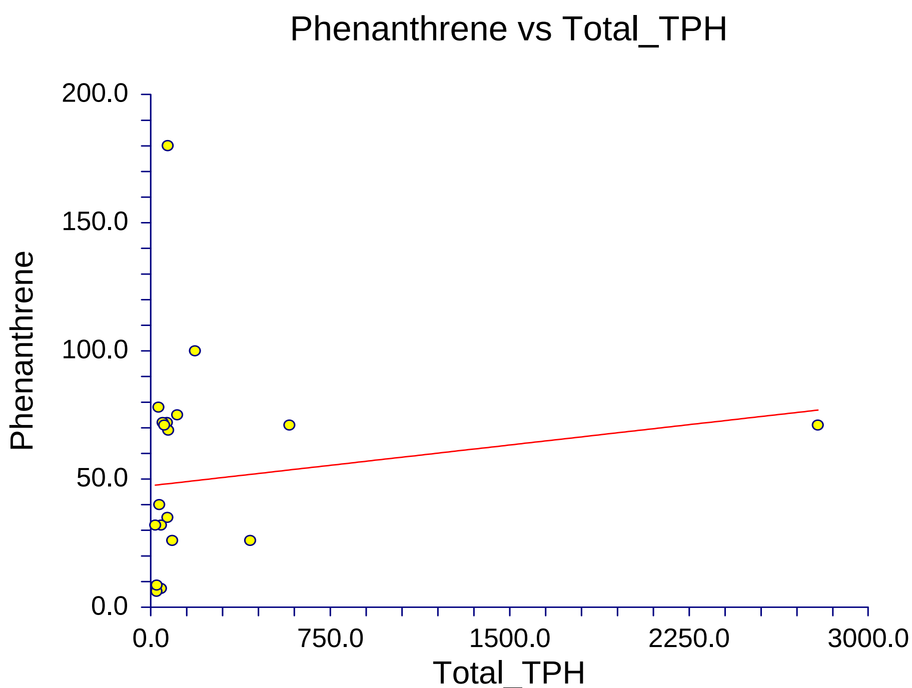
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Indeno_1_2_3_cd_pyrene	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	41.6837	Rows Prediction Only	6
Slope	0.0150	Sum of Frequencies	22
R-Squared	0.0838	Sum of Weights	22.0000
Correlation	0.2895	Coefficient of Variation	0.6677
Mean Square Error	903.2637	Square Root of MSE	30.05435

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:34:08 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Phenanthrene X = Total_TPH

Linear Regression Plot Section



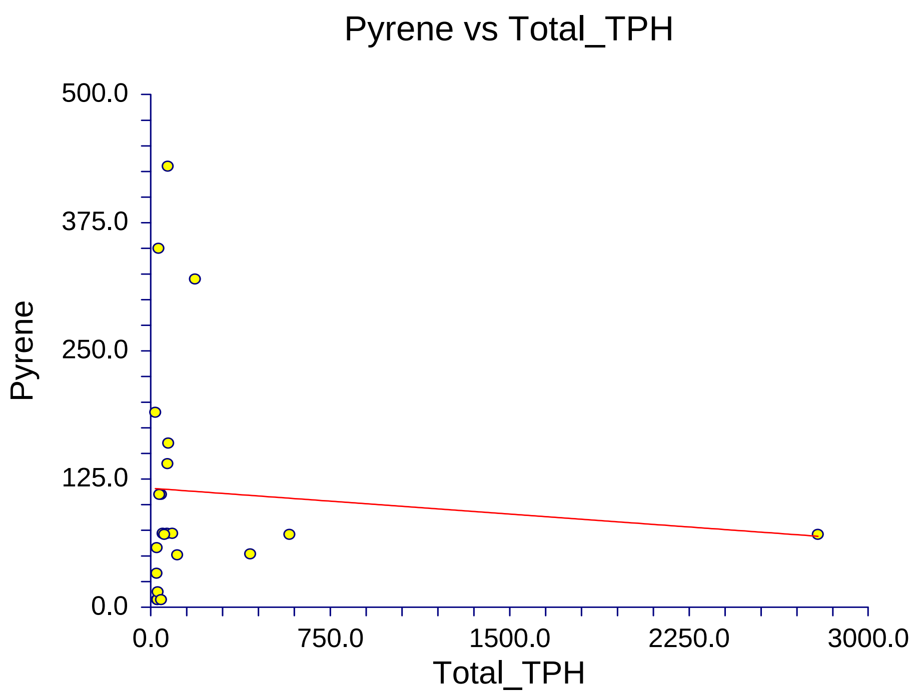
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Phenanthrene	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	47.3950	Rows Prediction Only	6
Slope	0.0106	Sum of Frequencies	22
R-Squared	0.0224	Sum of Weights	22.0000
Correlation	0.1495	Coefficient of Variation	0.8494
Mean Square Error	1784.263	Square Root of MSE	42.24054

Linear Regression Report

Page/Date/Time 1 6/21/2011 2:35:12 PM
Database C:\Documents and Settings\hg ... 72 fuel pier spreadsheet.S0
Y = Pyrene X = Total_TPH

Linear Regression Plot Section



Run Summary Section

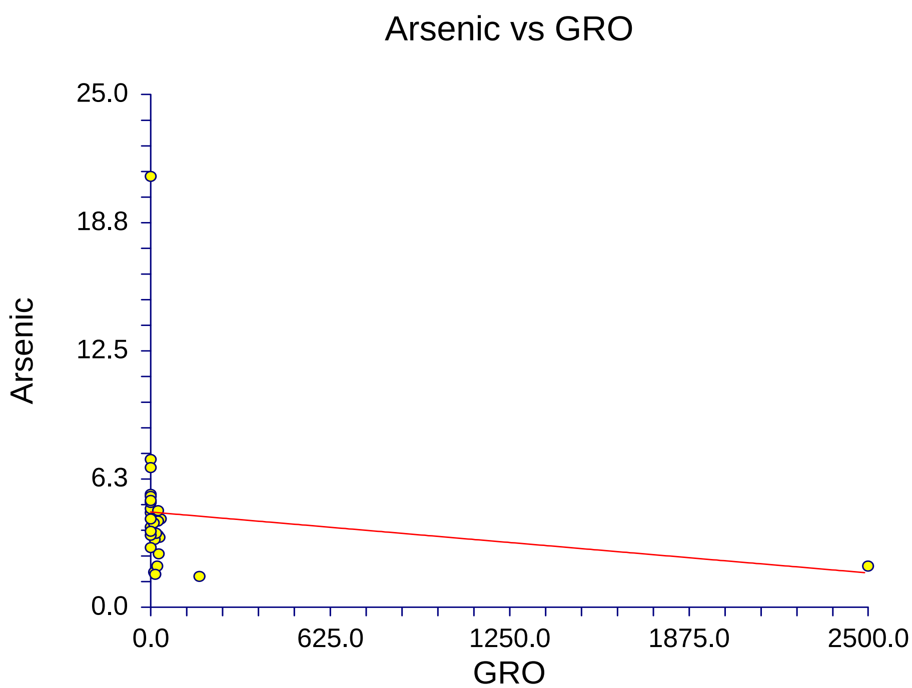
Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Pyrene	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	22
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	115.9910	Rows Prediction Only	6
Slope	-0.0168	Sum of Frequencies	22
R-Squared	0.0074	Sum of Weights	22.0000
Correlation	-0.0859	Coefficient of Variation	1.0476
Mean Square Error	13835.36	Square Root of MSE	117.6238

Metals vs. TPH GRO

[redacted]on Report

Page/Date/Time 1 6/20/2011 7:51:17 PM
Database
Y = Arsenic X = GRO

Linear Regression Plot Section



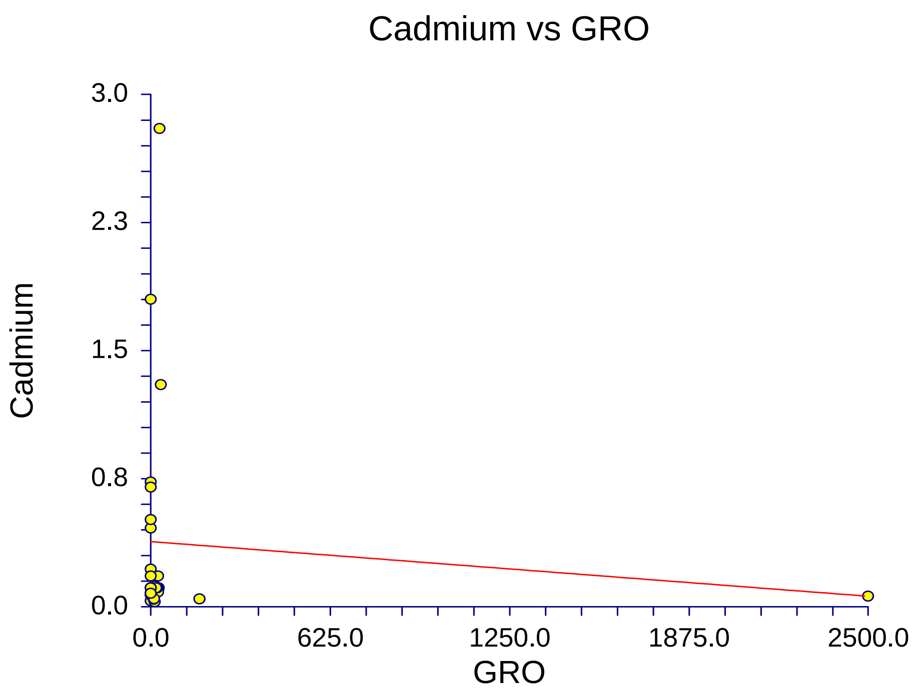
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Arsenic	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	4.6389	Rows Prediction Only	0
Slope	-0.0012	Sum of Frequencies	28
R-Squared	0.0249	Sum of Weights	28.0000
Correlation	-0.1578	Coefficient of Variation	0.7891
Mean Square Error	12.68892	Square Root of MSE	3.562151

[redacted]on Report

Page/Date/Time 1 6/20/2011 7:58:52 PM
Database
Y = Cadmium X = GRO

Linear Regression Plot Section



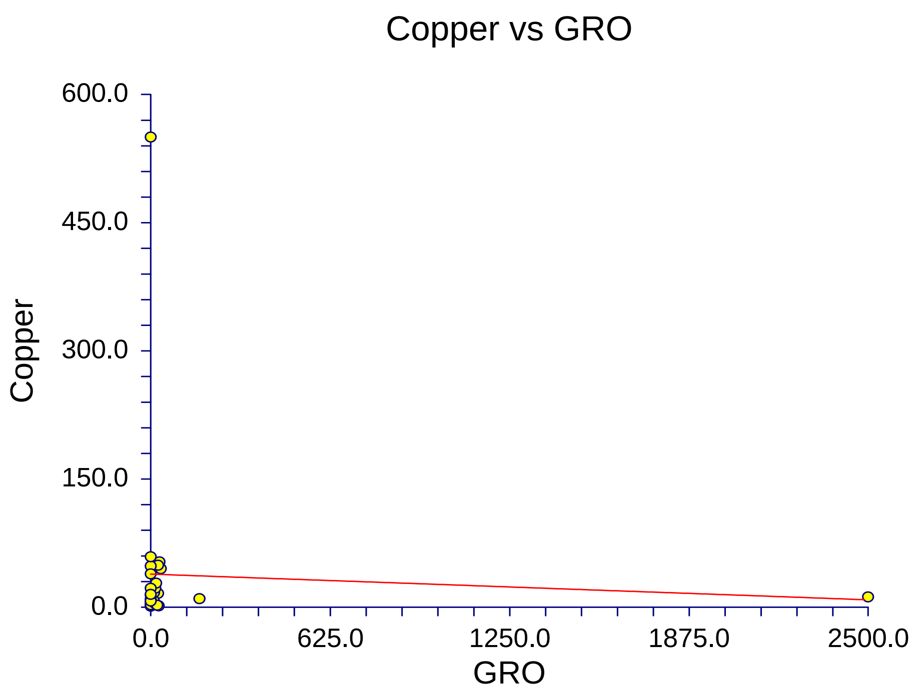
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Cadmium	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.3815	Rows Prediction Only	0
Slope	-0.0001	Sum of Frequencies	28
R-Squared	0.0091	Sum of Weights	28.0000
Correlation	-0.0956	Coefficient of Variation	1.7362
Mean Square Error	0.4083032	Square Root of MSE	0.6389861

[redacted]

Page/Date/Time 1 6/20/2011 8:24:54 PM
Database
Y = Copper X = GRO

Linear Regression Plot Section



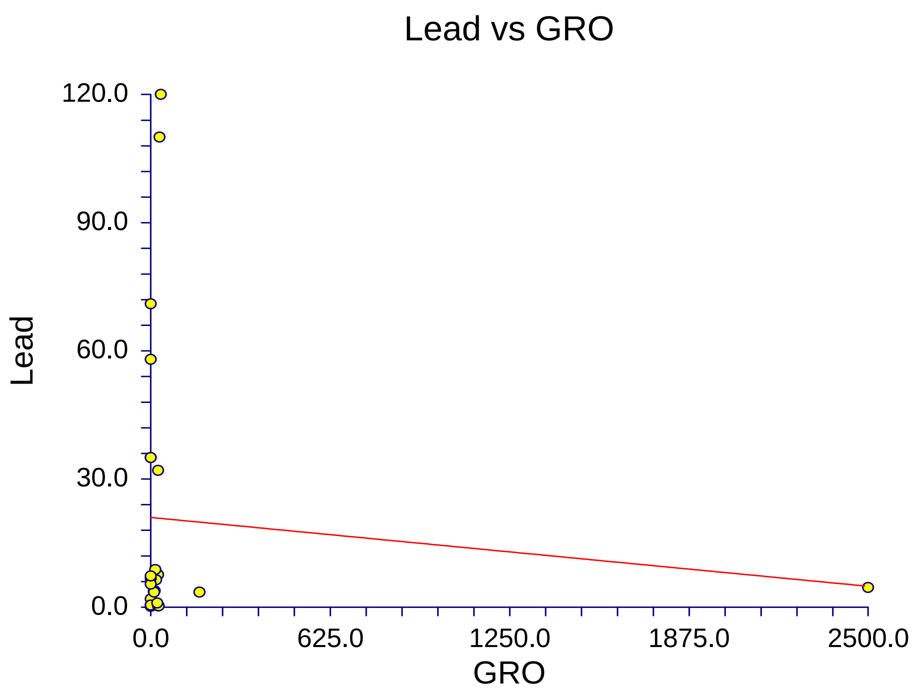
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Copper	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	38.7130	Rows Prediction Only	0
Slope	-0.0120	Sum of Frequencies	28
R-Squared	0.0031	Sum of Weights	28.0000
Correlation	-0.0555	Coefficient of Variation	2.7718
Mean Square Error	10775.17	Square Root of MSE	103.8035

[redacted]

Page/Date/Time 1 6/20/2011 8:26:24 PM
Database
Y = Lead X = GRO

Linear Regression Plot Section



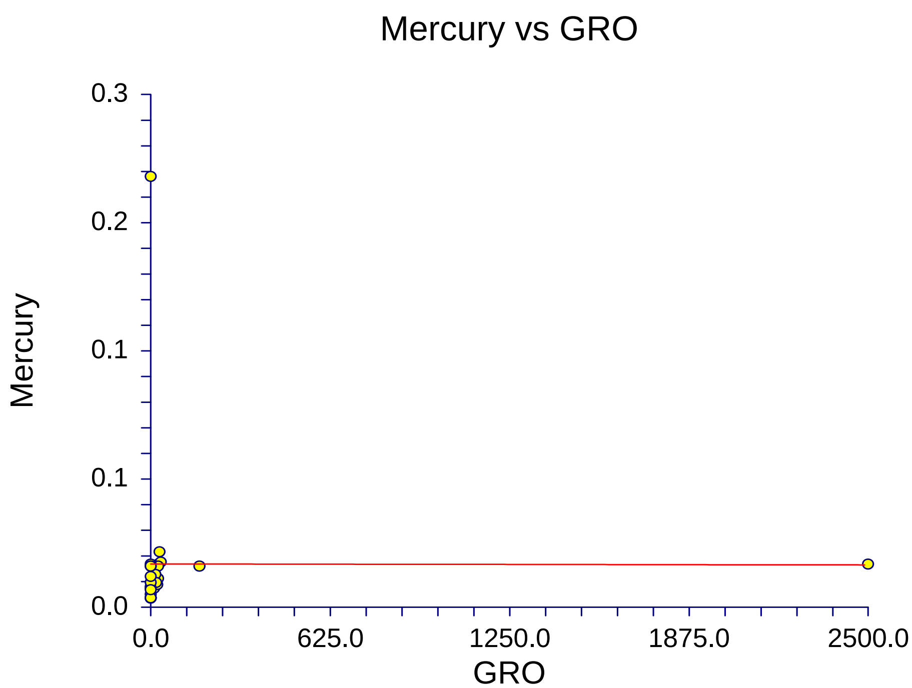
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Lead	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	26
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	21.0023	Rows Prediction Only	2
Slope	-0.0064	Sum of Frequencies	26
R-Squared	0.0088	Sum of Weights	26.0000
Correlation	-0.0938	Coefficient of Variation	1.6796
Mean Square Error	1159.483	Square Root of MSE	34.05119

[redacted]

Page/Date/Time 1 6/20/2011 8:27:45 PM
Database
Y = Mercury X = GRO

Linear Regression Plot Section



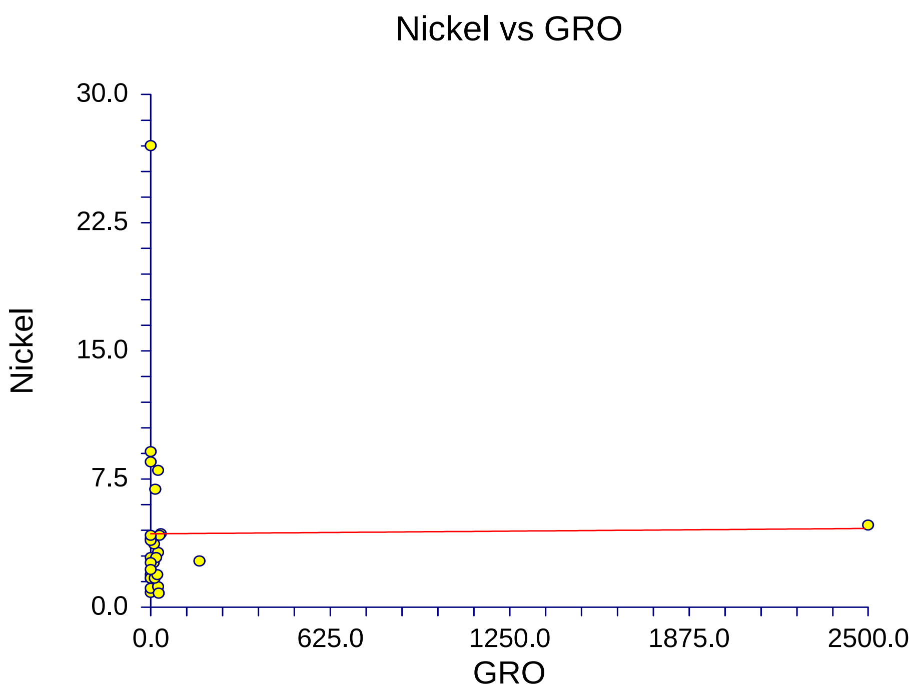
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mercury	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0211	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	28
R-Squared	0.0000	Sum of Weights	28.0000
Correlation	-0.0025	Coefficient of Variation	1.8174
Mean Square Error	1.467021E-03	Square Root of MSE	3.830171E-02

[redacted]

Page/Date/Time 1 6/20/2011 8:29:08 PM
Database
Y = Nickel X = GRO

Linear Regression Plot Section



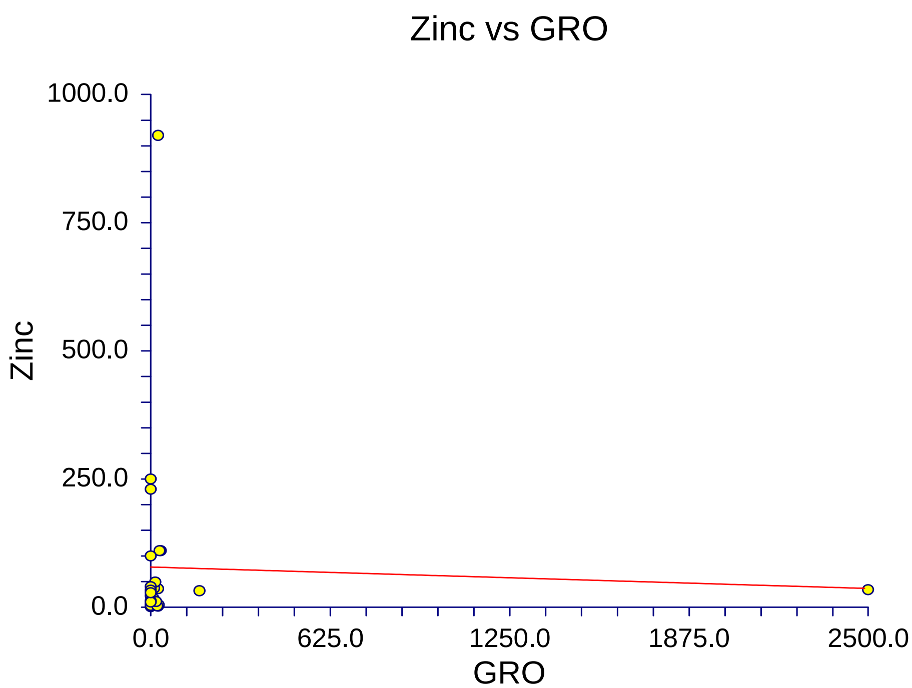
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Nickel	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	4.2933	Rows Prediction Only	0
Slope	0.0001	Sum of Frequencies	28
R-Squared	0.0001	Sum of Weights	28.0000
Correlation	0.0118	Coefficient of Variation	1.1794
Mean Square Error	25.79534	Square Root of MSE	5.078911

[redacted]on Report

Page/Date/Time 1 6/20/2011 8:37:42 PM
Database
Y = Zinc X = GRO

Linear Regression Plot Section



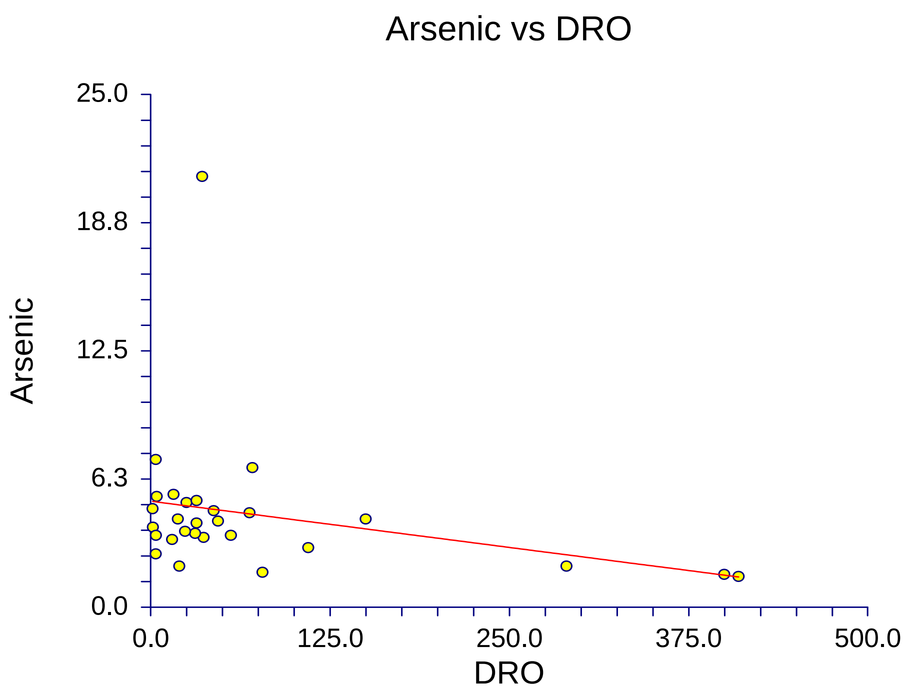
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Zinc	Rows Processed	28
Independent Variable	GRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	78.3077	Rows Prediction Only	0
Slope	-0.0167	Sum of Frequencies	28
R-Squared	0.0020	Sum of Weights	28.0000
Correlation	-0.0444	Coefficient of Variation	2.3531
Mean Square Error	32449.36	Square Root of MSE	180.1371

Metals vs. TPH DRO

Page/Date/Time 1 6/20/2011 7:50:43 PM
Database
Y = Arsenic X = DRO

Linear Regression Plot Section



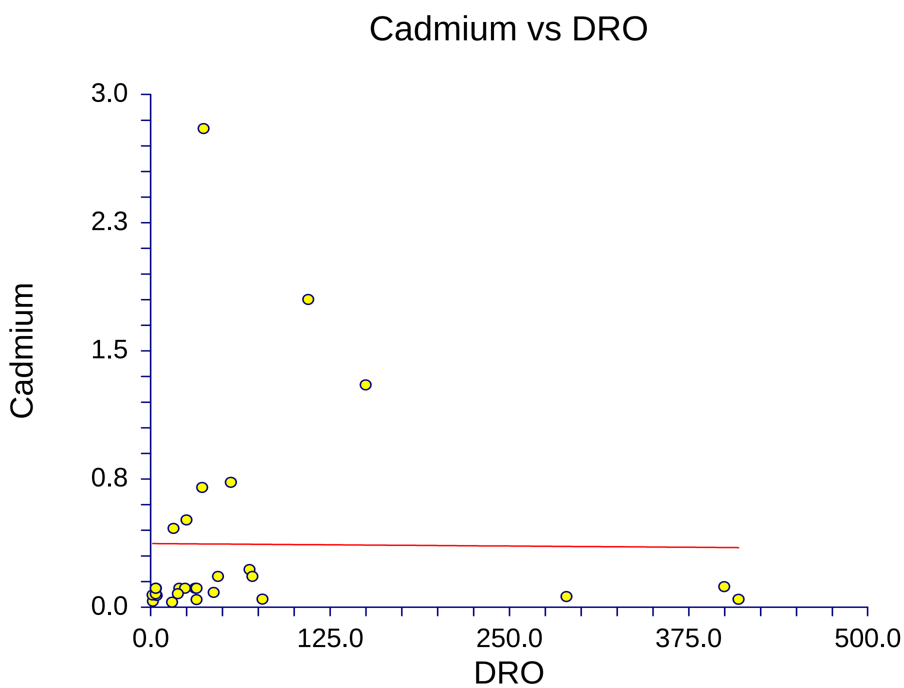
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Arsenic	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	5.1676	Rows Prediction Only	0
Slope	-0.0090	Sum of Frequencies	28
R-Squared	0.0794	Sum of Weights	28.0000
Correlation	-0.2818	Coefficient of Variation	0.7667
Mean Square Error	11.97939	Square Root of MSE	3.461126

[redacted]on Report

Page/Date/Time 1 6/20/2011 7:58:35 PM
Database
Y = Cadmium X = DRO

Linear Regression Plot Section



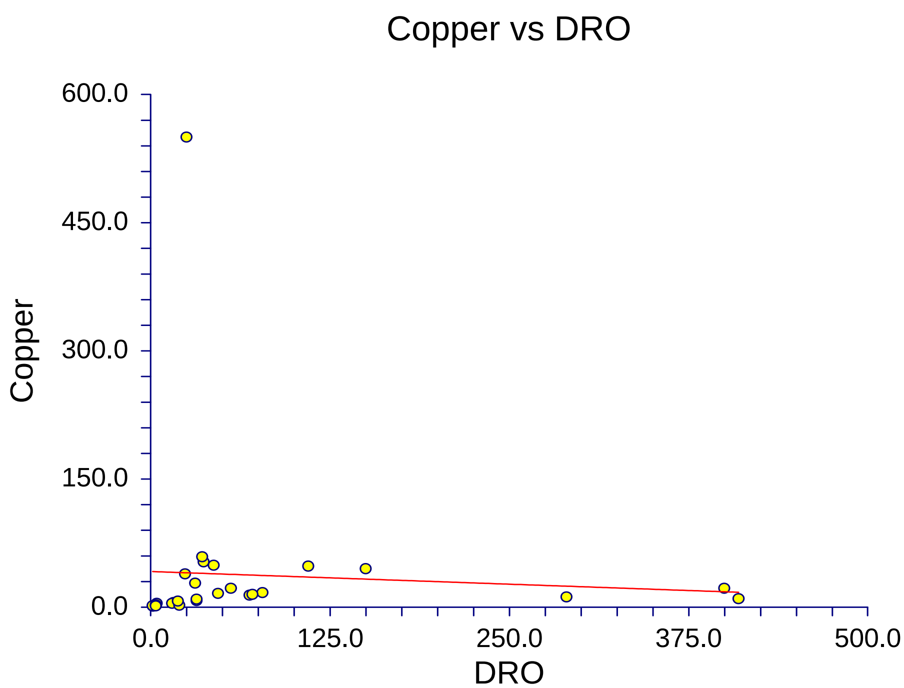
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Cadmium	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.3722	Rows Prediction Only	0
Slope	-0.0001	Sum of Frequencies	28
R-Squared	0.0001	Sum of Weights	28.0000
Correlation	-0.0101	Coefficient of Variation	1.7441
Mean Square Error	0.4120253	Square Root of MSE	0.641892

[redacted]on Report

Page/Date/Time 1 6/20/2011 8:24:38 PM
Database
Y = Copper X = DRO

Linear Regression Plot Section



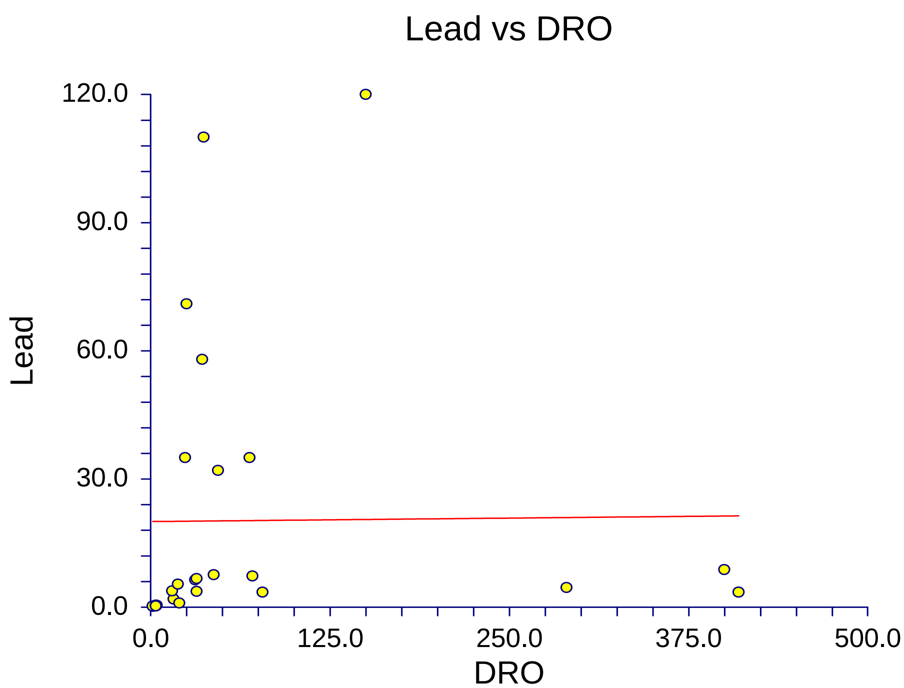
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Copper	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	41.7438	Rows Prediction Only	0
Slope	-0.0592	Sum of Frequencies	28
R-Squared	0.0041	Sum of Weights	28.0000
Correlation	-0.0643	Coefficient of Variation	2.7703
Mean Square Error	10763.8	Square Root of MSE	103.7487

[redacted]

Page/Date/Time 1 6/20/2011 8:26:08 PM
Database
Y = Lead X = DRO

Linear Regression Plot Section

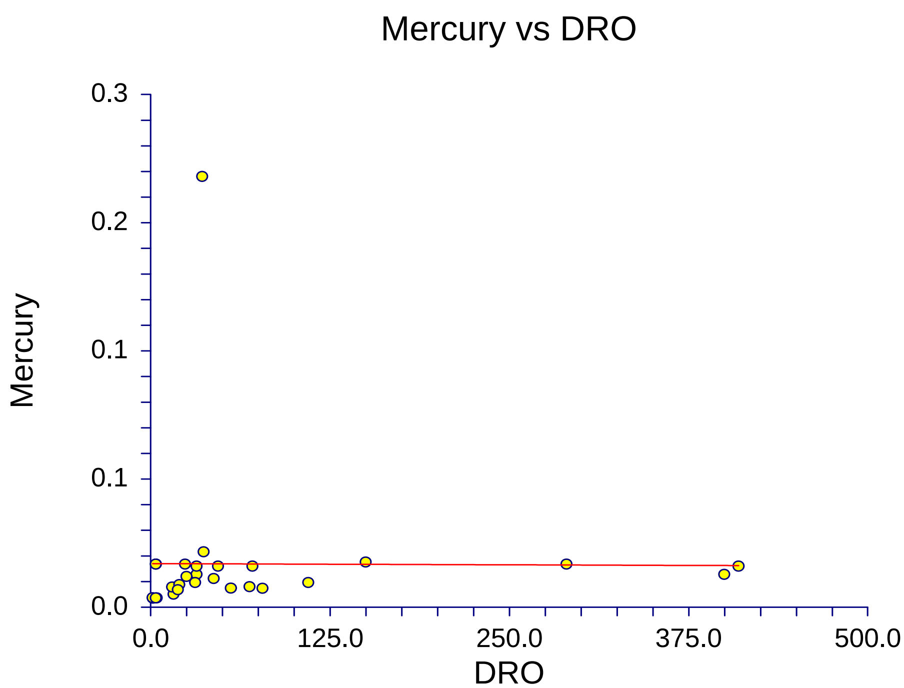


Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Lead	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	26
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	20.0428	Rows Prediction Only	2
Slope	0.0032	Sum of Frequencies	26
R-Squared	0.0001	Sum of Weights	26.0000
Correlation	0.0110	Coefficient of Variation	1.6869
Mean Square Error	1169.64	Square Root of MSE	34.2

Page/Date/Time 1 6/20/2011 8:27:29 PM
Database
Y = Mercury X = DRO

Linear Regression Plot Section



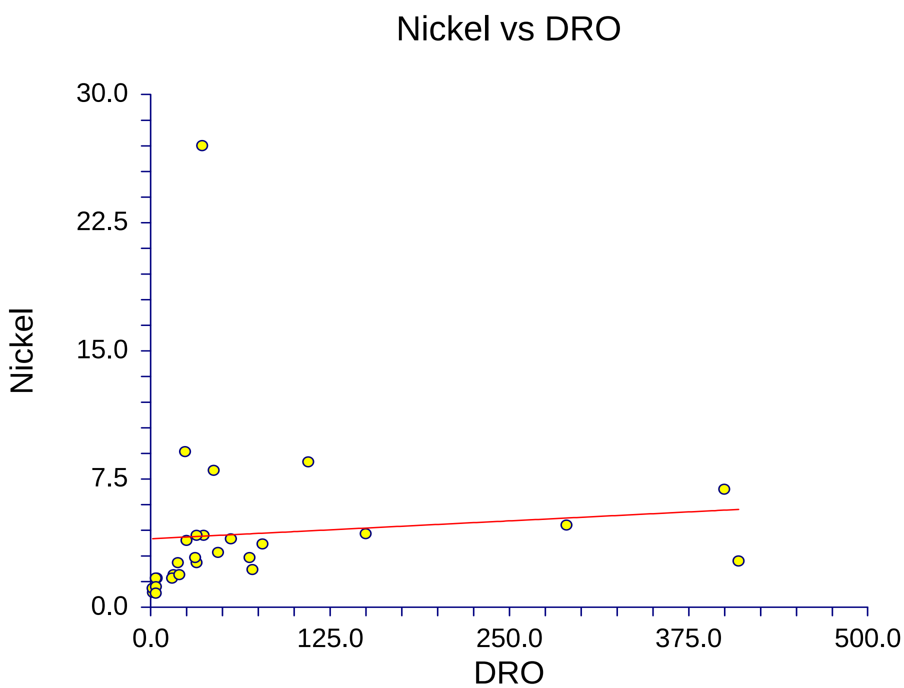
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Mercury	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0212	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	28
R-Squared	0.0000	Sum of Weights	28.0000
Correlation	-0.0069	Coefficient of Variation	1.8174
Mean Square Error	1.46696E-03	Square Root of MSE	3.830091E-02

[redacted]

Page/Date/Time 1 6/20/2011 8:28:52 PM
Database
Y = Nickel X = DRO

Linear Regression Plot Section



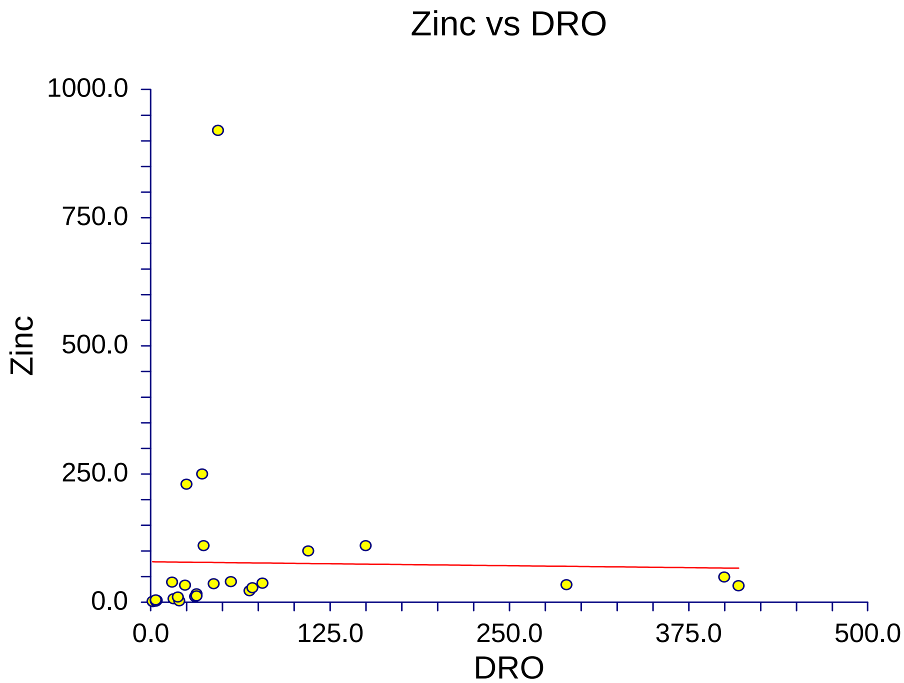
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Nickel	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	4.0029	Rows Prediction Only	0
Slope	0.0042	Sum of Frequencies	28
R-Squared	0.0086	Sum of Weights	28.0000
Correlation	0.0930	Coefficient of Variation	1.1744
Mean Square Error	25.57587	Square Root of MSE	5.05726

[redacted]on Report

Page/Date/Time 1 6/20/2011 8:37:28 PM
Database
Y = Zinc X = DRO

Linear Regression Plot Section



Run Summary Section

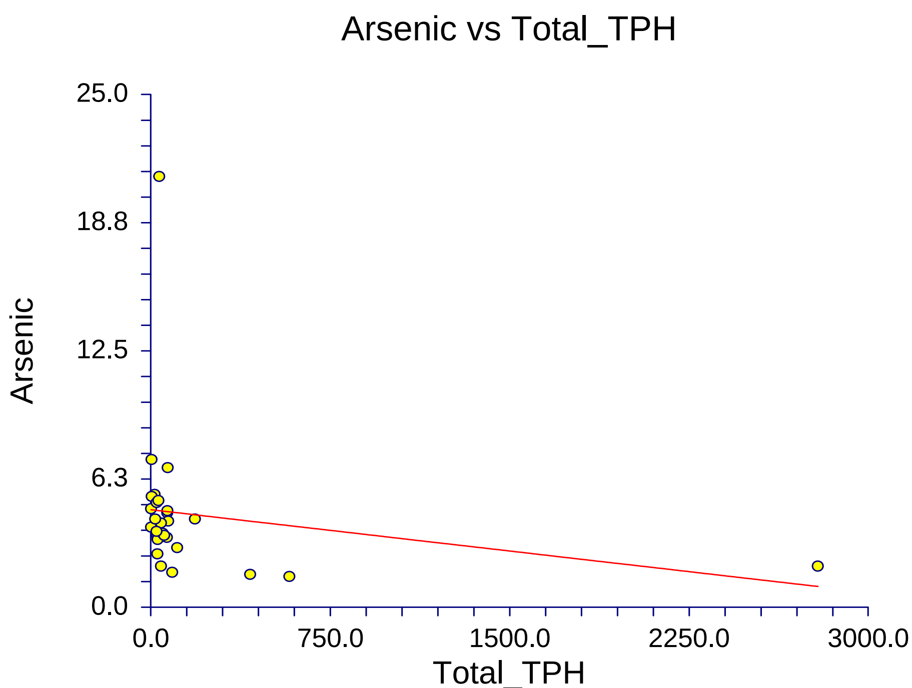
Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Zinc	Rows Processed	28
Independent Variable	DRO	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	78.7534	Rows Prediction Only	0
Slope	-0.0304	Sum of Frequencies	28
R-Squared	0.0004	Sum of Weights	28.0000
Correlation	-0.0190	Coefficient of Variation	2.3550
Mean Square Error	32501.86	Square Root of MSE	180.2827

Metals vs. Total TPH

[redacted]on Report

Page/Date/Time 1 6/20/2011 7:51:35 PM
Database
Y = Arsenic X = Total_TPH

Linear Regression Plot Section



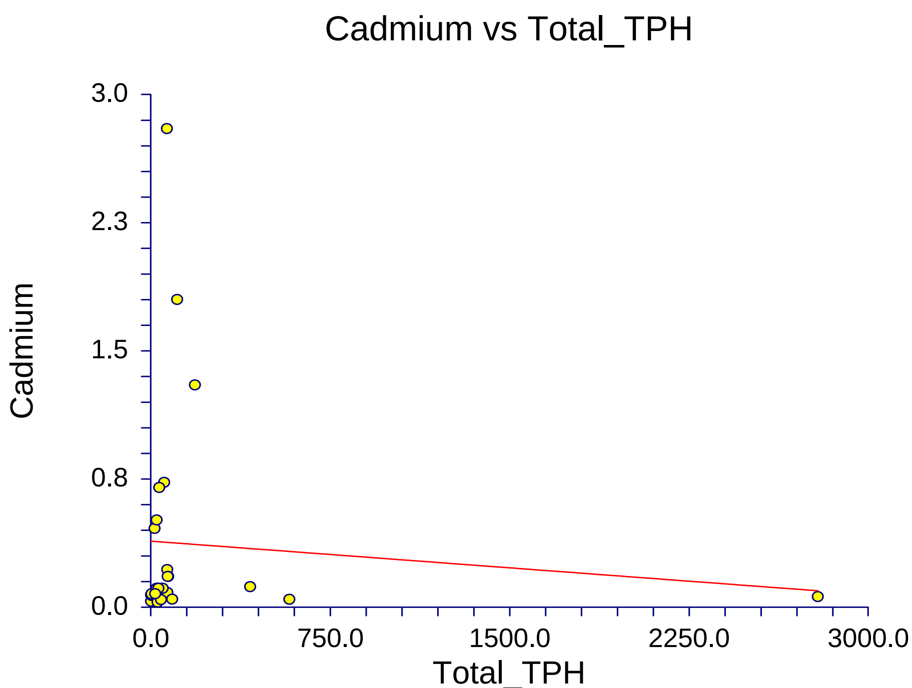
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Arsenic	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	4.7519	Rows Prediction Only	0
Slope	-0.0013	Sum of Frequencies	28
R-Squared	0.0399	Sum of Weights	28.0000
Correlation	-0.1998	Coefficient of Variation	0.7830
Mean Square Error	12.49324	Square Root of MSE	3.534578

[redacted]on Report

Page/Date/Time 1 6/20/2011 7:59:06 PM
Database
Y = Cadmium X = Total_TPH

Linear Regression Plot Section



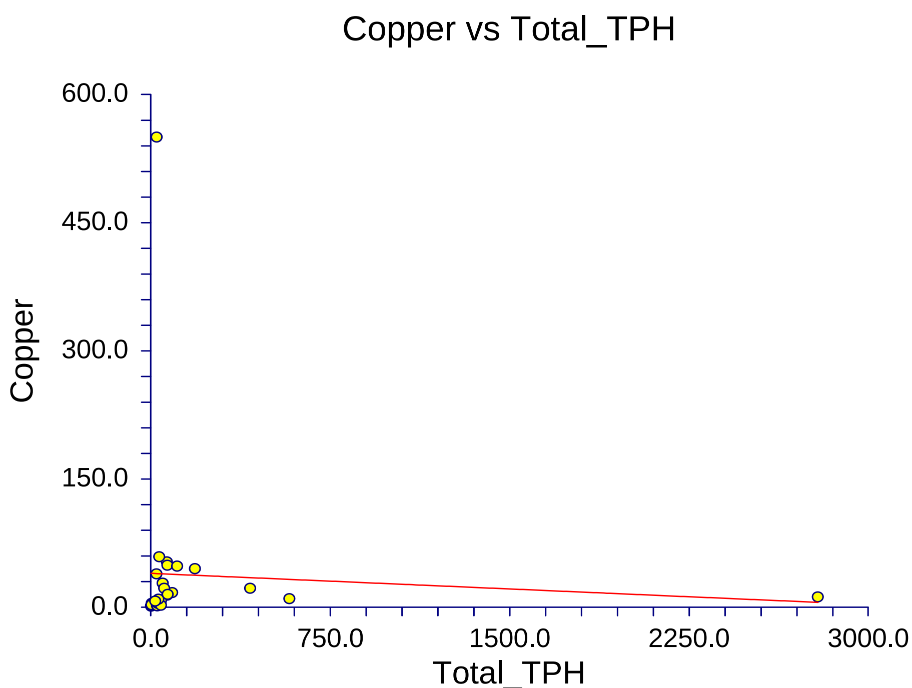
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Cadmium	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.3865	Rows Prediction Only	0
Slope	-0.0001	Sum of Frequencies	28
R-Squared	0.0076	Sum of Weights	28.0000
Correlation	-0.0871	Coefficient of Variation	1.7376
Mean Square Error	0.4089381	Square Root of MSE	0.6394826

[redacted]

Page/Date/Time 1 6/20/2011 8:25:07 PM
Database
Y = Copper X = Total_TPH

Linear Regression Plot Section



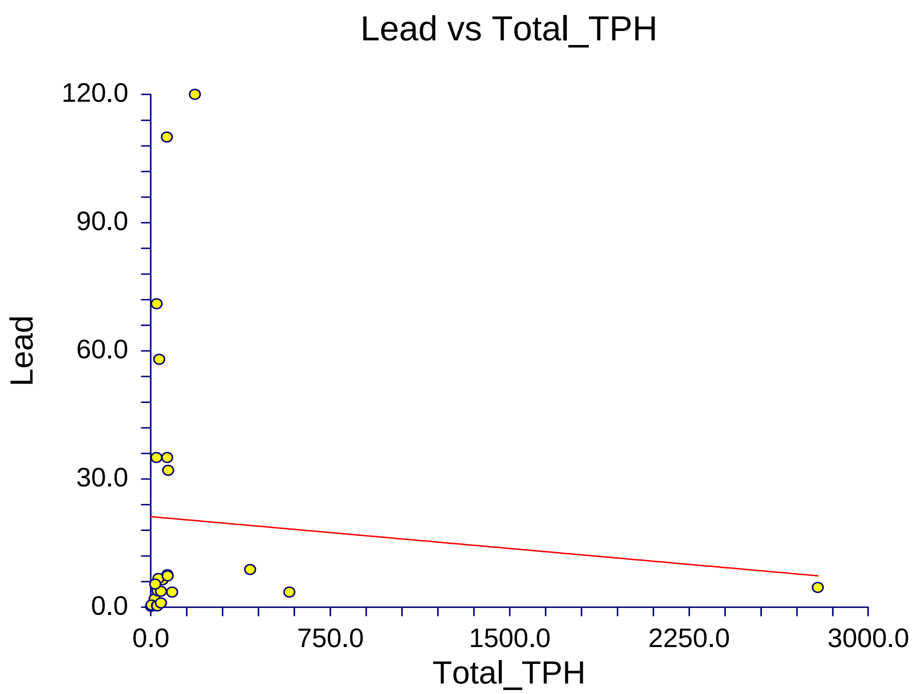
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Copper	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	39.6051	Rows Prediction Only	0
Slope	-0.0122	Sum of Frequencies	28
R-Squared	0.0040	Sum of Weights	28.0000
Correlation	-0.0629	Coefficient of Variation	2.7706
Mean Square Error	10765.69	Square Root of MSE	103.7579

[redacted]

Page/Date/Time 1 6/20/2011 8:26:39 PM
Database
Y = Lead X = Total_TPH

Linear Regression Plot Section



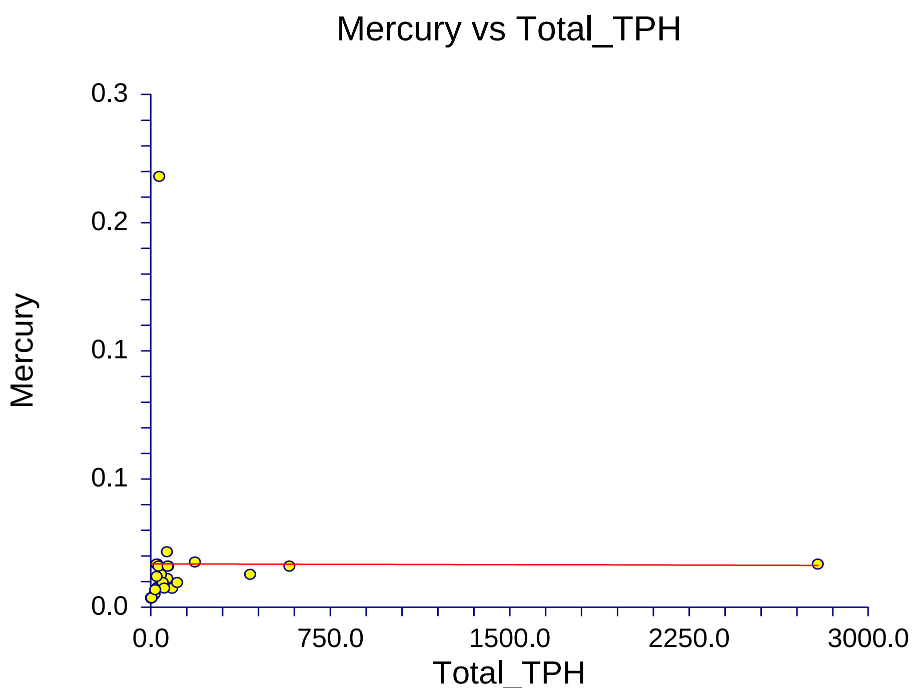
Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Lead	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	26
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	21.1888	Rows Prediction Only	2
Slope	-0.0050	Sum of Frequencies	26
R-Squared	0.0066	Sum of Weights	26.0000
Correlation	-0.0811	Coefficient of Variation	1.6815
Mean Square Error	1162.098	Square Root of MSE	34.08956

[redacted]

Page/Date/Time 1 6/20/2011 8:27:56 PM
Database
Y = Mercury X = Total_TPH

Linear Regression Plot Section



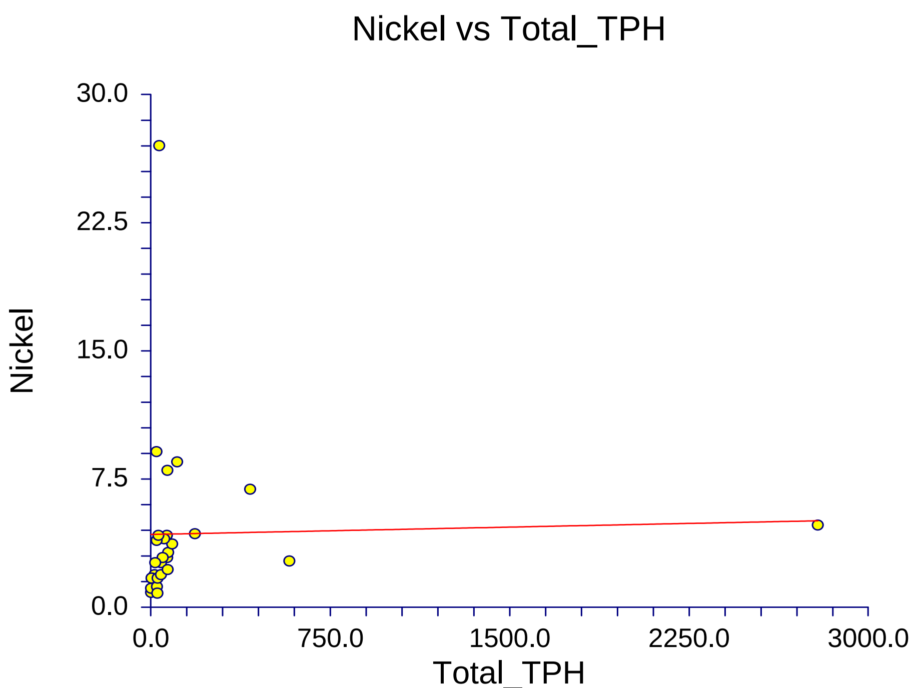
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Mercury	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	0.0211	Rows Prediction Only	0
Slope	0.0000	Sum of Frequencies	28
R-Squared	0.0000	Sum of Weights	28.0000
Correlation	-0.0037	Coefficient of Variation	1.8174
Mean Square Error	1.467009E-03	Square Root of MSE	3.830156E-02

[redacted]

Page/Date/Time 1 6/20/2011 8:29:21 PM
Database
Y = Nickel X = Total_TPH

Linear Regression Plot Section



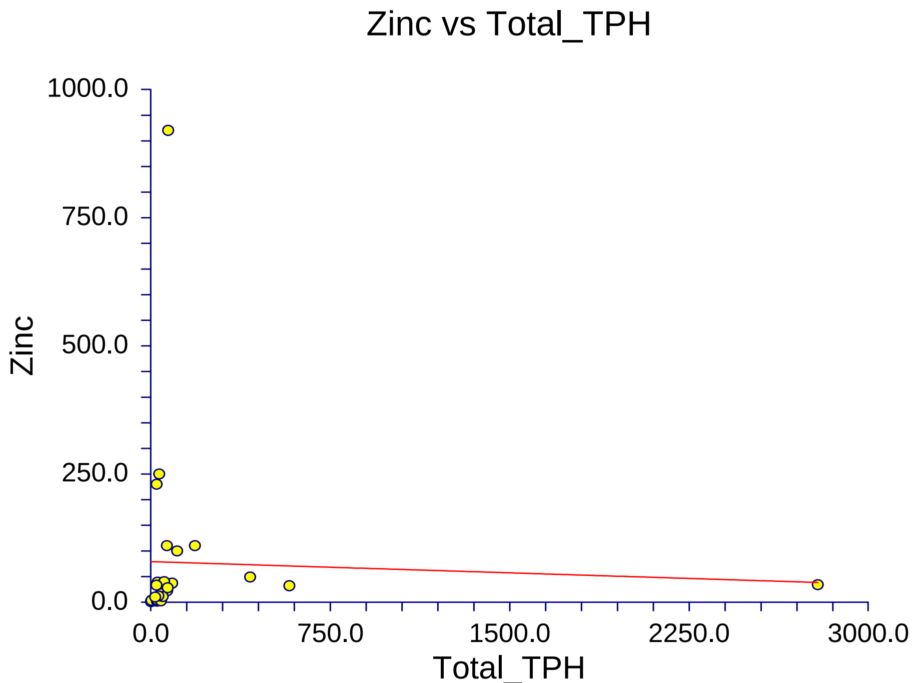
Run Summary Section

Parameter	**Value**	**Parameter**	**Value**
Dependent Variable	Nickel	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	4.2556	Rows Prediction Only	0
Slope	0.0003	Sum of Frequencies	28
R-Squared	0.0009	Sum of Weights	28.0000
Correlation	0.0303	Coefficient of Variation	1.1789
Mean Square Error	25.7752	Square Root of MSE	5.076928

[redacted]

Page/Date/Time 1 6/20/2011 8:37:57 PM
Database
Y = Zinc X = Total_TPH

Linear Regression Plot Section



Run Summary Section

Parameter	Value	Parameter	Value
Dependent Variable	Zinc	Rows Processed	28
Independent Variable	Total_TPH	Rows Used in Estimation	28
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	79.1336	Rows Prediction Only	0
Slope	-0.0146	Sum of Frequencies	28
R-Squared	0.0019	Sum of Weights	28.0000
Correlation	-0.0434	Coefficient of Variation	2.3532
Mean Square Error	32452.28	Square Root of MSE	180.1452

APPENDIX C
DATA VALIDATION REPORT SUMMARIES

TEST AMERICA SDG 68067512

DataQual

Environmental Services, LLC

Michael Baker, Jr., Inc.
Airside Business Park
100 Airside Drive
Moon Township, PA 15108

June 13, 2011
SDG# 68067512, Test America
NAPR SWMU 74- Fueling Piers Area, Puerto Rico

Dear Mr. Kimes,

The following Data Validation report is provided as requested for the parameters noted in the table below for SDG # 68067512. The data validation was performed in accordance with the SW-846 methods utilized by the laboratory, the Region II Standard Operating Procedures for the Validation of Organic Data Acquired Using SW-846 Method (8260B-Rev 2, August 2008-SOP #HW-24 and 8270D-Rev 4, August 2008- SOP#HW-22) and professional judgment. Region II has not developed a validation checklist SOP for the methods used to assess the inorganic parameters analyzed by SW-846 methods 6020A/7470A/7471A Metals or the organic parameters analyzed by SW-846 methods 8015_DRO and 8015_GRO). Therefore, alternative worksheets were provided. Region II flagging conventions were used. All areas of concern are discussed in the body of the report and a summary of data qualification is provided.

Sample ID	Lab ID	Matrix	VOA	SVOA LL PAH	GRO	DRO	Metals
74SB748-00	680-67512-1	soil	X	X	X	X	X
74SB748-00D	680-67512-2	soil	X	X	X	X	X
74SB748-01	680-67512-3	soil	X	X	X	X	X
74SB748-01D	680-67512-4	soil	X	X	X	X	X
74SB749-00	680-67512-5	soil	X	X	X	X	X
74SB749-01	680-67512-6	soil	X	X	X	X	X
74SB750-00	680-67512-7	soil	X	X	X	X	X
74SB750-01	680-67512-8	soil	X	X	X	X	X
74SB751-00	680-67512-9	soil	X	X	X	X	X
74SB751-01	680-67512-10	soil	X	X	X	X	X
74SB752-00	680-67512-11	soil	X	X	X	X	X
74SB752-01	680-67512-12	soil	X	X	X	X	X
74SB753-00	680-67512-13	soil	X	X	X	X	X
74SB753-01	680-67512-14	soil	X	X	X	X	X
74TB114	680-67512-15	water	X		X		
74SB748-00 MS	680-67512-1MS	soil	X	X	X	X	X
74SB748-00 MSD	680-67512-1MSD	soil	X	X	X	X	X
74SB748-01 MS	680-67512-3MS	soil	X	X	X	X	X
74SB748-01 MSD	680-67512-3MSD	soil	X	X	X	X	X

The following quality control samples were provided with this SDG: sample 74SB748-00D-field duplicate of sample 74SB748-00; sample 74SB748-01D-field duplicate of sample 74SB748-01; and sample 74TB114-trip blank.

5830 Amberway Drive • St. Louis, MO 63128 • 314-330-1327 • Fax 314-849-6264

The samples were evaluated based on the following criteria:

- Data Completeness
- Sample Condition *
- Technical Holding Times *
- GC/MS Tuning *
- ICP-MS Tuning *
- GC Performance *
- Initial/Continuing Calibrations
- Blanks
- Internal Standards *
- Surrogate Recoveries
- Laboratory Control Samples *
- Matrix Spike Recoveries *
- Matrix Spike Pair RPDs *
- Serial Dilutions
- Field Duplicates
- Identification/Quantitation *
- Reporting Limits *
- Tentatively Identified Compounds NA

* - indicates that qualifications were not required based on this criteria

Overall Evaluation of Data/Potential Usability Issues

A summary of qualifications applied to the sample results are noted below for the fractions validated. Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. When more than one qualifier is associated with a compound/analyte the validator has chosen the qualifier that best indicates possible bias in the results and flagged the data accordingly. However, information regarding all quality control issues is provided in the body of the report and on the qualification summary page. *If an issue is not addressed in this narrative there were no actions required based on unmet quality control criteria.*

VOA

The continuing calibrations exhibited some compounds with high %D values, which resulted in qualifying compound result values as estimated.

SVOA

No qualifications to the data were required.

GRO

Three samples exhibited non-compliant surrogate recoveries which required qualifications to the data.

One of the field duplicate pairs did not exhibit comparable results which resulted in qualifications to the data.

DRO

One sample required qualification due to contamination noted in the associated field QC blanks.

Metals

Qualifications were required in the samples based on field QC blank contamination.

Two analytes required qualification based on non-compliant serial dilution %Ds.

One analyte required qualification in the field duplicate pair of samples 74SB748-00.

Specific Evaluation of Data

Data Completeness

Resubmissions were required for missing sample receipt log-in forms. The laboratory was contacted and the requested forms were submitted. A copy of all e-mail correspondence is included in the worksheets section of the data validation report.

Technical Holding Times

According to chain of custody records, sampling was performed on 4/18/11 and samples were received at the laboratory 4/19/11. All sample preparation and analysis was performed within Region II and/or method holding time requirements.

Initial/Continuing Calibration

VOA

Calibration standards exhibited RRF values that were non-compliant. A summary of these non-compliances and affected samples are noted in the following table. Sample results are qualified as indicated.

Standard ID	Compound(s)	RRF, %RSD, %D	Samples	Q Flag
CC 4/25/11	acrolein dichlorodifluoromethane	23.3% 36.9%	all soil samples	J/UJ
CC 4/24/11	iodomethane bromomethane	51.4% 28.9%	74TB114	J/UJ

Blanks

DRO

The associated field QC blanks exhibited contamination as noted in the following table. Compounds for which there was no action required. are not included in the following table.

Blank ID	Compound	Concentration	Action Level
74ER114	DRO	0.024J mg/L	RL
74FB01	DRO	0.034J mg/L	RL

Associated samples and required qualifications are noted in the following table.

Sample ID	Compound	Q Flag
74SB748-01D	DRO	U at RL

Metals

The associated field QC blanks exhibited contamination as noted in the following table. The concentration of barium reported in the blanks was above the RL. Region II guidelines for blank qualifications were followed.

Blank ID	Analyte	Concentration	Action Level
74FB01	barium	9.1 ug/L	91 mg/Kg
74ER114	barium	11.0 ug/L	110 mg/Kg

Associated samples and required qualifications are noted in the following table.

Sample ID	Analyte	Q Flag
74SB748-01, 74SB748-01D, 74SB752-01	barium	J

Surrogates

GRO

The samples listed in the table below exhibited non-compliant surrogate recoveries, qualifications were applied as stated. According to the case narrative, sample 74SB753-01 had insufficient sample to perform a re-analysis and the re-analysis of samples 74SB752-00 and 74SB753-00 confirmed the non-compliances in the initial analyses.

Sample ID	Non-compliant Surrogate	% Rec	QC limit	Qualifier
74SB752-00	4-bromofluorobenzene	40	51-117	J/UJ
74SB753-00	a,a,a-trifluorotoluene 4-bromofluorobenzene	62 26	64-116 51-117	
74SB753-01	4-bromofluorobenzene	34	51-117	

Serial Dilutions

Metals

The serial dilution analysis submitted in this SDG exhibited non-compliant %Ds for barium and vanadium, requiring qualification in the field samples. A summary of these non-compliances and affected samples are noted in the following table.

SD	Analytes	Samples	%D	Q Flag
74SB748-00	barium	all soil samples	11	J/UJ
	vanadium		11	

Field Duplicate

GRO

Sample 74SB748-00 and duplicate sample 74SB748-00 did not exhibit comparable results for GRO with 175% RPD; therefore the results were qualified as estimated (J).

Metals

The field duplicate pair of samples 74SB748-00 and 74SB748-00D exhibited an absolute difference for nickel that was greater than 2X the RL (RL – nickel 1 mg/Kg). Therefore, nickel was flagged as estimated in both the sample and the duplicate.

A summary of qualifications required is provided on the following page. Please do not hesitate to contact DataQual ES with any questions regarding this validation report.

Sincerely,

Jacqueline Cleveland

Jacqueline Cleveland
Vice President

Summary of Data Qualifications

VOA

Sample ID	Compound	Results	Q flag
all soil samples	acrolein dichlorodifluoromethane	+/-	J/UJ
74TB114	iodomethane bromomethane	+/-	J/UJ

SVOA

Sample ID	Compound	Results	Q flag
No qualifications were required			

GRO

Sample ID	Compound	Results	Q flag
74SB752-00, 74SB753-00, 74SB753-01	GRO	+/-	J/UJ
74SB748-00, 74SB748-00D	GRO	+	J

DRO

Sample ID	Compound	Results	Q flag
74SB748-01D	DRO	+J	U at RL

Metals

Sample ID	Analyte	Results	Q flag
74SB748-01, 74SB748-0D, 74SB752-01	barium	+ up to 110 mg/Kg	J
all samples	barium vanadium	+/-	J/UJ
74SB748-00, 74SB748-00D	nickel	+	J

Glossary of Qualification Flags and Abbreviations

Qualification Flags (Q-Flags)

U	not detected above the reported sample quantitation limit
J	estimated value
UJ	reported quantitation limit is qualified as estimated
N	analyte has been tentatively identified
JN	analyte has been tentatively identified, estimated value
R	result is rejected; the presence or absence of the analyte cannot be verified

Method/Preparation/Field QC Blank Qualification Flags (Q-Flags)

Organic Methods

NA	The sample result for the blank contaminant is greater than the LOQ (2X sample LOQ for common laboratory contaminants) when the blank value is less than the LOQ. The sample result for the blank contaminant is not qualified with any blank qualifiers.
LOQ	The sample result for the blank contaminant is less than the LOQ (2X sample LOQ for common laboratory contaminants) but greater than the MDL when the blank value is less than the LOQ. The sample result for the blank contaminant is changed to the LOQ and qualified as non-detect U.

Inorganic Methods

ICB/CCB/PB Action:

No Action -	The sample result is greater than the LOQ and greater than ten times (10X) the blank value.
U -	The sample result is greater than or equal to the MDL but less than or equal to the LOQ, result is reported as non-detect at the LOQ, when the ICB/CCB/PB result is less or greater than the LOQ.

Glossary of Qualification Flags and Abbreviations, continued

R -	Sample result is greater than the LOQ and less than the ICB/CCB/PB value when the ICB/CCB/PB value is greater than the LOQ.
J -	Sample result is greater than the ICB/CCB/PB value but less than 10X the ICB/CCB/PB value when ICB/CCB/PB value is greater than the LOQ.
J/UJ -	Sample result is less than 10X LOQ when blank result is below the negative LOQ.

Field QC Blank action:

Note – Use field blanks to qualify data only if field blank results are greater than prep blank results.
Do not use rinsate blank associated with soils to qualify water samples and vice versa.

No Action -	The sample result is greater than the LOQ and greater than ten times (10X) the blank value.
U -	The sample result is greater than or equal to the MDL but less than or equal to the LOQ, result is reported as non-detect at the LOQ, when the FB result is less or greater than the LOQ.
R -	Sample result is greater than the LOQ and less than the FB value when the FB value is greater than the LOQ.
J -	Sample result is greater than the FB value but less than 10X the FB value when FB value is greater than the LOQ.

General Abbreviations

RL	reporting limit
MDL	method detection limit
IDL	instrument detection limit
LOD	Level of Detection
LOQ	Level of Quantitation
+	positive result
-	non-detect result

TEST AMERICA SDG 68067543

DataQual

Environmental Services, LLC

Michael Baker, Jr., Inc.
Airside Business Park
100 Airside Drive
Moon Township, PA 15108

June 13, 2011
SDG# 68067543, Test America
NAPR SWMU 74- Fueling Piers Area, Puerto Rico

Dear Mr. Kimes,

The following Data Validation report is provided as requested for the parameters noted in the table below for SDG # 68067543. The data validation was performed in accordance with the SW-846 methods utilized by the laboratory, the Region II Standard Operating Procedures for the Validation of Organic Data Acquired Using SW-846 Method (8260B-Rev 2, August 2008- SOP #HW-24 and 8270D- Rev 4, August 2008- SOP#HW-22) and professional judgment. Region II has not developed a validation checklist SOP for the methods used to assess the inorganic parameters analyzed by SW-846 methods 6020A/7470A/7471A Metals or the organic parameters analyzed by SW-846 methods 8015_DRO and 8015_GRO). Therefore, alternative worksheets were provided. Region II flagging conventions were used. All areas of concern are discussed in the body of the report and a summary of data qualification is provided.

Sample ID	Lab ID	Matrix	VOA	SVOA LL PAH	GRO	DRO	Metals
74GW246B	680-67543-1	water		X			
74GW246BD	680-67543-2	water		X			
74FB01	680-67543-3	water	X	X	X	X	X
74ER114	680-67543-4	water	X	X	X	X	X
74ER116	680-67543-6	water	X	X	X	X	X
74SB754-00	680-67543-7	soil	X	X	X	X	X
74SB755-00	680-67543-8	soil	X	X	X	X	X
74TB115	680-67543-9	water	X	X	X		
74GW246B MS	680-67543-1MS	water		X			
74GW246B MSD	680-67543-1MSD	water		X			
74SB755-00 MS	680-67543-8MS	soil					X
74SB755-00 MSD	680-67543-8MSD	soil					X

The following quality control samples were provided with this SDG: sample 74GW246BD-field duplicate of sample 74GW246B; samples 74ER114 and 74ER116-equipment blanks; sample 74FB01-field blank; and sample 74TB115-trip blank.

The samples were evaluated based on the following criteria:

- Data Completeness
- Sample Condition *
- Technical Holding Times *
- GC/MS Tuning *

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- ICP-MS Tuning *
- GC Performance *
- Initial/Continuing Calibrations
- Blanks
- Internal Standards *
- Surrogate Recoveries *
- Laboratory Control Samples *
- Matrix Spike Recoveries *
- Matrix Spike Pair RPDs
- Serial Dilutions *
- Field Duplicates *
- Identification/Quantitation *
- Reporting Limits *
- Tentatively Identified Compounds NA

* - indicates that qualifications were not required based on this criteria

Overall Evaluation of Data/Potential Usability Issues

A summary of qualifications applied to the sample results are noted below for the fractions validated. Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. When more than one qualifier is associated with a compound/analyte the validator has chosen the qualifier that best indicates possible bias in the results and flagged the data accordingly. However, information regarding all quality control issues is provided in the body of the report and on the qualification summary page. *If an issue is not addressed in this narrative there were no actions required based on unmet quality control criteria.*

VOA

The continuing calibrations exhibited some compounds with high %D values, which resulted in qualifying two compound result values as estimated.

SVOA

No qualifications to the data were required.

GRO

No qualifications to the data were required.

DRO

No qualifications to the data were required.

Metals

Qualifications were required in the samples based on field QC blank contamination.

One analyte required rejection based on non-compliant matrix spike pair RPDs.

Specific Evaluation of Data

Data Completeness

Resubmissions were required for missing sample receipt log-in forms. The laboratory was contacted and the requested forms were submitted. A copy of all e-mail correspondence is included in the worksheets section of the data validation report.

Technical Holding Times

According to chain of custody records, sampling was performed on 4/18-19/11 and samples were received at the laboratory 4/20/11. All sample preparation and analysis was performed within Region II and/or method holding time requirements.

Initial/Continuing Calibration

VOA

Calibration standards exhibited %D values that were non-compliant. A summary of these non-compliances and affected samples are noted in the following table. Sample results are qualified as indicated.

Standard ID	Compound(s)	RRF, %RSD, %D	Samples	Q Flag
CC 4/27/11	dichlorodifluoromethane	36.1%	74SB754-00, 74B755-00	J/UJ
CC 4/22/11	bromomethane	34.7%	74FB01, 74ER114, 74ER116, 74TB115	J/UJ

Blanks

Metals

The associated field QC blanks exhibited contamination as noted in the following table. The concentration of barium reported in the blanks was above the RL. Region II guidelines for blank qualifications were followed.

Blank ID	Analyte	Concentration	Action Level
74FB01	barium	9.1 ug/L	91 mg/Kg

Associated samples and required qualifications are noted in the following table.

Sample ID	Analyte	Q Flag
74SB754-00, 74SB755-00	barium	J

Matrix Spike Pair RPDs

Metals

The matrix spike pair analysis submitted in this SDG exhibited a non-compliant RPD > 125% for lead. The %recoveries for this analyte were not assessed because of the concentration of the target in the native sample (>4X the spike amount). However, the large variance in recoveries between spike aliquots indicates a potential for matrix issues in the lead results. Therefore, Region II guidance for matrix duplicate results was used to flag the associated field samples. A summary of these non-compliances and affected samples are noted in the following table.

Spike ID	Analytes	Samples	RPD	Q Flag
74SB755-00	lead	all soil samples	172	R

A summary of qualifications required is provided on the following page. Please do not hesitate to contact DataQual ES with any questions regarding this validation report.

Sincerely,

Jacqueline Cleveland

Jacqueline Cleveland
Vice President

Summary of Data Qualifications

VOA

Sample ID	Compound	Results	Q flag
74SB754-00, 74B755-00	dichlorodifluoromethane	+/-	J/UJ
74FB01, 74ER114, 74ER116, 74TB115	bromomethane	+/-	J/UJ

SVOA

Sample ID	Compound	Results	Q flag
No qualifications were required			

GRO

Sample ID	Compound	Results	Q flag
No qualifications were required			

DRO

Sample ID	Compound	Results	Q flag
No qualifications were required			

Metals

Sample ID	Analyte	Results	Q flag
74SB754-00, 74SB755-00	barium	+ up to 91 mg/Kg	J
74SB754-00, 74SB755-00	lead	+	R

Glossary of Qualification Flags and Abbreviations

Qualification Flags (Q-Flags)

U	not detected above the reported sample quantitation limit
J	estimated value
UJ	reported quantitation limit is qualified as estimated
N	analyte has been tentatively identified
JN	analyte has been tentatively identified, estimated value
R	result is rejected; the presence or absence of the analyte cannot be verified

Method/Preparation/Field QC Blank Qualification Flags (Q-Flags)

Organic Methods

NA — The sample result for the blank contaminant is greater than the LOQ (2X sample LOQ for common laboratory contaminants) when the blank value is less than the LOQ. The sample result for the blank contaminant is not qualified with any blank qualifiers.

LOQ — The sample result for the blank contaminant is less than the LOQ (2X sample LOQ for common laboratory contaminants) but greater than the MDL when the blank value is less than the LOQ. The sample result for the blank contaminant is changed to the LOQ and qualified as non-detect U.

Inorganic Methods

ICB/CCB/PB Action:

No Action - The sample result is greater than the LOQ and greater than ten times (10X) the blank value.

U - The sample result is greater than or equal to the MDL but less than or equal to the LOQ, result is reported as non-detect at the LOQ, when the ICB/CCB/PB result is less or greater than the LOQ.

Glossary of Qualification Flags and Abbreviations, continued

R -	Sample result is greater than the LOQ and less than the ICB/CCB/PB value when the ICB/CCB/PB value is greater than the LOQ.
J -	Sample result is greater than the ICB/CCB/PB value but less than 10X the ICB/CCB/PB value when ICB/CCB/PB value is greater than the LOQ.
J/UJ -	Sample result is less than 10X LOQ when blank result is below the negative LOQ.

Field QC Blank action:

Note – Use field blanks to qualify data only if field blank results are greater than prep blank results.

Do not use rinsate blank associated with soils to qualify water samples and vice versa.

No Action -	The sample result is greater than the LOQ and greater than ten times (10X) the blank value.
U -	The sample result is greater than or equal to the MDL but less than or equal to the LOQ, result is reported as non-detect at the LOQ, when the FB result is less or greater than the LOQ.
R -	Sample result is greater than the LOQ and less than the FB value when the FB value is greater than the LOQ.
J -	Sample result is greater than the FB value but less than 10X the FB value when FB value is greater than the LOQ.

General Abbreviations

RL	reporting limit
MDL	method detection limit
IDL	instrument detection limit
LOD	Level of Detection
LOQ	Level of Quantitation
+	positive result
-	non-detect result

TEST AMERICA SDG 68067897

DataQual

Environmental Services, LLC

Michael Baker, Jr., Inc.
Airside Business Park
100 Airside Drive
Moon Township, PA 15108

June 13, 2011
SDG# 68067897, Test America
NAPR SWMU 74- Fueling Piers Area, Puerto Rico

Dear Mr. Kimes,

The following Data Validation report is provided as requested for the parameters noted in the table below for SDG # 68067897. The data validation was performed in accordance with the SW-846 methods utilized by the laboratory, the Region II Standard Operating Procedures for the Validation of Organic Data Acquired Using SW-846 Method (8260B-Rev 2, August 2008- SOP #HW-24 and 8270D- Rev 4, August 2008- SOP#HW-22) and professional judgment. Region II has not developed a validation checklist SOP for the methods used to assess the inorganic parameters analyzed by SW-846 methods 6020A/7470A/7471A Metals or the organic parameters analyzed by SW-846 methods 8015_DRO and 8015_GRO). Therefore, alternative worksheets were provided. Region II flagging conventions were used. All areas of concern are discussed in the body of the report and a summary of data qualification is provided.

Sample ID	Lab ID	Matrix	VOA	SVOA LL PAH	GRO	DRO	Metals
74ER117	680-67897-1	water	X	X	X	X	X
74TB117	680-67897-2	water	X		X		
74SB756-00	680-67897-3	soil	X	X	X	X	X
74SB757-00	680-67897-4	soil	X	X	X	X	X
74SB758-00	680-67897-5	soil	X	X	X	X	X
74SB759-00	680-67897-6	soil	X	X	X	X	X
74SB759-00D	680-67897-7	soil	X	X	X	X	X
74SB760-00	680-67897-8	soil	X	X	X	X	X
74SB759-00 MS	680-67897-6 MS	soil	X	X	X	X	X
74SB759-00 MSD	680-67897-6 MSD	soil	X	X	X	X	X

The following quality control samples were provided with this SDG: sample 74SB759-00D-field duplicate of sample 74SB759-00; sample 74ER117-equipment blank; and sample 74TB117-trip blank.

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The samples were evaluated based on the following criteria:

• Data Completeness	
• Sample Condition	*
• Technical Holding Times	*
• GC/MS Tuning	*
• ICP-MS Tuning	*
• GC Performance	*
• Initial/Continuing Calibrations	
• Blanks	
• Internal Standards	*
• Surrogate Recoveries	*
• Laboratory Control Samples	*
• Matrix Spike Recoveries	
• Matrix Spike Pair RPDs	*
• Serial Dilutions	*
• Field Duplicates	
• Identification/Quantitation	*
• Reporting Limits	*
• Tentatively Identified Compounds	NA

* - indicates that qualifications were not required based on this criteria

Overall Evaluation of Data/Potential Usability Issues

A summary of qualifications applied to the sample results are noted below for the fractions validated. Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. When more than one qualifier is associated with a compound/analyte the validator has chosen the qualifier that best indicates possible bias in the results and flagged the data accordingly. However, information regarding all quality control issues is provided in the body of the report and on the qualification summary page. *If an issue is not addressed in this narrative there were no actions required based on unmet quality control criteria.*

VOA

The continuing calibrations exhibited some compounds with high %D values, which resulted in qualifying result values as estimated.

Due to non-compliant MS/MSD recoveries qualifications were required to the associated sample.

SVOA

Due to non-compliant MS/MSD recoveries qualifications were required to the associated sample.

Blank contamination was noted in the method and/or QC blanks associated with samples in this batch. Qualifications were added to the data.

Non-comparable results were exhibited in the field duplicate pair therefore qualifications were added to the data.

GRO

Due to non-compliant MS/MSD recoveries qualifications were required to the associated sample.

DRO

The associated field duplicate pair exhibited a RPD greater than 50%. Therefore the reported results for DRO in the field duplicate pair were qualified as estimated J.

Metals

The serial dilution analysis exhibited two analytes with non-compliant %Ds. Qualifications were applied to the data.

Specific Evaluation of Data

Data Completeness

Resubmissions were required for missing sample receipt log-in forms. The laboratory was contacted and the requested forms were submitted. A copy of all e-mail correspondence is included in the worksheets section of the data validation report.

Technical Holding Times

According to chain of custody records, sampling was performed on 4/29/11 and samples were received at the laboratory 4/30/11. All sample preparation and analysis was performed within Region II and/or method holding time requirements.

Initial/Continuing Calibration

VOA

Calibration standards exhibited %D values that were non-compliant. A summary of these non-compliances and affected samples are noted in the following table. Sample results are qualified as indicated.

Standard ID	Compound(s)	RRF, %RSD, %D	Samples	Q Flag
CC 5/12/11	acrolein 3-chloro-1-propene chloroethane trichlorofluoromethane	22.3% 22.5% 22.9% 26.4%	all soil samples	J/UJ
CC 5/5/11	iodomethane bromomethane	35.4% 29.4%	all water samples	J/UJ

Blanks

SVOA

The associated method and/or QC blanks exhibited contamination as noted in the following table. Compounds for which there was no action required, are not included in the following table, see worksheets for full list of compounds.

Blank ID	Compound	Concentration	Reporting Limit
74ER007	naphthalene	0.30 ug/L	0.20 ug/L

Associated samples and required qualifications are noted in the following table.

Sample ID	Compound	Q Flag
74SB756-00	naphthalene	U at RL

Matrix Spike Recoveries

VOA

The MS and MSD associated with sample 74SB759-00 and duplicate sample 74SB759-00D exhibited non-compliant recoveries for vinyl acetate at 31% and 27% (QC limit 36-152%); therefore the non-detected results in the associated sample were qualified as estimated (UJ).

SVOA

The MS and MSD associated with sample 74SB759-00 and duplicate sample 74SB759-00D exhibited non-compliant recoveries for those compounds listed in the table below. Qualifications were applied as noted. The data is usable but should be considered biased low.

Associated Sample ID	Compound	% MS	% MSD	QC Limit	Qualifier
74SB759-00 74SB759-00D	benzo(a)anthracene	28	-23	39-157	J
	benzo(a)pyrene	18	-29	41-158	
	benzo(b)fluoranthene	-104	-94	35-152	
	benzo(k)fluoranthene	-17	-102	38-148	
	chrysene	25	-90	38-147	
	fluoranthene	155	-167	36-147	
	phenanthrene	165	7	40-135	
	pyrene	-56	-227	38-145	

GRO

The MS and MSD associated with sample 74SB759-00 and duplicate sample 74SB759-00D exhibited non-compliant recoveries for GRO at 55% and 56% (QC limit 64-133%); therefore the non-detected results in the associated samples were qualified as estimated (UJ).

Serial Dilutions

Metals

The serial dilution analysis submitted in this SDG exhibited non-compliant %Ds for barium and cobalt, requiring qualification in the field samples. A summary of these non-compliances and affected samples are noted in the following table.

SD	Analytes	Samples	%D	Q Flag
74SB759-00	barium	all soil samples	12	J/UJ
	cobalt		12	

Field Duplicates

SVOA

Sample 74SB759-00 and duplicate sample 74SB759-00D did not exhibit comparable results for those compounds listed in the table below. Qualifications were applied as stated.

Compound	% RPD	Qualifier
benzo(a)anthracene	105	J
benzo(a)pyrene	90	
benzo(k)fluoranthene	84	
phenanthrene	84	

DRO

The field duplicate pair of samples 74SB759-00 and 74SB759-00D exhibited a high RPD as noted in the table below. Qualifications were applied as stated.

Compound	% RPD	Qualifier
DRO	51	J

A summary of qualifications required is provided on the following page. Please do not hesitate to contact DataQual ES with any questions regarding this validation report.

Sincerely,

Jacqueline Cleveland
Vice President

Summary of Data Qualifications

VOA

Sample ID	Compound	Results	Q flag
all soils samples	acrolein 3-chloro-1-propene chloroethane trichlorofluoromethane	+/-	J/UJ
all water samples	iodomethane bromomethane	+/-	J/UJ
74SB759-00, 74SB759-00D	vinyl acetate	-	UJ

SVOA

Sample ID	Compound	Results	Q flag
74SB756-00	naphthalene	+	U at RL
74SB759-00, 74SB759-00D	benzo(a)anthracene benzo(a)pyrene benzo(b)fluoranthene benzo(k)fluoranthene chrysene fluoranthene phenanthrene pyrene	+	J
74SB759-00, 74SB759-00D	benzo(a)anthracene benzo(a)pyrene benzo(k)fluoranthene phenanthrene	+	J

GRO

Sample ID	Compound	Results	Q flag
74SB759-00, 74SB759-00D	GRO	-	UJ

DRO

Sample ID	Compound	Results	Q flag
74SB759-00, 74SB759-00D	DRO	+	J

Metals

Sample ID	Analyte	Results	Q flag
all soil samples	barium cobalt	+/-	J/UJ

Glossary of Qualification Flags and Abbreviations

Qualification Flags (Q-Flags)

U	not detected above the reported sample quantitation limit
J	estimated value
UJ	reported quantitation limit is qualified as estimated
N	analyte has been tentatively identified
JN	analyte has been tentatively identified, estimated value
R	result is rejected; the presence or absence of the analyte cannot be verified

Method/Preparation/Field QC Blank Qualification Flags (Q-Flags)

Organic Methods

NA	The sample result for the blank contaminant is greater than the LOQ (2X sample LOQ for common laboratory contaminants) when the blank value is less than the LOQ. The sample result for the blank contaminant is not qualified with any blank qualifiers.
LOQ	The sample result for the blank contaminant is less than the LOQ (2X sample LOQ for common laboratory contaminants) but greater than the MDL when the blank value is less than the LOQ. The sample result for the blank contaminant is changed to the LOQ and qualified as non-detect U.

Inorganic Methods

ICB/CCB/PB Action:

No Action -	The sample result is greater than the LOQ and greater than ten times (10X) the blank value.
U -	The sample result is greater than or equal to the MDL but less than or equal to the LOQ, result is reported as non-detect at the LOQ, when the ICB/CCB/PB result is less or greater than the LOQ.

Glossary of Qualification Flags and Abbreviations, continued

R - Sample result is greater than the LOQ and less than the ICB/CCB/PB value when the ICB/CCB/PB value is greater than the LOQ.

J - Sample result is greater than the ICB/CCB/PB value but less than 10X the ICB/CCB/PB value when ICB/CCB/PB value is greater than the LOQ.

J/UJ - Sample result is less than 10X LOQ when blank result is below the negative LOQ.

Field QC Blank action:

Note -- Use field blanks to qualify data only if field blank results are greater than prep blank results.

Do not use rinsate blank associated with soils to qualify water samples and vice versa.

No Action - The sample result is greater than the LOQ and greater than ten times (10X) the blank value.

U - The sample result is greater than or equal to the MDL but less than or equal to the LOQ, result is reported as non-detect at the LOQ, when the FB result is less or greater than the LOQ.

R - Sample result is greater than the LOQ and less than the FB value when the FB value is greater than the LOQ.

J - Sample result is greater than the FB value but less than 10X the FB value when FB value is greater than the LOQ.

General Abbreviations

RL	reporting limit
MDL	method detection limit
IDL	instrument detection limit
LOD	Level of Detection
LOQ	Level of Quantitation
+	positive result
-	non-detect result

PUERTO RICO CHEMIST CERTIFICATION

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

PUERTO RICO CERTIFICATION

I Herby certify that I have reviewed the Quality Assurance Data for Project Number **680-67512-1,** and to the best of my knowledge, the results are correct and reliable.

Abraham Ortiz

$1.00 $1.00

A 1327565

ESTADO LIBRE ASOCIADO DE PUERTO RICO

Lic Abraham Ortiz Charriez

QUIMICO LICENCIADO

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

PUERTO RICO CERTIFICATION

I Herby certify that I have reviewed the Quality Assurance Data for Project Number **680-67543-1,** and to the best of my knowledge, the results are correct and reliable.

Abraham Ortiz

$1.00 $1.00
A 1327555
ESTADO LIBRE ASOCIADO DE PUERTO RICO
QUIMICO LICENCIADO
Lic. Abraham Ortiz Chaparro
Lic. 3314

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

PUERTO RICO CERTIFICATION

I Herby certify that I have reviewed the Quality Assurance Data for Project Number **680-67897-1,** and to the best of my knowledge, the results are correct and reliable.

Abraham Ortiz

$1.00 $1.00

A 1327556

ESTADO LIBRE ASOCIADO DE PUERTO RICO

Lic. Abraham Ortiz Chavez

QUIMICO LICENCIADO

APPENDIX D
DATA USED IN THE ECOLOGICAL RISK ASSESSMENT

APPENDIX D-1

SURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB231		74SB748		74SB749		74SB750		74SB751		74SB752		74SB753	
Sample ID	74SB231-00		74SB748-00		74SB749-00		74SB750-00		74SB751-00		74SB752-00		74SB753-00	
Date	5/20/2008		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011	
Depth Range (ft bgs)	0.0-1.0		0.3-1.0		0.0-1.0		0.0-1.0		0.4-1.0		0.4-1.0		0.0-1.0	
Volatile Organics (ug/kg)														
1,1,1,2-Tetrachloroethane	0.95	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,1,1-Trichloroethane	0.86	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,1,2,2-Tetrachloroethane	2.1	U	NA		NA		NA		NA		NA		NA	
1,1,2-Trichloroethane	1.8	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,1-Dichloroethane	0.74	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,1-Dichloroethene	0.8	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,2,3-Trichloropropane	2.1	UJ	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,2-Dibromo-3-Chloropropane	4.2	UJ	9.8	U	11	U	10	U	10	U	8	U	8.2	U
1,2-Dibromoethane	2.2	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,2-Dichloroethane	1.5	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,2-Dichloropropane	1.6	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
2-Butanone (MEK)	7.1	UJ	24	U	27	U	26	U	25	U	20	U	21	U
2-Hexanone	3.1	UJ	24	U	27	U	26	U	25	U	20	U	21	U
3-Chloro-1-propene	2.2	UJ	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
4-Methyl-2-pentanone (MIBK)	4.3	UJ	24	U	27	U	26	U	25	U	20	U	21	U
Acetone	70	U	49	U	55	U	51	U	50	U	40	U	41	U
Acetonitrile	67	UJ	200	U	220	U	210	U	200	U	160	U	160	U
Acrolein	28	R	98	UJ	110	UJ	100	UJ	100	UJ	80	UJ	82	UJ
Acrylonitrile	34	UJ	98	U	110	U	100	U	100	U	80	U	82	U
Benzene	1.2	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Bromodichloromethane	1.2	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Bromoform	1.6	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Bromomethane	2.4	UJ	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Carbon disulfide	0.76	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Carbon tetrachloride	1.5	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Chlorobenzene	1.1	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Chloroethane	1.8	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U

APPENDIX D-1

SURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB231		74SB748		74SB749		74SB750		74SB751		74SB752		74SB753	
Sample ID	74SB231-00		74SB748-00		74SB749-00		74SB750-00		74SB751-00		74SB752-00		74SB753-00	
Date	5/20/2008		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011	
Depth Range (ft bgs)	0.0-1.0		0.3-1.0		0.0-1.0		0.0-1.0		0.4-1.0		0.4-1.0		0.0-1.0	
Volatile Organics (ug/kg) (cont.)														
Chloroform	0.74	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Chloromethane	1.1	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Chloroprene	0.85	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
cis-1,3-Dichloropropene	1.3	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Dibromochloromethane	0.74	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Dibromomethane	1.8	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Dichlorodifluoromethane	1.3	U	4.9	UJ	5.5	UJ	5.1	UJ	5	UJ	4	UJ	4.1	UJ
Ethyl methacrylate	3.3	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Ethylbenzene	1.1	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Iodomethane	1.5	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Isobutyl alcohol	100	R	200	U	220	U	210	U	200	U	160	U	160	U
Methacrylonitrile	36	U	98	U	110	U	100	U	100	U	80	U	82	U
Methyl methacrylate	5.5	U	9.8	U	11	U	10	U	10	U	8	U	8.2	U
Methylene Chloride	1.5	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Pentachloroethane	3.3	UJ	24	U	27	U	26	U	25	U	20	U	21	U
Propionitrile	31	UJ	98	U	110	U	100	U	100	U	80	U	82	U
Styrene	0.98	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Tetrachloroethene	1.1	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Toluene	1.2	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
trans-1,2-Dichloroethene	1.4	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
trans-1,3-Dichloropropene	1.3	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
trans-1,4-Dichloro-2-butene	4.6	U	9.8	U	11	U	10	U	10	U	8	U	8.2	U
Trichloroethene	1.5	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Trichlorofluoromethane	2.2	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Vinyl acetate	2.2	U	9.8	U	11	U	10	U	10	U	8	U	8.2	U
Vinyl chloride	0.86	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Xylenes, Total	3.4	U	9.8	U	11	U	10	U	10	U	8	U	8.2	U

APPENDIX D-1

SURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB231	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID	74SB231-00	74SB748-00	74SB749-00	74SB750-00	74SB751-00	74SB752-00	74SB753-00
Date	5/20/2008	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	0.0-1.0	0.3-1.0	0.0-1.0	0.0-1.0	0.4-1.0	0.4-1.0	0.0-1.0
LLPAHs (ug/kg)							
2-Methylnaphthalene	NA	71 U	72 U	69 U	74 U	72 U	69 U
Acenaphthene	NA	71 U	72 U	69 U	74 U	72 U	69 U
Acenaphthylene	NA	71 U	72 U	69 U	74 U	72 U	69 U
Anthracene	NA	71 U	51 J	69 U	74 U	72 U	69 U
Benzo[a]anthracene	NA	71 U	190	140	78	72 U	69 U
Benzo[a]pyrene	NA	71 U	170	200	90	25 J	120
Benzo[b]fluoranthene	NA	71 U	190	230	74 U	72 U	69 U
Benzo[g,h,i]perylene	NA	43 J	170	92	52 J	72 U	69 U
Benzo[k]fluoranthene	NA	71 U	160	170	130	72 U	69 U
Chrysene	NA	39 J	210	160	100	72 U	74
Dibenz(a,h)anthracene	NA	71 U	57 J	45 J	74 U	72 U	69 U
Fluoranthene	NA	71 U	330	120	110	72 U	69 U
Fluorene	NA	71 U	72 U	69 U	74 U	72 U	69 U
Indeno[1,2,3-cd]pyrene	NA	71 U	110	84	38 J	72 U	69 U
Naphthalene	NA	71 U	72 U	69 U	74 U	72 U	69 U
Phenanthrene	NA	71 U	100	69 U	35 J	26 J	26 J
Pyrene	NA	71 U	320	160	140	72 U	52 J
LLPAH Totals (µg/kg)							
Low molecular weight PAHs	NA	568	841	603	589	530	509
High molecular weight PAHs	NA	579	1577	1281	776	601	660

APPENDIX D-1

SURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB231		74SB748		74SB749		74SB750		74SB751		74SB752		74SB753	
Sample ID	74SB231-00		74SB748-00		74SB749-00		74SB750-00		74SB751-00		74SB752-00		74SB753-00	
Date	5/20/2008		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011	
Depth Range (ft bgs)	0.0-1.0		0.3-1.0		0.0-1.0		0.0-1.0		0.4-1.0		0.4-1.0		0.0-1.0	
Metals (mg/kg)														
Antimony	0.39	U	2	U	2.9		2	U	2.1	U	2	U	2	U
Arsenic	4.6		2		4.3		4.2		4.7		1.7		1.6	
Barium	25		190	J	29	J	44	J	55	J	150	J	110	J
Beryllium	0.038	U	0.17		0.064	J	0.078	J	0.093	J	0.14		0.25	
Cadmium	0.22		0.062	J	1.3		0.18		0.086	J	0.047	J	0.12	
Chromium	8.4		7.3		20		13		15		4.2		9.5	
Cobalt	2.7		6.3		2.6		3		9.3		6.5		7.3	
Copper	14		12		45		16		49		17		22	
Lead	35		4.6		120		32		7.6		3.5		8.8	
Mercury	0.01	J	0.021	U	0.022		0.02		0.014	J	0.0092	J	0.016	J
Nickel	2.9		4.8	J	4.3		3.2		8		3.7		6.9	
Selenium	0.26	J	1		0.97	U	0.98	U	0.77	J	1.5		1.8	
Silver	0.04	J	0.2	U	0.84		0.2	U	0.21	U	0.2	U	0.2	U
Thallium	0.25	U	0.2	U	0.054	J	0.068	J	0.21	U	0.2	U	0.2	U
Tin	8.4	U	20	U	19	U	20	U	21	U	20	U	20	U
Vanadium	18		46	J	21	J	22	J	60	J	40	J	64	J
Zinc	22		34		110		920		36		37		49	

APPENDIX D-1

SURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB760
Sample ID	74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB760-00
Date	4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Volatile Organics (ug/kg)							
1,1,1,2-Tetrachloroethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1,1-Trichloroethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1-Dichloroethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1-Dichloroethene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2,3-Trichloropropane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2-Dibromo-3-Chloropropane	11 U	12 U	13 U	12 U	11 U	11 U	11 U
1,2-Dibromoethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2-Dichloroethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2-Dichloropropane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
2-Butanone (MEK)	28 U	30 U	31 U	31 U	27 U	28 U	27 U
2-Hexanone	28 U	30 U	31 U	31 U	27 U	28 U	27 U
3-Chloro-1-propene	5.6 U	6 U	6.3 UJ	6.1 UJ	5.3 UJ	5.6 UJ	5.4 UJ
4-Methyl-2-pentanone (MIBK)	28 U	30 U	31 U	31 U	27 U	28 U	27 U
Acetone	56 U	60 U	63 U	61 U	53 U	56 U	54 U
Acetonitrile	220 U	240 U	250 U	240 U	210 U	220 U	220 U
Acrolein	110 U	120 U	130 UJ	120 UJ	110 UJ	110 UJ	110 UJ
Acrylonitrile	110 U	120 U	130 U	120 U	110 U	110 U	110 U
Benzene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Bromodichloromethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Bromoform	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Bromomethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Carbon disulfide	5.9	5.5 J	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Carbon tetrachloride	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Chlorobenzene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Chloroethane	5.6 U	6 U	6.3 UJ	6.1 UJ	5.3 UJ	5.6 UJ	5.4 UJ

APPENDIX D-1

SURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB760
Sample ID	74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB760-00
Date	4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Volatile Organics (ug/kg) (cont.)							
Chloroform	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Chloromethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Chloroprene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
cis-1,3-Dichloropropene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Dibromochloromethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Dibromomethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Dichlorodifluoromethane	5.6 UJ	6 UJ	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Ethyl methacrylate	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Ethylbenzene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Iodomethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Isobutyl alcohol	220 U	240 U	250 U	240 U	210 U	220 U	220 U
Methacrylonitrile	110 U	120 U	130 U	120 U	110 U	110 U	110 U
Methyl methacrylate	11 U	12 U	13 U	12 U	11 U	11 U	11 U
Methylene Chloride	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Pentachloroethane	28 U	30 U	31 U	31 U	27 U	28 U	27 U
Propionitrile	110 U	120 U	130 U	120 U	110 U	110 U	110 U
Styrene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Tetrachloroethene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Toluene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
trans-1,2-Dichloroethene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
trans-1,3-Dichloropropene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
trans-1,4-Dichloro-2-butene	11 U	12 U	13 U	12 U	11 U	11 U	11 U
Trichloroethene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Trichlorofluoromethane	5.6 U	6 U	6.3 UJ	6.1 UJ	5.3 UJ	5.6 UJ	5.4 UJ
Vinyl acetate	11 U	12 U	13 U	12 U	11 U	11 UJ	11 U
Vinyl chloride	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Xylenes, Total	11 U	12 U	13 U	12 U	11 U	11 U	11 U

APPENDIX D-1

SURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB760
Sample ID	74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB760-00
Date	4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
LLPAHs (ug/kg)							
2-Methylnaphthalene	71 U	75 U	4.2 J	7.4 U	7.2 U	7.2 U	7.2 U
Acenaphthene	71 U	75 U	7.2 U	7.4 U	7.2 U	3.8 J	9.4
Acenaphthylene	71 U	75 U	11	7.4 U	7.2 U	17	17
Anthracene	71 U	75 U	25	4 J	4.5 J	26	52
Benzo[a]anthracene	71 U	75 U	63	13	37	160 J	140
Benzo[a]pyrene	44 J	59 J	110	20	50	180 J	140
Benzo[b]fluoranthene	73	68 J	200	36	89	270 J	240
Benzo[g,h,i]perylene	36 J	76	53	7.4 U	24	52	66
Benzo[k]fluoranthene	71 U	56 J	180	33	73	230 J	210
Chrysene	71 U	46 J	110	31	50	200 J	250
Dibenz(a,h)anthracene	71 U	75 U	20	7.4 U	7.2 U	7.2 U	22
Fluoranthene	71 U	43 J	97	32	50	300 J	400
Fluorene	71 U	75 U	7.2 U	7.4 U	7.2 U	3.6 J	7.6
Indeno[1,2,3-cd]pyrene	71 U	44 J	26	5 J	12	26	36
Naphthalene	71 U	75 U	7.2 U	7.4 U	7.2 U	7.2 U	7.2 U
Phenanthrene	71 U	75 U	40	6.2 J	8.6	78 J	180
Pyrene	71 U	51 J	110	33	58	350 J	430
LLPAH Totals (µg/kg)							
Low molecular weight PAHs	568	568	198.8	79.2	99.1	442.8	680.4
High molecular weight PAHs	579	550	872	185.8	400.2	1475.2	1534

APPENDIX D-1

SURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB754		74SB755		74SB756		74SB757		74SB758		74SB759		74SB760	
Sample ID	74SB754-00		74SB755-00		74SB756-00		74SB757-00		74SB758-00		74SB759-00		74SB760-00	
Date	4/19/2011		4/19/2011		4/29/2011		4/29/2011		4/29/2011		4/29/2011		4/29/2011	
Depth Range (ft bgs)	0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0	
Metals (mg/kg)														
Antimony	2	U	2.2	U	1.8	J	2.1	U	2.1	U	2.1	U	2	U
Arsenic	3.5		2.9		21		3.7		5.1		5.2		6.8	
Barium	65	J	54	J	38	J	44	J	17	J	15	J	20	J
Beryllium	0.079	J	0.095	J	0.059	J	0.099	J	0.06	J	0.11	U	0.099	U
Cadmium	0.73		1.8		0.7		0.11		0.51		0.11		0.18	
Chromium	11		18		27		19		11		9.4		7.8	
Cobalt	4.8		10		10	J	6.5	J	2.9	J	1.9	J	1.7	J
Copper	22		48		59		39		550		9.3		15	
Lead	25	R	50	R	58		35		71		6.7		7.3	
Mercury	0.0093	J	0.012	J	0.21		0.021	U	0.015	J	0.0085	J	0.02	U
Nickel	4		8.5		27		9.1		3.9		4.2		2.2	
Selenium	0.87	J	0.83	J	0.97	U	1.1	U	1.1	U	1.1	U	0.99	U
Silver	0.2	U	0.16	J	0.1	J	0.21	U	0.83		0.21	U	0.2	U
Thallium	0.16	J	0.21	J	0.061	J	0.21	U	0.21	U	0.21	U	0.2	U
Tin	20	U	22	U	19	U	21	U	21	U	21	U	20	U
Vanadium	34		62		29		48		31		18		13	
Zinc	40		100		250		33		230		12		28	

APPENDIX D-1

SURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes/Qualifiers

J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Not detected at the Method Detection Limit/Limit of Detection
UJ - Reported quantitation limit is qualified as estimated
R - Rejected data; data is not usable
ft bgs - feet below ground surface
LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons
µg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram
NA - Not Applicable

APPENDIX D-2

SUBSURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID	74SB748-01	74SB749-01	74SB750-01	74SB751-01	74SB752-01	74SB753-01
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	1.0-3.0	1.0-2.3	1.0-2.5	1.0-3.0	1.0-3.0	1.0-3.0
Volatile Organics (µg/kg)						
1,1,1,2-Tetrachloroethane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
1,1,1-Trichloroethane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
1,1-Dichloroethane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
1,1-Dichloroethene	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
1,2,3-Trichloropropane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
1,2-Dibromo-3-Chloropropane	14 U	12 U	13 U	9.7 U	9.6 U	10 U
1,2-Dibromoethane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
1,2-Dichloroethane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
1,2-Dichloropropane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
2-Butanone (MEK)	34 U	31 U	33 U	24 U	24 U	25 U
2-Hexanone	34 U	31 U	33 U	24 U	24 U	25 U
3-Chloro-1-propene	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
4-Methyl-2-pentanone (MIBK)	34 U	31 U	33 U	24 U	24 U	25 U
Acetone	69 U	62 U	66 U	48 U	48 U	50 U
Acetonitrile	280 U	250 U	260 U	190 U	190 U	200 U
Acrolein	140 U	120 UJ	130 UJ	97 UJ	96 UJ	100 UJ
Acrylonitrile	140 U	120 U	130 U	97 U	96 U	100 U
Benzene	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Bromodichloromethane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Bromoform	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Bromomethane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Carbon disulfide	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Carbon tetrachloride	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Chlorobenzene	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U
Chloroethane	6.9 U	6.2 U	6.6 U	4.8 U	4.8 U	5 U

APPENDIX D-2

SUBSURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748		74SB749		74SB750		74SB751		74SB752		74SB753	
Sample ID	74SB748-01		74SB749-01		74SB750-01		74SB751-01		74SB752-01		74SB753-01	
Date	4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011	
Depth Range (ft bgs)	1.0-3.0		1.0-2.3		1.0-2.5		1.0-3.0		1.0-3.0		1.0-3.0	
Volatile Organics (µg/kg) (cont.)												
Chloroform	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Chloromethane	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Chloroprene	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
cis-1,3-Dichloropropene	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Dibromochloromethane	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Dibromomethane	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Dichlorodifluoromethane	6.9	UJ	6.2	UJ	6.6	UJ	4.8	UJ	4.8	UJ	5	UJ
Ethyl methacrylate	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Ethylbenzene	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Iodomethane	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Isobutyl alcohol	280	U	250	U	260	U	190	U	190	U	200	U
Methacrylonitrile	140	U	120	U	130	U	97	U	96	U	100	U
Methyl methacrylate	14	U	12	U	13	U	9.7	U	9.6	U	10	U
Methylene Chloride	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Pentachloroethane	34	U	31	U	33	U	24	U	24	U	25	U
Propionitrile	140	U	120	U	130	U	97	U	96	U	100	U
Styrene	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Tetrachloroethene	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Toluene	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
trans-1,2-Dichloroethene	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
trans-1,3-Dichloropropene	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
trans-1,4-Dichloro-2-butene	14	U	12	U	13	U	9.7	U	9.6	U	10	U
Trichloroethene	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Trichlorofluoromethane	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Vinyl acetate	14	U	12	U	13	U	9.7	U	9.6	U	10	U
Vinyl chloride	6.9	U	6.2	U	6.6	U	4.8	U	4.8	U	5	U
Xylenes, Total	14	U	12	U	13	U	9.7	U	9.6	U	10	U

APPENDIX D-2

SUBSURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID	74SB748-01	74SB749-01	74SB750-01	74SB751-01	74SB752-01	74SB753-01
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	1.0-3.0	1.0-2.3	1.0-2.5	1.0-3.0	1.0-3.0	1.0-3.0
LLPAHs (µg/kg)						
2-Methylnaphthalene	7.5 U	72 U	7.1 U	74 U	7.3 U	72 U
Acenaphthene	7.5 U	72 U	7.1 U	74 U	7.3 U	72 U
Acenaphthylene	7.5 U	72 U	7.1 U	74 U	7.3 U	72 U
Anthracene	7.5 U	72 U	6.1 J	74 U	7.3 U	72 U
Benzo[a]anthracene	7.5 U	72 U	23	72 J	7.3 U	72 U
Benzo[a]pyrene	7.5 U	66 J	45	63 J	7.3 U	25 J
Benzo[b]fluoranthene	7.5 U	110	45	74 U	4.7 J	72 U
Benzo[g,h,i]perylene	7.5 U	62 J	30	74 U	7.3 U	72 U
Benzo[k]fluoranthene	7.5 U	41 J	36	83	2.3 J	72 U
Chrysene	7.5 U	42 J	24	62 J	7.3 U	72 U
Dibenz(a,h)anthracene	7.5 U	72 U	10	74 U	7.3 U	72 U
Fluoranthene	7.5 U	72 U	10	110	7.3 U	72 U
Fluorene	7.5 U	72 U	7.1 U	74 U	7.3 U	72 U
Indeno[1,2,3-cd]pyrene	7.5 U	46 J	27	74 U	7.3 U	72 U
Naphthalene	7.5 U	72 U	7.1 U	74 U	7.3 U	72 U
Phenanthrene	7.5 U	72 U	7.1 U	32 J	7.3 U	72 U
Pyrene	7.5 U	72 U	15	110	7.3 U	72 U
LLPAH Totals (µg/kg)						
Low molecular weight PAHs	60	576	58.7	586	58.4	576
High molecular weight PAHs	67.5	583	255	686	58.1	601

APPENDIX D-2

SUBSURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID	74SB748		74SB749		74SB750		74SB751		74SB752		74SB753	
Sample ID	74SB748-01		74SB749-01		74SB750-01		74SB751-01		74SB752-01		74SB753-01	
Date	4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011	
Depth Range (ft bgs)	1.0-3.0		1.0-2.3		1.0-2.5		1.0-3.0		1.0-3.0		1.0-3.0	
Metals (mg/kg)												
Antimony	2.2	U	2.9		2.1	U	2.1	U	2.1	U	2.1	U
Arsenic	3.5		3.4		3.3		4.1		2		3.6	
Barium	11	J	21	J	34	J	56	J	9.7	J	35	J
Beryllium	0.11	U	0.11	U	0.11	U	0.054	J	0.11	U	0.072	J
Cadmium	0.11	U	2.8		0.029	J	0.044	J	0.11	U	0.11	U
Chromium	3.5		13		4.7		10		11		5.1	
Cobalt	0.37		1.7		0.97		2		0.57		2.2	
Copper	1.9		53		4.5		7.7		2.2		28	
Lead	0.32	J	110		3.8		3.7		0.97		6.4	
Mercury	0.021	U	0.027		0.0098	J	0.016	J	0.011	J	0.012	J
Nickel	1.2		4.2		1.7		2.6		1.9		2.9	
Selenium	1.1	U	1.1	U	1.1	U	1	U	1.1	U	1.1	U
Silver	0.22	U	0.4		0.21	U	0.21	U	0.21	U	0.21	U
Thallium	0.057	J	0.22	U	0.21	U	0.21	U	0.21	U	0.21	U
Tin	22	U	22	U	21	U	21	U	21	U	21	U
Vanadium	5.1	J	14	J	11	J	20	J	5.5	J	20	J
Zinc	1.9	J	110		39		16		2.4	J	11	

APPENDIX D-2

SUBSURFACE SOIL ANALYTICAL DATA USED IN THE ECOLOGICAL RISK ASSESSMENT
FUELING PIERS AREA, SWMU 74 - FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes/Qualifiers

J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Not detected at the Limit of Detection
UJ - Reported quantitation limit is qualified as estimated
ft bgs - feet below ground surface
LLPAHs - Low Level Polynuclear Aromatic Hydrycarbons
μg/kg - micrograms per kilogram
mg/kg - milligrams per kilogram

APPENDIX E
IDENTIFICATION OF BIOACCUMULATIVE CHEMICALS

APPENDIX E

IDENTIFICATION OF BIOACCUMULATIVE CHEMICALS

Only those organic chemicals with a log octanol-water partition coefficient (K_{ow}) value greater than or equal to 3.0 will be considered a bioaccumulative chemical. Justification for defining bioaccumulative organic chemicals as those with log K_{ow} values greater than or equal to 3.0 is provided below.

- The potential for organic chemicals to accumulate in organisms has been shown to correlate well with the K_{ow}. USEPA (1985), as sited in USEPA/ACOE (1998), recommends that only chemicals for which the log K_{ow} is greater than 3.5 be considered for evaluation of bioaccumulation potential since chemicals with log K_{ow} values less than 3.5 are not likely to bioaccumulate to a significant degree.

- Although organic chemicals with log K_{ow} values in the 2 to 7 range have at least some potential to bioconcentrate (Connell, 1990), significant bioconcentration does not generally occur for chemicals with log K_{ow} values less than 3.0 (Maki and Duthie, 1978) to 5.0 (Gobas and Mackay, 1990). Most work with bioconcentration (uptake from the surrounding medium, such as water) and bioaccumulation (uptake from all exposure routes, including diet) of organic chemicals has concerned chemicals with log K_{ow} values of 3.0 or more (USEPA, 1995a), since organic chemicals with lower log K_{ow} values generally have little potential for significant bioaccumulation.

- The USEPA has developed a number of scoring algorithms to evaluate the relative hazard of chemicals to human and/or ecological receptors. All of these algorithms have a component that addresses bioaccumulation potential. The evaluation of bioaccumulation potential is generally based on measured or estimated (using log K_{ow} values) BCFs or BAFs, or less commonly using log K_{ow} itself. For example, USEPA (1980) developed a bioaccumulation potential scoring system that considered organics with BCF values of less than 100 (equivalent to a log K_{ow} of approximately 3.0) to have negligible potential to bioaccumulate in aquatic food webs, while organic chemicals with BCFs in the 100 to 1,000 range (equivalent to log K_{ow} values of about 3.0 to 4.3) are considered to have low bioaccumulation potential. The more recent Scoring and Ranking Assessment Model (SCRAM), developed by EPA Region 5 for the Great Lakes, has similar bioaccumulation scoring cut-offs (USEPA, 2002).

- The proposed categorization of persistent, bioaccumulative, and toxic (PBT) chemicals under the Toxic Substances Control Act (TSCA) defines chemicals with a tendency to accumulate in organisms as those with a BCF or BAF of greater than 1,000 (Federal Register 63(192):53417; 10/5/98). Using the equation listed below (USEPA, 1995b), a BCF/BAF of 1,000 equates to a log K_{ow} value of approximately 4.3.

$$Log\ BCF = [(0.79)(log\ K_{ow}) - 0.40] \qquad \text{(Equation E-1)}$$

- The Beta Test Version 1.0 of the EPA Waste Minimization Prioritization Tool (WMPT), used to develop a list of PBTs for the Resource Conservation and Recovery Act (RCRA) program, defined organic chemicals with a low potential to bioaccumulate as those with log K_{ow} values of less than 3.5 and those with a high potential to bioaccumulate as those with log K_{ow} values greater than 5.0 (USEPA, 1998). The 1998 version of the EPA WMPT defines bioaccumulation potential based on BCF or BAF values (rather than on log K_{ow} values directly), with a scoring "fenceline" for organic chemicals with a low bioaccumulation potential defined as a BCF or BAF of less than 250. Although the tool no longer uses log K_{ow} directly, log K_{ow} values can be used to estimate a BCF or BAF value. Using Equation E-1, a BCF/BAF of 250 equates to a log K_{ow} value of approximately 3.5.

- Garten and Trabalka (1983) have reviewed terrestrial food web data and concluded that only organic chemicals with log K_{ow} values greater than 3.5 have the potential to significantly bioaccumulate from food to birds to mammals.

The information listed above indicates that a log K_{ow} of 3.0 to 3.5 is a reasonable, non-arbitrary range for defining an organic chemical with the potential to bioaccumulate. For conservatism, the low end (3.0) of this log K_{ow} range will be used to define a bioaccumulative organic chemical. Table 7-3 lists log K_{ow} values (range and recommended value) for the volatile organic compounds (VOCs) and polynuclear aromatic hydrocarbons (PAHs) that were analyzed for in media collected at SWMU 74 (fueling piers area). Log K_{ow} values were obtained from the USEPA (1995c and 2009). The recommended value from these sources generally represents a "high-end" or best estimate from empirical data. The organic chemicals that will be evaluated in the dietary intake models are those with a log K_{ow} value of greater than or equal to 3.0. For conservatism, the maximum value in the log K_{ow} range is used for this determination, not the recommended value.

Inorganic chemicals were not quantitatively screened for bioaccumulation potential since log K_{ow} values are not available for these chemicals. Although all Appendix IX metals are retained for evaluation in the upper trophic level food chain models, only mercury and selenium are known to biomagnify in food chains (in organic forms [Suter II, 1993]) and only cadmium, copper, and zinc generally have the potential to bioaccumulate significantly. The other metals are retained by default.

Appendix E References

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APPENDIX F
ProUCL CALCULATIONS FOR SURFACE SOIL

Arsenic: SWMU 74 - Fueling Piers Area Surface Soil

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	1.6	Minimum of Log Data	0.47
Maximum	21	Maximum of Log Data	3.045
Mean	5.093	Mean of log Data	1.395
Median	4.25	SD of log Data	0.644
SD	4.807		
Std. Error of Mean	1.285	Lognormal Distribution Test	
Coefficient of Variation	0.944	Shapiro Wilk Test Statistic	0.899
Skewness	3.152	Shapiro Wilk Critical Value	0.874
		Data appear Lognormal at 5% Significance Level	

Relevant UCL Statistics

Normal Distribution Test		Assuming Lognormal Distribution	
Shapiro Wilk Test Statistic	0.587	**95% H-UCL**	**7.447**
Shapiro Wilk Critical Value	0.874	95% Chebyshev (MVUE) UCL	8.699
Data not Normal at 5% Significance Level		97.5% Chebyshev (MVUE) UCL	10.35
		99% Chebyshev (MVUE) UCL	13.6
Assuming Normal Distribution			
95% Student's-t UCL	7.368	Data Distribution	
95% UCLs (Adjusted for Skewness)		Data appear Lognormal at 5% Significance Level	
95% Adjusted-CLT UCL (Chen-1995)	8.362		
95% Modified-t UCL (Johnson-1978)	7.548	Nonparametric Statistics	
		95% CLT UCL	7.206
Gamma Distribution Test		95% Jackknife UCL	7.368
k star (bias corrected)	1.853	95% Standard Bootstrap UCL	7.104
Theta Star	2.748	95% Bootstrap-t UCL	11.04
MLE of Mean	5.093	95% Hall's Bootstrap UCL	16.62
MLE of Standard Deviation	3.741	95% Percentile Bootstrap UCL	7.471
nu star	51.88	95% BCA Bootstrap UCL	8.693
Approximate Chi Square Value (.05)	36.34	95% Chebyshev(Mean, Sd) UCL	10.69
Adjusted Level of Significance	0.0312	97.5% Chebyshev(Mean, Sd) UCL	13.12
Adjusted Chi Square Value	34.62	99% Chebyshev(Mean, Sd) UCL	17.87
Anderson-Darling Test Statistic	0.907		
Anderson-Darling 5% Critical Value	0.745	**Potential UCL to use:**	
Kolmogorov-Smirnov Test Statistic	0.257	**95% H-UCL**	**7.447 mg/kg**
Kolmogorov-Smirnov 5% Critical Value	0.231		
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
95% Approximate Gamma UCL	7.271		
95% Adjusted Gamma UCL	7.633		

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cadmium: SWMU 74 - Fueling Piers Area Surface Soil

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	12

Raw Statistics		Log-transformed Statistics	
Minimum	0.047	Minimum of Log Data	-3.058
Maximum	1.8	Maximum of Log Data	0.588
Mean	0.44	Mean of log Data	-1.447
Median	0.18	SD of log Data	1.153
SD	0.531		
Std. Error of Mean	0.142	Lognormal Distribution Test	
Coefficient of Variation	1.209	Shapiro Wilk Test Statistic	0.934
Skewness	1.726	Shapiro Wilk Critical Value	0.874
		Data appear Lognormal at 5% Significance Level	

Relevant UCL Statistics			
Normal Distribution Test		Assuming Lognormal Distribution	
Shapiro Wilk Test Statistic	0.744	95% H-UCL	1.212
Shapiro Wilk Critical Value	0.874	95% Chebyshev (MVUE) UCL	1.056
Data not Normal at 5% Significance Level		97.5% Chebyshev (MVUE) UCL	1.328
		99% Chebyshev (MVUE) UCL	1.864
Assuming Normal Distribution			
95% Student's-t UCL	0.691	Data Distribution	
95% UCLs (Adjusted for Skewness)		Data appear Gamma Distributed at 5% Significance Level	
95% Adjusted-CLT UCL (Chen-1995)	0.743		
95% Modified-t UCL (Johnson-1978)	0.702	Nonparametric Statistics	
		95% CLT UCL	0.673
Gamma Distribution Test		95% Jackknife UCL	0.691
k star (bias corrected)	0.779	95% Standard Bootstrap UCL	0.665
Theta Star	0.565	95% Bootstrap-t UCL	0.89
MLE of Mean	0.44	95% Hall's Bootstrap UCL	0.898
MLE of Standard Deviation	0.498	95% Percentile Bootstrap UCL	0.67
nu star	21.8	95% BCA Bootstrap UCL	0.739
Approximate Chi Square Value (.05)	12.19	95% Chebyshev(Mean, Sd) UCL	1.059
Adjusted Level of Significance	0.0312	97.5% Chebyshev(Mean, Sd) UCL	1.327
Adjusted Chi Square Value	11.25	99% Chebyshev(Mean, Sd) UCL	1.853
Anderson-Darling Test Statistic	0.707		
Anderson-Darling 5% Critical Value	0.763	**Potential UCL to use:**	
Kolmogorov-Smirnov Test Statistic	0.236	**95% Approximate Gamma UCL**	**0.786 mg/kg**
Kolmogorov-Smirnov 5% Critical Value	0.236		
Data appear Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
95% Approximate Gamma UCL	**0.786**		
95% Adjusted Gamma UCL	0.852		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium: SWMU 74 - Fueling Piers Area Surface Soil

General Statistics

Number of Valid Observations	Number of Valid Observations	14	Number of Distinct Observations	13

Raw Statistics			Log-transformed Statistics	
Minimum	Minimum	4.2	Minimum of Log Data	1.435
Maximum	Maximum	27	Maximum of Log Data	3.296
Mean	Mean	12.9	Mean of log Data	2.449
Median	Median	11	SD of log Data	0.49
SD	SD	6.209		
Std. Error of Mean	Std. Error of Mean	1.659	Lognormal Distribution Test	
Coefficient of Variation	Coefficient of Variation	0.481	Shapiro Wilk Test Statistic	0.979
Skewness	Skewness	0.891	Shapiro Wilk Critical Value	0.874
			Data appear Lognormal at 5% Significance Level	
Relevant UCL Statistics				
Normal Distribution Test			Assuming Lognormal Distribution	
	Shapiro Wilk Test Statistic	0.933	95% H-UCL	17.16
	Shapiro Wilk Critical Value	0.874	95% Chebyshev (MVUE) UCL	20.53
Data appear Normal at 5% Significance Level			97.5% Chebyshev (MVUE) UCL	23.81
			99% Chebyshev (MVUE) UCL	30.26
Assuming Normal Distribution				
	95% Student's-t UCL	**15.84**	Data Distribution	
95% UCLs (Adjusted for Skewness)			Data appear Normal at 5% Significance Level	
	95% Adjusted-CLT UCL (Chen-1995)	16.05		
	95% Modified-t UCL (Johnson-1978)	15.9	Nonparametric Statistics	
			95% CLT UCL	15.63
Gamma Distribution Test			95% Jackknife UCL	15.84
	k star (bias corrected)	3.819	95% Standard Bootstrap UCL	15.62
	Theta Star	3.378	95% Bootstrap-t UCL	16.45
	MLE of Mean	12.9	95% Hall's Bootstrap UCL	16.33
	MLE of Standard Deviation	6.601	95% Percentile Bootstrap UCL	15.59
	nu star	106.9	95% BCA Bootstrap UCL	16.1
	Approximate Chi Square Value (.05)	84.07	95% Chebyshev(Mean, Sd) UCL	20.13
	Adjusted Level of Significance	0.0312	97.5% Chebyshev(Mean, Sd) UCL	23.26
	Adjusted Chi Square Value	81.38	99% Chebyshev(Mean, Sd) UCL	29.41
	Anderson-Darling Test Statistic	0.225		
	Anderson-Darling 5% Critical Value	0.738	**Potential UCL to use:**	
	Kolmogorov-Smirnov Test Statistic	0.145	**95% Student's-t UCL**	**15.84 mg/kg**
	Kolmogorov-Smirnov 5% Critical Value	0.229		
Data appear Gamma Distributed at 5% Significance Level				
Assuming Gamma Distribution				
	95% Approximate Gamma UCL	16.41		
	95% Adjusted Gamma UCL	16.95		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Copper: SWMU 74 - Fueling Piers Area Surface Soil

General Statistics

Number of Valid Observations	14
Number of Distinct Observations	13

Raw Statistics

Minimum	9.3
Maximum	550
Mean	65.52
Median	22
SD	140.4
Std. Error of Mean	37.53
Coefficient of Variation	2.143
Skewness	3.653

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.398
Shapiro Wilk Critical Value	0.874

Data not Normal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	132

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	166.4
95% Modified-t UCL (Johnson-1978)	138.1

Gamma Distribution Test

k star (bias corrected)	0.641
Theta Star	102.2
MLE of Mean	65.52
MLE of Standard Deviation	81.82
nu star	17.95
Approximate Chi Square Value (.05)	9.357
Adjusted Level of Significance	0.0312
Adjusted Chi Square Value	8.544
Anderson-Darling Test Statistic	1.861
Anderson-Darling 5% Critical Value	0.77
Kolmogorov-Smirnov Test Statistic	0.31
Kolmogorov-Smirnov 5% Critical Value	0.238

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	125.7
95% Adjusted Gamma UCL	137.7

Log-transformed Statistics

Minimum of Log Data	2.23
Maximum of Log Data	6.31
Mean of log Data	3.391
SD of log Data	1.03

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.827
Shapiro Wilk Critical Value	0.874

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL	113.7
95% Chebyshev (MVUE) UCL	110.4
97.5% Chebyshev (MVUE) UCL	137.5
99% Chebyshev (MVUE) UCL	190.6

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL	127.2
95% Jackknife UCL	132
95% Standard Bootstrap UCL	125.6
95% Bootstrap-t UCL	461.5
95% Hall's Bootstrap UCL	396.2
95% Percentile Bootstrap UCL	138.2
95% BCA Bootstrap UCL	180.1
95% Chebyshev(Mean, Sd) UCL	**229.1**
97.5% Chebyshev(Mean, Sd) UCL	299.9
99% Chebyshev(Mean, Sd) UCL	438.9

Potential UCL to use:	
95% Chebyshev (Mean, Sd) UCL	**229.1 mg/kg**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Lead: SWMU 74 - Fueling Piers Area Surface Soil

General Statistics			
Number of Valid Observations	12	Number of Distinct Observations	11
Number of Missing Values	2		

Raw Statistics		Log-transformed Statistics	
Minimum	3.5	Minimum of Log Data	1.253
Maximum	120	Maximum of Log Data	4.787
Mean	32.46	Mean of log Data	2.88
Median	20.4	SD of log Data	1.193
SD	35.55		
Std. Error of Mean	10.26		
Coefficient of Variation	1.095		
Skewness	1.547		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.801	Shapiro Wilk Test Statistic	0.913
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	50.89	95% H-UCL	117.9
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	87.21
95% Adjusted-CLT UCL (Chen-1995)	54.24	97.5% Chebyshev (MVUE) UCL	110.6
95% Modified-t UCL (Johnson-1978)	51.65	99% Chebyshev (MVUE) UCL	156.5

Data Distribution

Data Follow Appr. Gamma Distribution at 5% Significance Level

Gamma Distribution Test		Nonparametric Statistics	
k star (bias corrected)	0.78	95% CLT UCL	49.34
Theta Star	41.61	95% Jackknife UCL	50.89
MLE of Mean	32.46	95% Standard Bootstrap UCL	48.87
MLE of Standard Deviation	36.75	95% Bootstrap-t UCL	62.25
nu star	18.72	95% Hall's Bootstrap UCL	62.38
Approximate Chi Square Value (.05)	9.913	95% Percentile Bootstrap UCL	49.63
Adjusted Level of Significance	0.029	95% BCA Bootstrap UCL	53.58
Adjusted Chi Square Value	8.95	95% Chebyshev(Mean, Sd) UCL	77.19
Anderson-Darling Test Statistic	0.577	97.5% Chebyshev(Mean, Sd) UCL	96.55
Anderson-Darling 5% Critical Value	0.758	99% Chebyshev(Mean, Sd) UCL	134.6
Kolmogorov-Smirnov Test Statistic	0.255		
Kolmogorov-Smirnov 5% Critical Value	0.253		
Data follow Appr. Gamma Distribution at 5% Significance Level			

Potential UCL to use:	
95% Approximate Gamma UCL:	**61.29 mg/kg**

Assuming Gamma Distribution	
95% Approximate Gamma UCL	**61.29**
95% Adjusted Gamma UCL	67.89

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mercury: SWMU 74 - Fueling Piers Area Surface Soil

General Statistics

Number of Valid Data	14
Number of Distinct Detected Data	11
Number of Detected Data	11
Number of Non-Detect Data	3
Percent Non-Detects	21.43%

Raw Statistics

Minimum Detected	0.0085
Maximum Detected	0.21
Mean of Detected	0.0315
SD of Detected	0.0594
Minimum Non-Detect	0.02
Maximum Non-Detect	0.021

Log-transformed Statistics

Minimum Detected	-4.768
Maximum Detected	-1.561
Mean of Detected	-4.096
SD of Detected	0.899
Minimum Non-Detect	-3.912
Maximum Non-Detect	-3.863

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	12
Number treated as Detected	2
Single DL Non-Detect Percentage	85.71%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.412
5% Shapiro Wilk Critical Value	0.85

Data not Normal at 5% Significance Level

Assuming Normal Distribution
DL/2 Substitution Method

Mean	0.0269
SD	0.0529
95% DL/2 (t) UCL	0.0519

Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.727
Theta Star	0.0433
nu star	15.99
A-D Test Statistic	2.151
5% A-D Critical Value	0.755
K-S Test Statistic	0.755
5% K-S Critical Value	0.263

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution
Gamma ROS Statistics using Extrapolated Data

Minimum	0.00238
Maximum	0.21
Mean	0.0282
Median	0.0132
SD	0.0529
k star	0.768
Theta star	0.0367
Nu star	21.5
AppChi2	11.96
95% Gamma Approximate UCL	0.0506
95% Adjusted Gamma UCL	0.0549

Note: DL/2 is not a recommended method.

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.678
5% Shapiro Wilk Critical Value	0.85

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution
DL/2 Substitution Method

Mean	-4.198
SD	0.815
95% H-Stat (DL/2) UCL	0.0368

Log ROS Method

Mean in Log Scale	-4.149
SD in Log Scale	0.804
Mean in Original Scale	0.0276
SD in Original Scale	0.0527
95% t UCL	0.0525
95% Percentile Bootstrap UCL	0.0554
95% BCA Bootstrap UCL	0.0695
95% H-UCL	0.0379

Data Distribution Test with Detected Values Only
Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics
Kaplan-Meier (KM) Method

Mean	0.0274
SD	0.0508
SE of Mean	0.0143
95% KM (t) UCL	0.0526
95% KM (z) UCL	0.0508
95% KM (jackknife) UCL	0.0523
95% KM (bootstrap t) UCL	0.236
95% KM (BCA) UCL	**0.0564**
95% KM (Percentile Bootstrap) UCL	0.0547
95% KM (Chebyshev) UCL	0.0895
97.5% KM (Chebyshev) UCL	0.116
99% KM (Chebyshev) UCL	0.169

Potential UCLs to use:	
95% KM (BCA) UCL	**0.0564 mg/kg**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Nickel: SWMU 74 - Fueling Piers Area Surface Soil

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	2.2	Minimum of Log Data	0.788
Maximum	27	Maximum of Log Data	3.296
Mean	6.621	Mean of log Data	1.656
Median	4.25	SD of log Data	0.633
SD	6.26		
Std. Error of Mean	1.673	Lognormal Distribution Test	
Coefficient of Variation	0.945	Shapiro Wilk Test Statistic	0.896
Skewness	3.005	Shapiro Wilk Critical Value	0.874
		Data appear Lognormal at 5% Significance Level	
Relevant UCL Statistics			
Normal Distribution Test		Assuming Lognormal Distribution	
Shapiro Wilk Test Statistic	0.607	**95% H-UCL**	**9.511**
Shapiro Wilk Critical Value	0.874	95% Chebyshev (MVUE) UCL	11.14
Data not Normal at 5% Significance Level		97.5% Chebyshev (MVUE) UCL	13.23
		99% Chebyshev (MVUE) UCL	17.34
Assuming Normal Distribution			
95% Student's-t UCL	9.584	Data Distribution	
95% UCLs (Adjusted for Skewness)		Data appear Lognormal at 5% Significance Level	
95% Adjusted-CLT UCL (Chen-1995)	10.81		
95% Modified-t UCL (Johnson-1978)	9.808	Nonparametric Statistics	
		95% CLT UCL	9.373
Gamma Distribution Test		95% Jackknife UCL	9.584
k star (bias corrected)	1.847	95% Standard Bootstrap UCL	9.271
Theta Star	3.585	95% Bootstrap-t UCL	13.92
MLE of Mean	6.621	95% Hall's Bootstrap UCL	19.2
MLE of Standard Deviation	4.872	95% Percentile Bootstrap UCL	9.486
nu star	51.72	95% BCA Bootstrap UCL	11.27
Approximate Chi Square Value (.05)	36.2	95% Chebyshev(Mean, Sd) UCL	13.91
Adjusted Level of Significance	0.0312	97.5% Chebyshev(Mean, Sd) UCL	17.07
Adjusted Chi Square Value	34.48	99% Chebyshev(Mean, Sd) UCL	23.27
Anderson-Darling Test Statistic	0.962		
Anderson-Darling 5% Critical Value	0.745	**Potential UCL to use:**	
Kolmogorov-Smirnov Test Statistic	0.236	**95% H-UCL**	**9.511 mg/kg**
Kolmogorov-Smirnov 5% Critical Value	0.231		
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
95% Approximate Gamma UCL	9.46		
95% Adjusted Gamma UCL	9.931		

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Vanadium: SWMU 74 - Fueling Piers Area Surface Soil

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	13	Minimum of Log Data	2.565
Maximum	64	Maximum of Log Data	4.159
Mean	36.14	Mean of log Data	3.47
Median	32.5	SD of log Data	0.516
SD	17.48		
Std. Error of Mean	4.671	Lognormal Distribution Test	
Coefficient of Variation	0.484	Shapiro Wilk Test Statistic	0.945
Skewness	0.404	Shapiro Wilk Critical Value	0.874
		Data appear Lognormal at 5% Significance Level	
Relevant UCL Statistics			
Normal Distribution Test		Assuming Lognormal Distribution	
Shapiro Wilk Test Statistic	0.919	95% H-UCL	49.08
Shapiro Wilk Critical Value	0.874	95% Chebyshev (MVUE) UCL	58.83
Data appear Normal at 5% Significance Level		97.5% Chebyshev (MVUE) UCL	68.56
		99% Chebyshev (MVUE) UCL	87.68
Assuming Normal Distribution			
95% Student's-t UCL	**44.42**	Data Distribution	
95% UCLs (Adjusted for Skewness)		Data appear Normal at 5% Significance Level	
95% Adjusted-CLT UCL (Chen-1995)	44.37		
95% Modified-t UCL (Johnson-1978)	44.5	Nonparametric Statistics	
		95% CLT UCL	43.83
Gamma Distribution Test		95% Jackknife UCL	44.42
k star (bias corrected)	3.513	95% Standard Bootstrap UCL	43.48
Theta Star	10.29	95% Bootstrap-t UCL	45.49
MLE of Mean	36.14	95% Hall's Bootstrap UCL	43.64
MLE of Standard Deviation	19.28	95% Percentile Bootstrap UCL	43.86
nu star	98.37	95% BCA Bootstrap UCL	44.5
Approximate Chi Square Value (.05)	76.49	95% Chebyshev(Mean, Sd) UCL	56.51
Adjusted Level of Significance	0.0312	97.5% Chebyshev(Mean, Sd) UCL	65.32
Adjusted Chi Square Value	73.93	99% Chebyshev(Mean, Sd) UCL	82.62
Anderson-Darling Test Statistic	0.317		
Anderson-Darling 5% Critical Value	0.739	**Potential UCL to use:**	
Kolmogorov-Smirnov Test Statistic	0.145	**95% Student's-t UCL**	**44.42 mg/kg**
Kolmogorov-Smirnov 5% Critical Value	0.23		
Data appear Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
95% Approximate Gamma UCL	46.48		
95% Adjusted Gamma UCL	48.09		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Zinc: SWMU 74 - Fueling Piers Area Surface Soil

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	14

Raw Statistics		Log-transformed Statistics	
Minimum	12	Minimum of Log Data	2.485
Maximum	920	Maximum of Log Data	6.824
Mean	135.8	Mean of log Data	4.128
Median	38.5	SD of log Data	1.159
SD	238		
Std. Error of Mean	63.6	Lognormal Distribution Test	
Coefficient of Variation	1.752	Shapiro Wilk Test Statistic	0.906
Skewness	3.159	Shapiro Wilk Critical Value	0.874
		Data appear Lognormal at 5% Significance Level	

Relevant UCL Statistics

Normal Distribution Test		Assuming Lognormal Distribution	
Shapiro Wilk Test Statistic	0.531	95% H-UCL	325.3
Shapiro Wilk Critical Value	0.874	95% Chebyshev (MVUE) UCL	281.5
Data not Normal at 5% Significance Level		97.5% Chebyshev (MVUE) UCL	354.3
		99% Chebyshev (MVUE) UCL	497.4

Assuming Normal Distribution		Data Distribution	
95% Student's-t UCL	248.4		
95% UCLs (Adjusted for Skewness)		Data appear Lognormal at 5% Significance Level	
95% Adjusted-CLT UCL (Chen-1995)	297.8		
95% Modified-t UCL (Johnson-1978)	257.4	Nonparametric Statistics	

Gamma Distribution Test			
		95% CLT UCL	240.4
		95% Jackknife UCL	248.4
k star (bias corrected)	0.647	95% Standard Bootstrap UCL	236.3
Theta Star	209.8	95% Bootstrap-t UCL	474.6
MLE of Mean	135.8	95% Hall's Bootstrap UCL	563.4
MLE of Standard Deviation	168.8	95% Percentile Bootstrap UCL	245.4
nu star	18.12	95% BCA Bootstrap UCL	311.8
Approximate Chi Square Value (.05)	9.476	**95% Chebyshev(Mean, Sd) UCL**	**413**
Adjusted Level of Significance	0.0312	97.5% Chebyshev(Mean, Sd) UCL	532.9
Adjusted Chi Square Value	8.658	99% Chebyshev(Mean, Sd) UCL	768.6
Anderson-Darling Test Statistic	1.228		
Anderson-Darling 5% Critical Value	0.77	**Potential UCL to use:**	
Kolmogorov-Smirnov Test Statistic	0.282	**95% Chebyshev (Mean, Sd) UCL:**	**413 mg/kg**
Kolmogorov-Smirnov 5% Critical Value	0.237		
Data not Gamma Distributed at 5% Significance Level			

Assuming Gamma Distribution	
95% Approximate Gamma UCL	259.6
95% Adjusted Gamma UCL	284.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

APPENDIX G
STATISTICAL EVALUATION FOR SURFACE SOIL

Two-Sample Test Report

Page/Date/Time 1 6/28/2011 8:30:33 AM
Database
Variable Arsenic

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean	
area=1SWMU 74	14	5.092857	4.80664	1.284629	2.317586	7.868129	
area=2NAPR Background		20	1.1765	0.7622096	0.1704352	0.8197749	1.533

Note: T-alpha (area=1SWMU 74) = 2.1604, T-alpha (area=2NAPR Background) = 2.0930

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	32	3.916357	3.119433	1.087016	1.702177	6.130537
Unequal	13.46	3.916357	4.866699	1.295885	1.126438	6.706276

Note: T-alpha (Equal) = 2.0369, T-alpha (Unequal) = 2.1529

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	3.6029	0.001053	Reject H0	0.937338	0.799126
Difference < 0	3.6029	0.999473	Accept H0	0.000000	0.000000
Difference > 0	3.6029	0.000527	Reject H0	0.969966	0.869089

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	3.0221	0.009489	Reject H0	0.799869	0.529988
Difference < 0	3.0221	0.995255	Accept H0	0.000003	0.000000
Difference > 0	3.0221	0.004745	Reject H0	0.888813	0.651392

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)	
Skewness Normality (area=1SWMU 74)	4.1661	0.000031	Reject normality	
Kurtosis Normality (area=1SWMU 74)	3.7621	0.000168	Reject normality	
Omnibus Normality (area=1SWMU 74)	31.5103	0.000000	Reject normality	
Skewness Normality (area=2NAPR Background)		0.6231	0.533202	Cannot reject normality
Kurtosis Normality (area=2NAPR Background)		-2.1066	0.035149	Reject normality
Omnibus Normality (area=2NAPR Background)		4.8262	0.089538	Cannot reject normality
Variance-Ratio Equal-Variance Test	39.7681	0.000000	Reject equal variances	
Modified-Levene Equal-Variance Test	2.9608	0.094965	Cannot reject equal variances	

Two-Sample Test Report

Page/Date/Time 2 6/28/2011 8:30:33 AM
Database
Variable Arsenic

Median Statistics

Variable	Count	Median	95% LCL of Median	95% UCL of Median
area=1SWMU 74	14	4.25	2	5.1
area=2NAPR Background	20	1.15	0.415	1.8

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
area=1SWMU 74	264	369	245	28.57301
area=2NAPR Background	16	226	350	28.57301

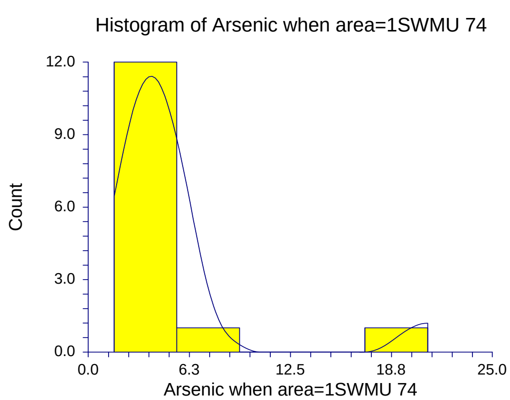
Number Sets of Ties = 2, Multiplicity Factor = 12

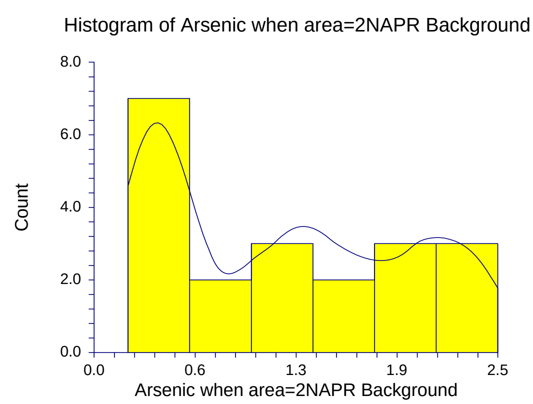
	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			4.3398	0.000014	Reject H0	4.3223	0.000015	Reject H0
Diff<0			4.3398	0.999993	Accept H0	4.3573	0.999993	Accept H0
Diff>0			4.3398	0.000007	Reject H0	4.3223	0.000008	Reject H0

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.785714	0.4466	.050	Reject H0	0.0000
D(1)<D(2)	0.000000	0.4466	.025	Accept H0	
D(1)>D(2)	0.785714	0.4466	.025	Reject H0	

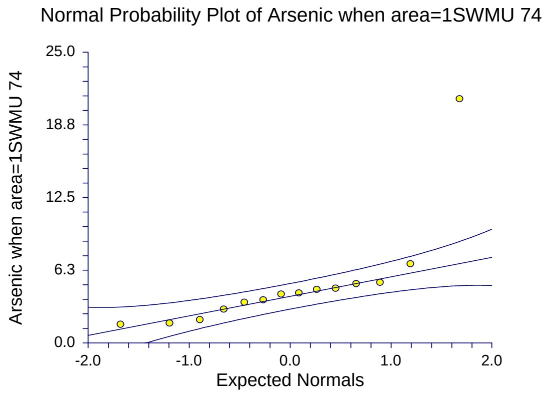
Plots Section

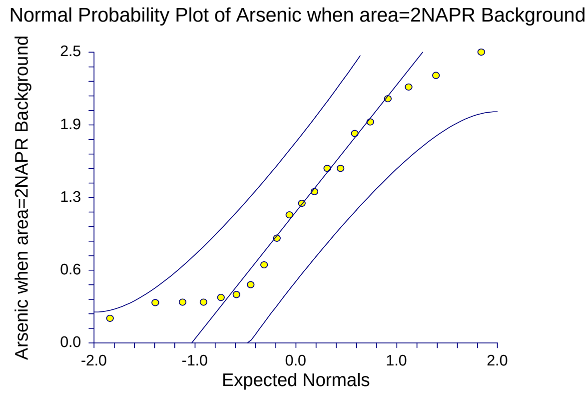


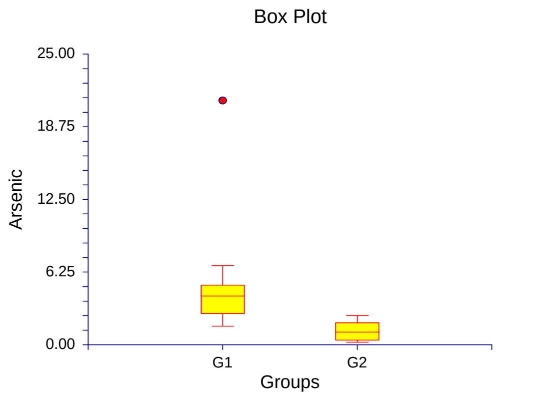


Two-Sample Test Report

Page/Date/Time 3 6/28/2011 8:30:33 AM
Database
Variable Arsenic







Two-Sample Test Report

Page/Date/Time	4	6/28/2011 8:30:33 AM
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Variable	Copper	

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean	
area=1SWMU 74	14	65.52143	140.4098	37.52608	-15.54875	146.5916	
area=2NAPR Background		18	77.11111	46.72511	11.01322	53.87526	100.3

Note: T-alpha (area=1SWMU 74) = 2.1604, T-alpha (area=2NAPR Background) = 2.1098

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	30	-11.58968	98.89535	35.24119	-83.5618	60.38243
Unequal	15.25	-11.58968	147.9802	39.1088	-94.82955	71.65018

Note: T-alpha (Equal) = 2.0423, T-alpha (Unequal) = 2.1284

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-0.3289	0.744541	Accept H0	0.061698	0.013713
Difference < 0	-0.3289	0.372270	Accept H0	0.092861	0.022113
Difference > 0	-0.3289	0.627730	Accept H0	0.024626	0.004135

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-0.2963	0.770965	Accept H0	0.058910	0.012694
Difference < 0	-0.2963	0.385482	Accept H0	0.086689	0.019942
Difference > 0	-0.2963	0.614518	Accept H0	0.026902	0.004687

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)	
Skewness Normality (area=1SWMU 74)	4.5693	0.000005	Reject normality	
Kurtosis Normality (area=1SWMU 74)	4.0651	0.000048	Reject normality	
Omnibus Normality (area=1SWMU 74)	37.4037	0.000000	Reject normality	
Skewness Normality (area=2NAPR Background)		1.7178	0.085828	Cannot reject normality
Kurtosis Normality (area=2NAPR Background)		0.6069	0.543938	Cannot reject normality
Omnibus Normality (area=2NAPR Background)		3.3192	0.190213	Cannot reject normality
Variance-Ratio Equal-Variance Test	9.0301	0.000061	Reject equal variances	
Modified-Levene Equal-Variance Test	0.2464	0.623255	Cannot reject equal variances	

Two-Sample Test Report

Page/Date/Time 5 6/28/2011 8:30:33 AM
Database
Variable Copper

Median Statistics

Variable	Count	Median	95% LCL of Median	95% UCL of Median
area=1SWMU 74	14	22	14	48
area=2NAPR Background	18	66.5	43	100

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
area=1SWMU 74	52	157	231	26.32007
area=2NAPR Background	200	371	297	26.32007

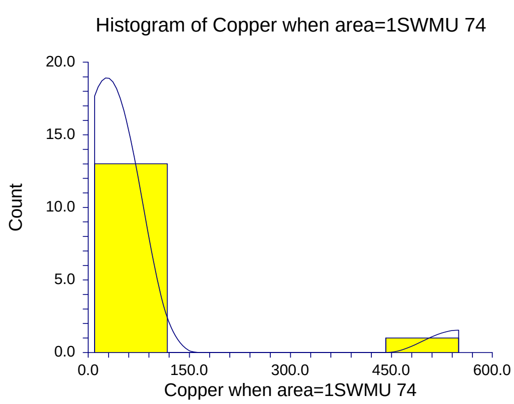
Number Sets of Ties = 2, Multiplicity Factor = 12

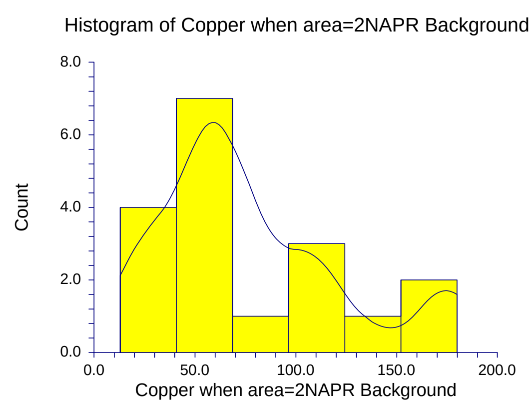
Alternative Hypothesis	Exact Probability Prob Level	Exact Probability Decision (5%)	Approximation Without Correction Z-Value	Approximation Without Correction Prob Level	Approximation Without Correction Decision (5%)	Approximation With Correction Z-Value	Approximation With Correction Prob Level	Approximation With Correction Decision (5%)
Diff<>0			-2.8115	0.004930	Reject H0	-2.7925	0.005230	Reject H0
Diff<0			-2.8115	0.002465	Reject H0	-2.7925	0.002615	Reject H0
Diff>0			-2.8115	0.997535	Accept H0	-2.8305	0.997677	Accept H0

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.579365	0.4563	.050	Reject H0	0.0058
D(1)<D(2)	0.579365	0.4563	.025	Reject H0	
D(1)>D(2)	0.071429	0.4563	.025	Accept H0	

Plots Section





Two-Sample Test Report

Page/Date/Time 6 6/28/2011 8:30:33 AM
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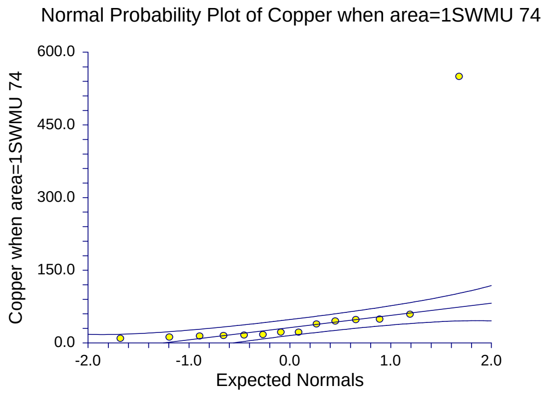
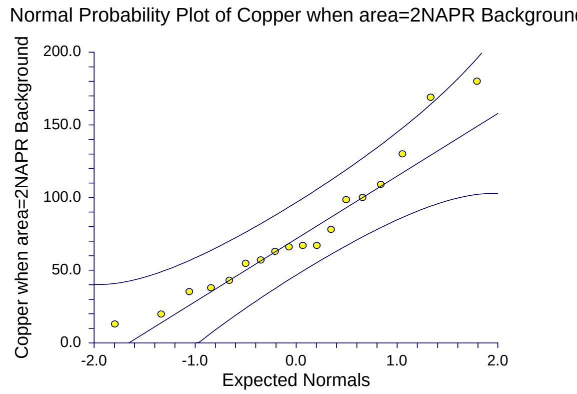
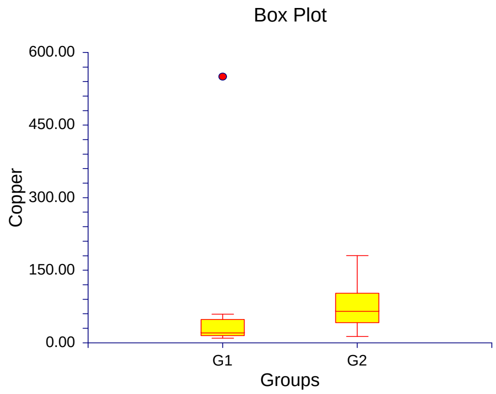
Variable Copper







Two-Sample Test Report

Page/Date/Time 7 6/28/2011 8:30:33 AM
Database
Variable Mercury

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean	
area=1SWMU 74	14	2.692857E-02	5.285452E-02	1.412597E-02	-3.588722E-03	5.744587E-02	
area=2NAPR Background		20	0.0516	2.960334E-02	6.619509E-03	3.774521E-02	6.545

Note: T-alpha (area=1SWMU 74) = 2.1604, T-alpha (area=2NAPR Background) = 2.0930

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	32	-2.467143E-02	4.068461E-02	1.417721E-02	-5.354945E-02	4.206594E-03
Unequal	18.72	-2.467143E-02	6.058018E-02	1.560003E-02	-0.0573559	8.013047E-03

Note: T-alpha (Equal) = 2.0369, T-alpha (Unequal) = 2.0952

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-1.7402	0.091431	Accept H0	0.392959	0.177603
Difference < 0	-1.7402	0.045716	Reject H0	0.523291	0.254902
Difference > 0	-1.7402	0.954284	Accept H0	0.000405	0.000032

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-1.5815	0.130514	Accept H0	0.323289	0.129162
Difference < 0	-1.5815	0.065257	Accept H0	0.451935	0.195683
Difference > 0	-1.5815	0.934743	Accept H0	0.000758	0.000072

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)	
Skewness Normality (area=1SWMU 74)	4.6061	0.000004	Reject normality	
Kurtosis Normality (area=1SWMU 74)	4.0924	0.000043	Reject normality	
Omnibus Normality (area=1SWMU 74)	37.9643	0.000000	Reject normality	
Skewness Normality (area=2NAPR Background)		0.7951	0.426537	Cannot reject normality
Kurtosis Normality (area=2NAPR Background)		0.0472	0.962376	Cannot reject normality
Omnibus Normality (area=2NAPR Background)		0.6345	0.728163	Cannot reject normality
Variance-Ratio Equal-Variance Test	3.1877	0.021797	Reject equal variances	
Modified-Levene Equal-Variance Test	0.3465	0.560231	Cannot reject equal variances	

Two-Sample Test Report

Page/Date/Time	8 6/28/2011 8:30:33 AM
Database	
Variable	Mercury

Median Statistics

Variable	Count	Median	95% LCL of Median	95% UCL of Median
area=1SWMU 74	14	0.01125	0.0093	0.016
area=2NAPR Background	20	0.054	0.03	0.07

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
area=1SWMU 74	45	150	245	28.52494
area=2NAPR Background	235	445	350	28.52494

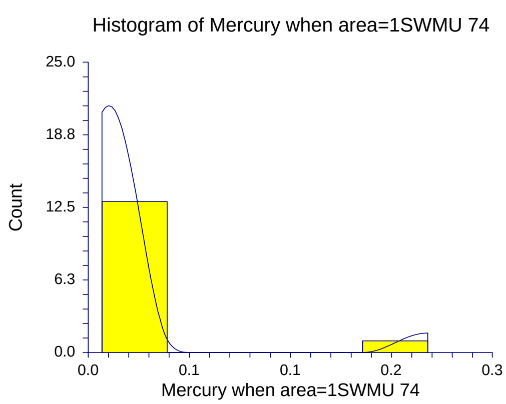
Number Sets of Ties = 6, Multiplicity Factor = 144

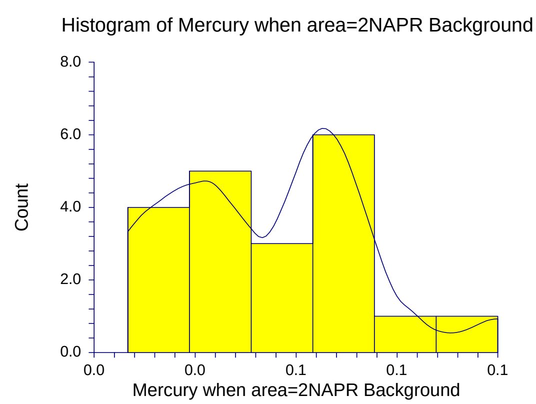
Alternative Hypothesis	Exact Probability Prob Level	Exact Probability Decision (5%)	Approximation Without Correction Z-Value	Approximation Without Correction Prob Level	Approximation Without Correction Decision (5%)	Approximation With Correction Z-Value	Approximation With Correction Prob Level	Approximation With Correction Decision (5%)
Diff<>0			-3.3304	0.000867	Reject H0	-3.3129	0.000923	Reject H0
Diff<0			-3.3304	0.000434	Reject H0	-3.3129	0.000462	Reject H0
Diff>0			-3.3304	0.999566	Accept H0	-3.3479	0.999593	Accept H0

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.728571	0.4466	.050	Reject H0	0.0001
D(1)<D(2)	0.728571	0.4466	.025	Reject H0	
D(1)>D(2)	0.071429	0.4466	.025	Accept H0	

Plots Section





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Page/Date/Time 9 6/28/2011 8:30:33 AM
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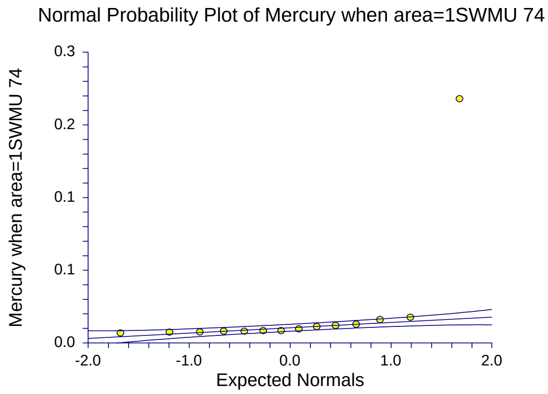
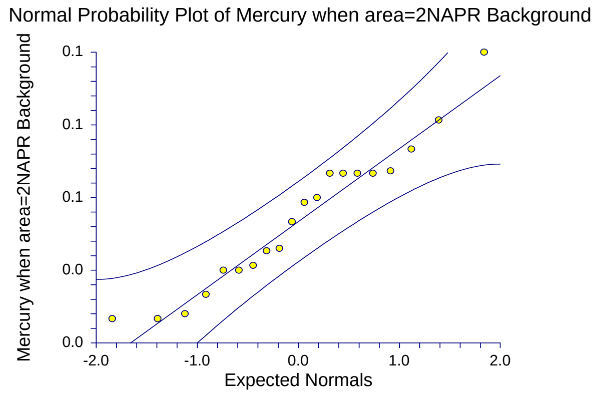
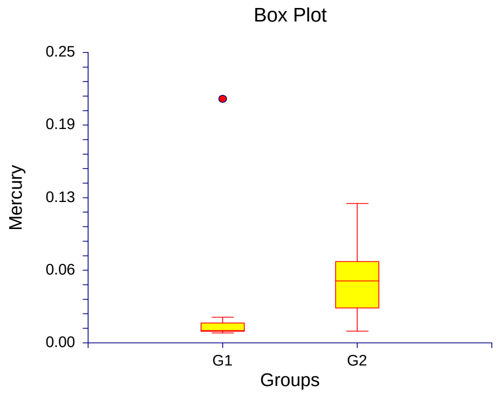
Variable Mercury







Two-Sample Test Report

Page/Date/Time 10 6/28/2011 8:30:33 AM
Database
Variable Vanadium

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean	
area=1SWMU 74	14	36.14286	17.47903	4.671467	26.05077	46.23495	
area=2NAPR Background	18	141.5667	58.77063	13.85237	112.3407	170.7	

Note: T-alpha (area=1SWMU 74) = 2.1604, T-alpha (area=2NAPR Background) = 2.1098

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	30	-105.4238	45.71269	16.28964	-138.6917	-72.15593
Unequal	20.74	-105.4238	61.31479	14.61885	-135.849	-74.99865

Note: T-alpha (Equal) = 2.0423, T-alpha (Unequal) = 2.0812

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-6.4718	0.000000	Reject H0	0.999991	0.999785
Difference < 0	-6.4718	0.000000	Reject H0	0.999999	0.999938
Difference > 0	-6.4718	1.000000	Accept H0	0.000000	0.000000

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-7.2115	0.000000	Reject H0	0.999999	0.999970
Difference < 0	-7.2115	0.000000	Reject H0	1.000000	0.999994
Difference > 0	-7.2115	1.000000	Accept H0	0.000000	0.000000

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (area=1SWMU 74)	0.7069	0.479659	Cannot reject normality
Kurtosis Normality (area=1SWMU 74)	-1.3210	0.186511	Cannot reject normality
Omnibus Normality (area=1SWMU 74)	2.2446	0.325530	Cannot reject normality
Skewness Normality (area=2NAPR Background)	-0.1157	0.907918	Cannot reject normality
Kurtosis Normality (area=2NAPR Background)	-1.1914	0.233499	Cannot reject normality
Omnibus Normality (area=2NAPR Background)	1.4328	0.488508	Cannot reject normality
Variance-Ratio Equal-Variance Test	11.3054	0.000071	Reject equal variances
Modified-Levene Equal-Variance Test	14.2334	0.000710	Reject equal variances

Two-Sample Test Report

Page/Date/Time 11 6/28/2011 8:30:33 AM
Database
Variable Vanadium

Median Statistics

Variable	Count	Median	95% LCL of Median	95% UCL of Median
area=1SWMU 74	14	32.5	18	48
area=2NAPR Background	18	151.5	84.2	180

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
area=1SWMU 74	6	111	231	26.32007
area=2NAPR Background	246	417	297	26.32007

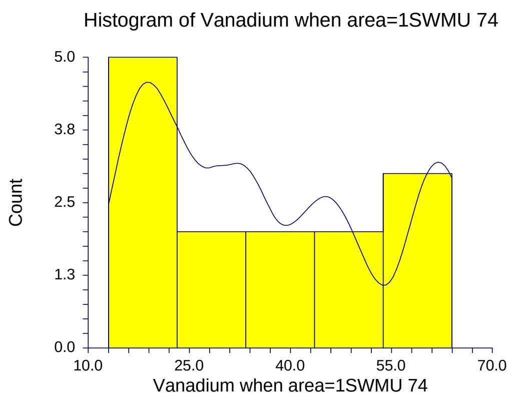
Number Sets of Ties = 2, Multiplicity Factor = 12

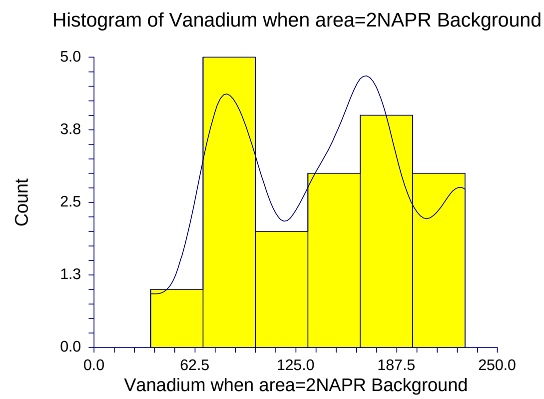
Alternative Hypothesis	Exact Probability Prob Level	Decision (5%)	Approximation Without Correction Z-Value	Prob Level	Decision (5%)	Approximation With Correction Z-Value	Prob Level	Decision (5%)
Diff<>0			-4.5593	0.000005	Reject H0	-4.5403	0.000006	Reject H0
Diff<0			-4.5593	0.000003	Reject H0	-4.5403	0.000003	Reject H0
Diff>0			-4.5593	0.999997	Accept H0	-4.5783	0.999998	Accept H0

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.944444	0.4563	.050	Reject H0	0.0000
D(1)<D(2)	0.944444	0.4563	.025	Reject H0	
D(1)>D(2)	0.000000	0.4563	.025	Accept H0	

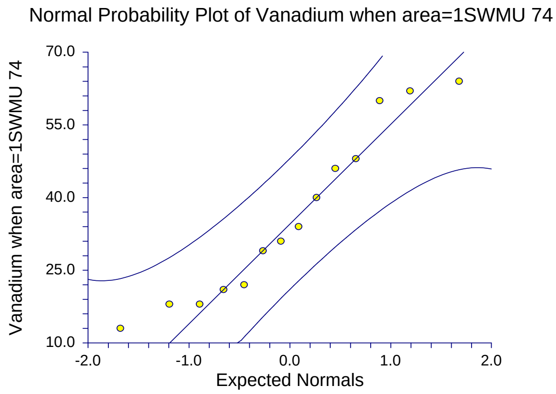
Plots Section

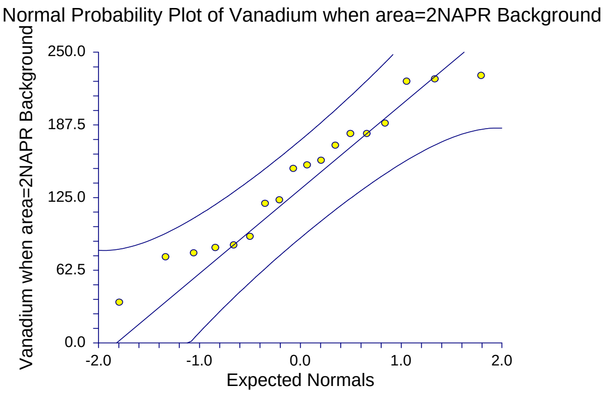


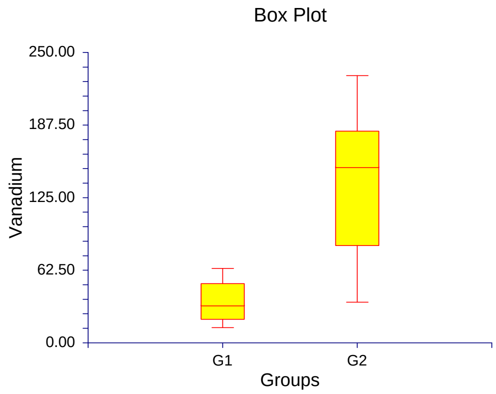


Two-Sample Test Report

Page/Date/Time 12 6/28/2011 8:30:33 AM
Database
Variable Vanadium







Two-Sample Test Report

Page/Date/Time 13 6/28/2011 8:30:33 AM
Database
Variable logZn

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean	
area=1SWMU 74	14	1.792886	0.5033795	0.1345338	1.502243	2.083528	
area=2NAPR Background		18	1.624961	0.3263568	7.692304E-02	1.462668	1.787

Note: T-alpha (area=1SWMU 74) = 2.1604, T-alpha (area=2NAPR Background) = 2.1098

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	30	0.1679246	0.4125018	0.1469943	-0.1322778	0.468127
Unequal	21.16	0.1679246	0.5999163	0.1549726	-0.1542102	0.4900593

Note: T-alpha (Equal) = 2.0423, T-alpha (Unequal) = 2.0787

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	1.1424	0.262328	Accept H0	0.197661	0.067561
Difference < 0	1.1424	0.868836	Accept H0	0.002872	0.000314
Difference > 0	1.1424	0.131164	Accept H0	0.298678	0.108475

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	1.0836	0.290746	Accept H0	0.178840	0.057877
Difference < 0	1.0836	0.854627	Accept H0	0.003521	0.000412
Difference > 0	1.0836	0.145373	Accept H0	0.275639	0.095027

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (area=1SWMU 74)	1.7313	0.083393	Cannot reject normality
Kurtosis Normality (area=1SWMU 74)	0.8970	0.369730	Cannot reject normality
Omnibus Normality (area=1SWMU 74)	3.8021	0.149414	Cannot reject normality
Skewness Normality (area=2NAPR Background)	-1.7679	0.077077	Cannot reject normality
Kurtosis Normality (area=2NAPR Background)	1.2303	0.218577	Cannot reject normality
Omnibus Normality (area=2NAPR Background)	4.6392	0.098314	Cannot reject normality
Variance-Ratio Equal-Variance Test	2.3791	0.095824	Cannot reject equal variances
Modified-Levene Equal-Variance Test	1.1888	0.284248	Cannot reject equal variances

Two-Sample Test Report

Page/Date/Time 14 6/28/2011 8:30:33 AM
Database
Variable logZn

Median Statistics

Variable	Count	Median	95% LCL of Median	95% UCL of Median
area=1SWMU 74	14	1.58515	1.4472	2.0414
area=2NAPR Background	18	1.6717	1.5315	1.8209

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
area=1SWMU 74	132.5	237.5	231	26.31766
area=2NAPR Background	119.5	290.5	297	26.31766

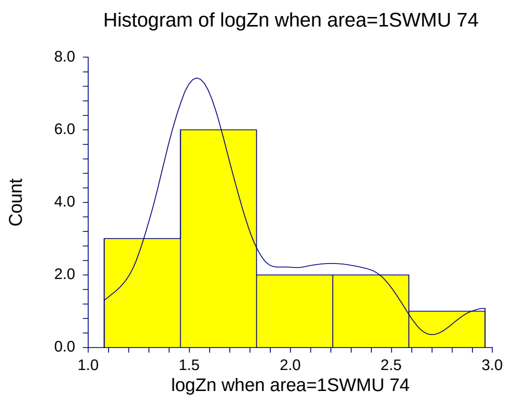
Number Sets of Ties = 3, Multiplicity Factor = 18

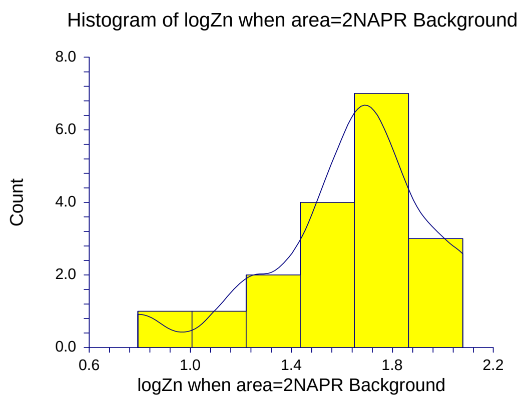
	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			0.2470	0.804922	Accept H0	0.2280	0.819659	Accept H0
Diff<0			0.2470	0.597539	Accept H0	0.2660	0.604873	Accept H0
Diff>0			0.2470	0.402461	Accept H0	0.2280	0.409829	Accept H0

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.230159	0.4563	.050	Accept H0	0.7056
D(1)<D(2)	0.182540	0.4563	.025	Accept H0	
D(1)>D(2)	0.230159	0.4563	.025	Accept H0	

Plots Section





Two-Sample Test Report

Page/Date/Time 15 6/28/2011 8:30:33 AM
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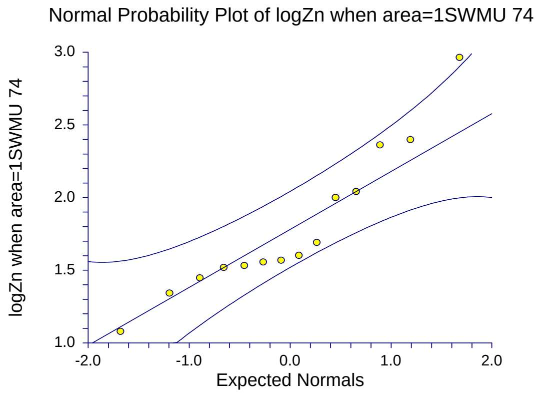
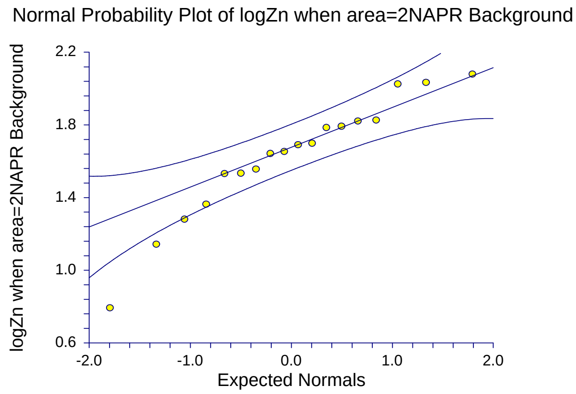
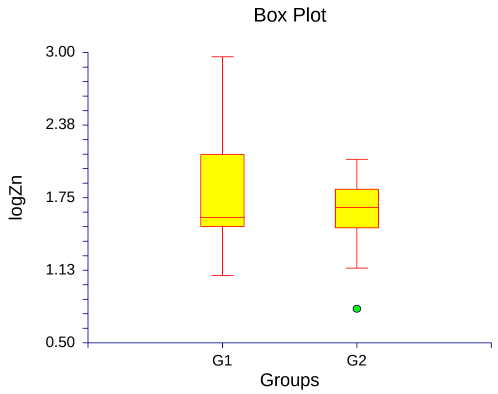
Variable logZn







Two-Sample Test Report

Page/Date/Time 16 6/28/2011 8:30:33 AM
Database
Variable Chromium

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
area=1SWMU 74	14	12.9	6.209174	1.659472	9.314929	16.48507
area=2NAPR Background	20	25.69	12.22198	2.732917	19.96994	31.41

Note: T-alpha (area=1SWMU 74) = 2.1604, T-alpha (area=2NAPR Background) = 2.0930

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	32	-12.79	10.21543	3.559729	-20.04093	-5.539069
Unequal	29.69	-12.79	13.70878	3.197293	-19.32257	-6.257434

Note: T-alpha (Equal) = 2.0369, T-alpha (Unequal) = 2.0432

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-3.5930	0.001082	Reject H0	0.936150	0.796494
Difference < 0	-3.5930	0.000541	Reject H0	0.969302	0.867072
Difference > 0	-3.5930	0.999459	Accept H0	0.000000	0.000000

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-4.0003	0.000387	Reject H0	0.971796	0.884461
Difference < 0	-4.0003	0.000193	Reject H0	0.988150	0.931640
Difference > 0	-4.0003	0.999807	Accept H0	0.000000	0.000000

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)
Skewness Normality (area=1SWMU 74)	1.5121	0.130515	Cannot reject normality
Kurtosis Normality (area=1SWMU 74)	0.6182	0.536466	Cannot reject normality
Omnibus Normality (area=1SWMU 74)	2.6685	0.263356	Cannot reject normality
Skewness Normality (area=2NAPR Background)	-0.3170	0.751214	Cannot reject normality
Kurtosis Normality (area=2NAPR Background)	-1.4144	0.157235	Cannot reject normality
Omnibus Normality (area=2NAPR Background)	2.1011	0.349739	Cannot reject normality
Variance-Ratio Equal-Variance Test	3.8745	0.016090	Reject equal variances
Modified-Levene Equal-Variance Test	4.5113	0.041495	Reject equal variances

Two-Sample Test Report

Page/Date/Time 17 6/28/2011 8:30:33 AM
Database
Variable Chromium

Median Statistics

Variable	Count	Median	95% LCL of Median	95% UCL of Median
area=1SWMU 74	14	11	7.8	18
area=2NAPR Background	20	29.95	12	33.6

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
area=1SWMU 74	53.5	158.5	245	28.56209
area=2NAPR Background	226.5	436.5	350	28.56209

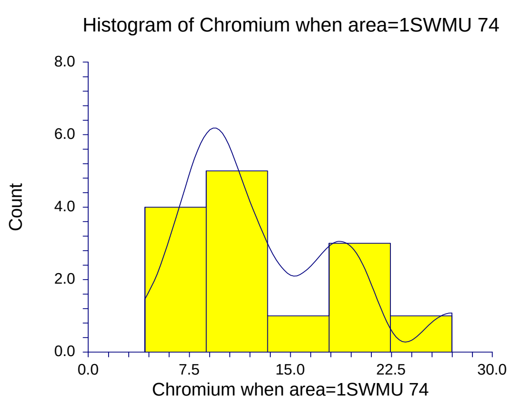
Number Sets of Ties = 4, Multiplicity Factor = 42

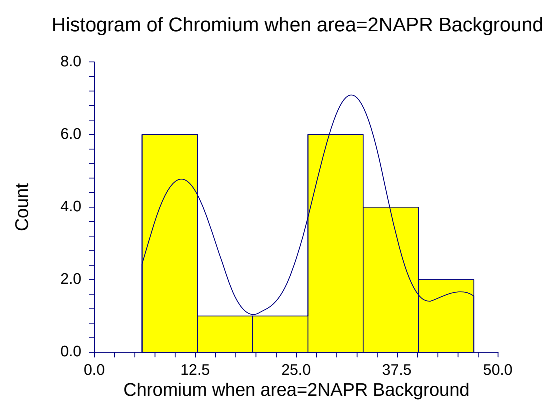
	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			-3.0285	0.002458	Reject H0	-3.0110	0.002604	Reject H0
Diff<0			-3.0285	0.001229	Reject H0	-3.0110	0.001302	Reject H0
Diff>0			-3.0285	0.998771	Accept H0	-3.0460	0.998840	Accept H0

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.578571	0.4466	.050	Reject H0	0.0045
D(1)<D(2)	0.578571	0.4466	.025	Reject H0	
D(1)>D(2)	0.000000	0.4466	.025	Accept H0	

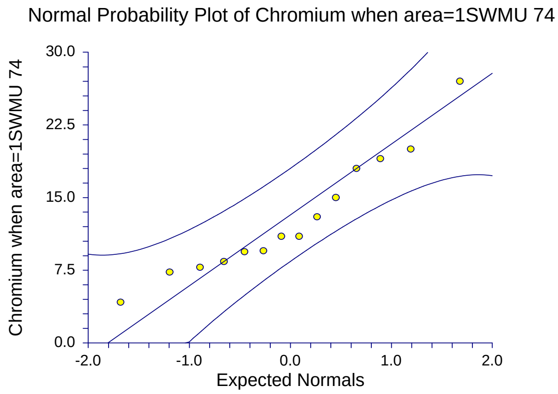
Plots Section

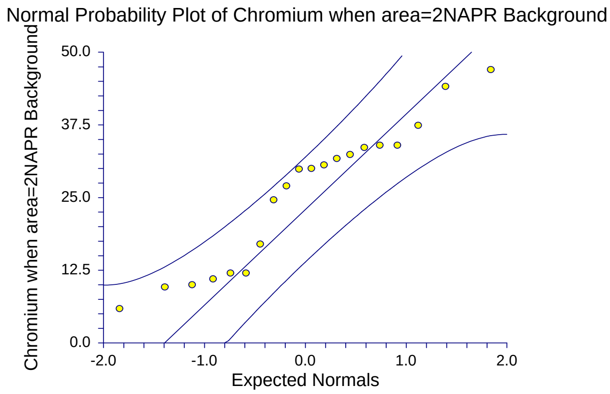


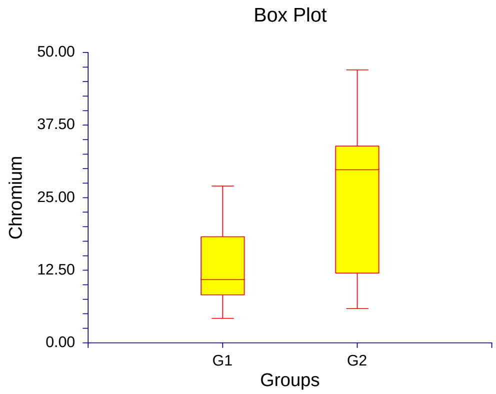


Two-Sample Test Report

Page/Date/Time 18 6/28/2011 8:30:33 AM
Database
Variable Chromium







Two-Sample Test Report

Page/Date/Time 19 6/28/2011 8:30:33 AM
Database
Variable logPb

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean	
area=1SWMU 74	12	1.250733	0.5181031	0.1495635	0.9215463	1.57992	
area=2NAPR Background		18	0.7980611	0.3669229	8.648454E-02	0.6155947	0.980

Note: T-alpha (area=1SWMU 74) = 2.2010, T-alpha (area=2NAPR Background) = 2.1098

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	28	0.4526722	0.4326616	0.1612435	0.12238	0.7829645
Unequal	18.26	0.4526722	0.6348726	0.1727681	9.007655E-02	0.8152679

Note: T-alpha (Equal) = 2.0484, T-alpha (Unequal) = 2.0987

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.8074	0.008994	Reject H0	0.773381	0.526070
Difference < 0	2.8074	0.995503	Accept H0	0.000006	0.000000
Difference > 0	2.8074	0.004497	Reject H0	0.862950	0.634847

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.6201	0.017210	Reject H0	0.698673	0.423960
Difference < 0	2.6201	0.991395	Accept H0	0.000015	0.000001
Difference > 0	2.6201	0.008605	Reject H0	0.809562	0.539565

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)	
Skewness Normality (area=1SWMU 74)	0.2795	0.779881	Cannot reject normality	
Kurtosis Normality (area=1SWMU 74)	-1.7029	0.088585	Cannot reject normality	
Omnibus Normality (area=1SWMU 74)	2.9780	0.225597	Cannot reject normality	
Skewness Normality (area=2NAPR Background)		0.3090	0.757347	Cannot reject normality
Kurtosis Normality (area=2NAPR Background)		-2.5317	0.011351	Reject normality
Omnibus Normality (area=2NAPR Background)		6.5050	0.038677	Reject normality
Variance-Ratio Equal-Variance Test	1.9938	0.194831	Cannot reject equal variances	
Modified-Levene Equal-Variance Test	4.5871	0.041055	Reject equal variances	

Two-Sample Test Report

Page/Date/Time 20 6/28/2011 8:30:33 AM
Database
Variable logPb

Median Statistics

Variable	Count	Median	95% LCL of Median	95% UCL of Median
area=1SWMU 74	12	1.2248	0.8261	1.7634
area=2NAPR Background	18	0.7315	0.5185	1.2041

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
area=1SWMU 74	164.5	242.5	186	23.61151
area=2NAPR Background	51.5	222.5	279	23.61151

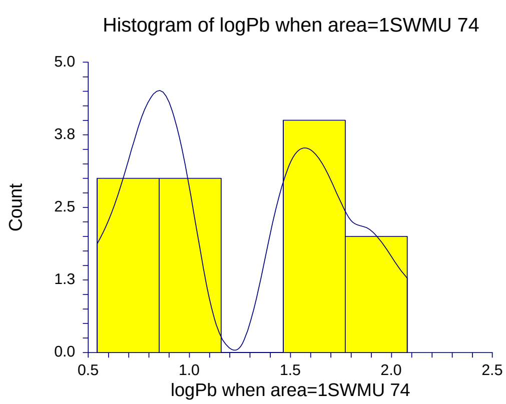
Number Sets of Ties = 4, Multiplicity Factor = 24

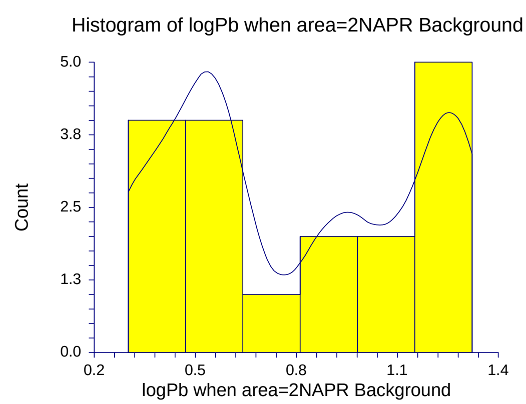
	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0			2.3929	0.016716	Reject H0	2.3717	0.017705	Reject H0
Diff<0			2.3929	0.991642	Accept H0	2.4141	0.992112	Accept H0
Diff>0			2.3929	0.008358	Reject H0	2.3717	0.008853	Reject H0

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.500000	0.4758	.050	Reject H0	0.0417
D(1)<D(2)	0.000000	0.4758	.025	Accept H0	
D(1)>D(2)	0.500000	0.4758	.025	Reject H0	

Plots Section





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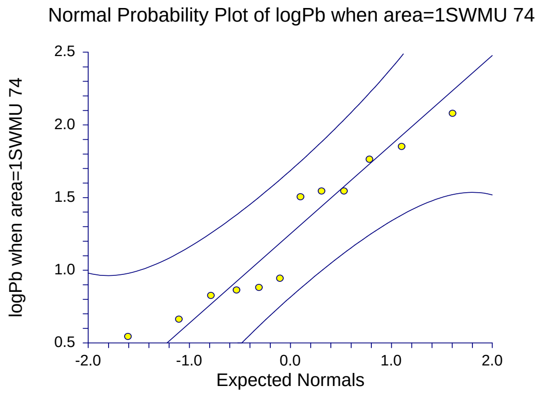
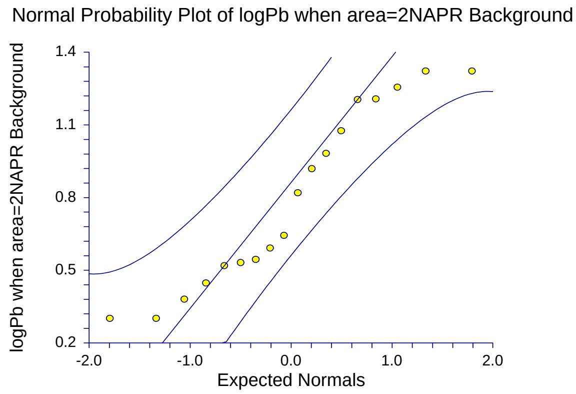
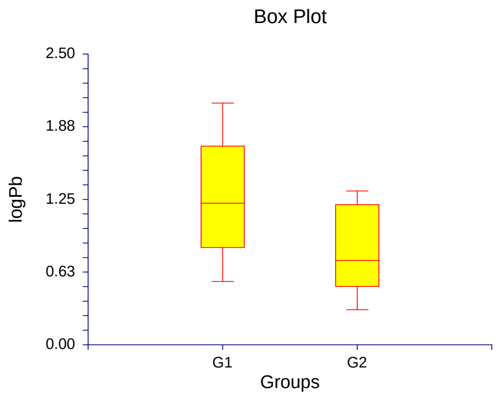
Page/Date/Time 21 6/28/2011 8:30:33 AM
Database
Variable logPb







Two-Sample Test Report

Page/Date/Time 22 6/28/2011 8:30:33 AM
Database
Variable logNi

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean	
area=1SWMU 74	14	0.71935	0.2748049	7.344471E-02	0.5606824	0.8780177	
area=2NAPR Background		19	0.9668369	0.2325265	5.334523E-02	0.8547627	1.078

Note: T-alpha (area=1SWMU 74) = 2.1604, T-alpha (area=2NAPR Background) = 2.1009

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	31	-0.2474868	0.2511242	8.845142E-02	-0.4278847	-6.708899E-02
Unequal	25.26	-0.2474868	0.359981	9.077356E-02	-0.4343418	-6.063186E-02

Note: T-alpha (Equal) = 2.0395, T-alpha (Unequal) = 2.0585

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-2.7980	0.008761	Reject H0	0.773509	0.528918
Difference < 0	-2.7980	0.004381	Reject H0	0.862418	0.636448
Difference > 0	-2.7980	0.995619	Accept H0	0.000006	0.000000

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-2.7264	0.011471	Reject H0	0.745886	0.488837
Difference < 0	-2.7264	0.005736	Reject H0	0.843124	0.600040
Difference > 0	-2.7264	0.994264	Accept H0	0.000008	0.000000

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)	
Skewness Normality (area=1SWMU 74)	2.1371	0.032592	Reject normality	
Kurtosis Normality (area=1SWMU 74)	1.7647	0.077615	Cannot reject normality	
Omnibus Normality (area=1SWMU 74)	7.6812	0.021481	Reject normality	
Skewness Normality (area=2NAPR Background)		-0.3304	0.741069	Cannot reject normality
Kurtosis Normality (area=2NAPR Background)		-1.9014	0.057256	Cannot reject normality
Omnibus Normality (area=2NAPR Background)		3.7243	0.155336	Cannot reject normality
Variance-Ratio Equal-Variance Test	1.3967	0.502344	Cannot reject equal variances	
Modified-Levene Equal-Variance Test	0.0482	0.827702	Cannot reject equal variances	

Two-Sample Test Report

Page/Date/Time 23 6/28/2011 8:30:33 AM
Database
Variable logNi

Median Statistics

Variable	Count	Median	95% LCL of Median	95% UCL of Median
area=1SWMU 74	14	0.62835	0.5051	0.9031
area=2NAPR Background	19	0.9345	0.7634	1.1761

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
area=1SWMU 74	62	167	238	27.45299
area=2NAPR Background	204	394	323	27.45299

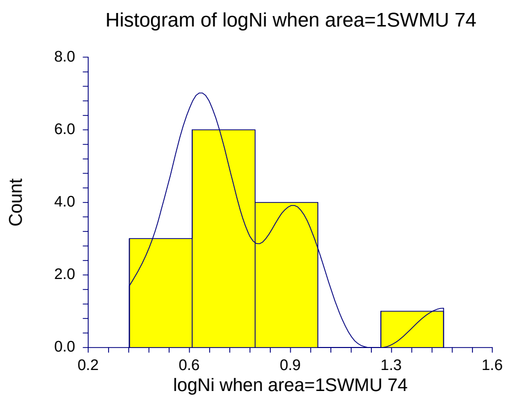
Number Sets of Ties = 0, Multiplicity Factor = 0

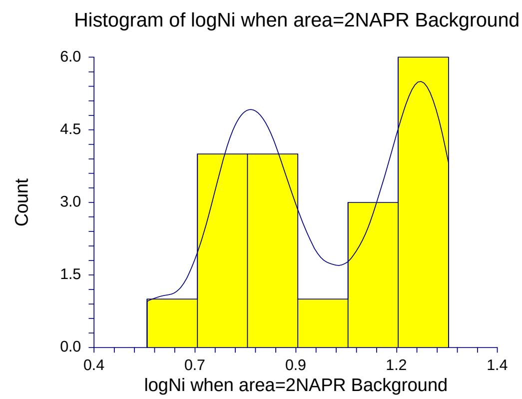
	Exact Probability		Approximation Without Correction			Approximation With Correction		
Alternative Hypothesis	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)	Z-Value	Prob Level	Decision (5%)
Diff<>0	0.008846	Reject H0	-2.5862	0.009703	Reject H0	-2.5680	0.010228	Reject H0
Diff<0	0.004423	Reject H0	-2.5862	0.004851	Reject H0	-2.5680	0.005114	Reject H0
Diff>0	0.995577	Accept H0	-2.5862	0.995149	Accept H0	-2.6045	0.995399	Accept H0

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.537594	0.4512	.050	Reject H0	0.0117
D(1)<D(2)	0.537594	0.4512	.025	Reject H0	
D(1)>D(2)	0.071429	0.4512	.025	Accept H0	

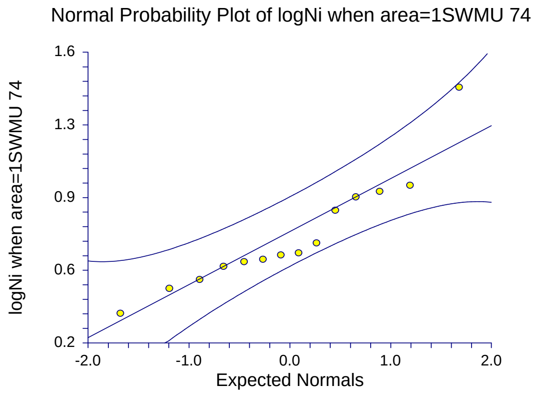
Plots Section

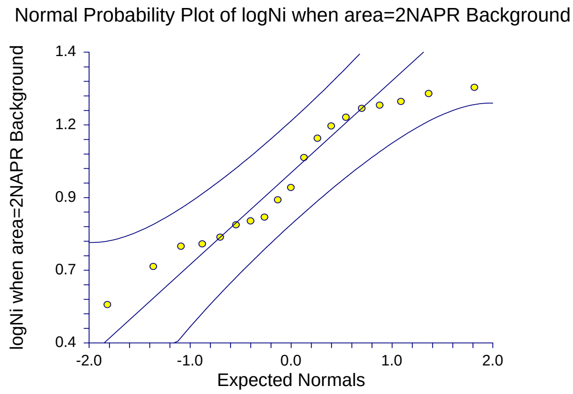


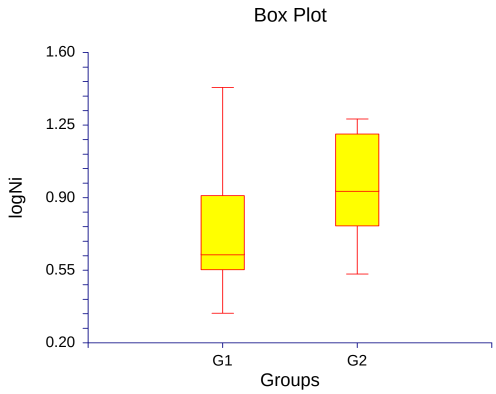


Two-Sample Test Report

Page/Date/Time 24 6/28/2011 8:30:33 AM
Database
Variable logNi







Two-Sample Test Report

Page/Date/Time 25 6/28/2011 8:30:33 AM
Database
Variable Beryllium

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean	
area=1SWMU 74	14	9.360714E-02	0.058927	0.0157489	0.0595837	0.1276306	
area=2NAPR Background		18	0.2841667	0.1553767	3.662263E-02	0.2068997	0.361

Note: T-alpha (area=1SWMU 74) = 2.1604, T-alpha (area=2NAPR Background) = 2.1098

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	30	-0.1905595	0.1232279	4.391206E-02	-0.2802399	-0.1008791
Unequal	22.85	-0.1905595	0.1661755	3.986534E-02	-0.2730578	-0.1080612

Note: T-alpha (Equal) = 2.0423, T-alpha (Unequal) = 2.0694

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-4.3396	0.000149	Reject H0	0.987355	0.935635
Difference < 0	-4.3396	0.000075	Reject H0	0.995258	0.965081
Difference > 0	-4.3396	0.999925	Accept H0	0.000000	0.000000

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-4.7801	0.000082	Reject H0	0.995487	0.967591
Difference < 0	-4.7801	0.000041	Reject H0	0.998595	0.984634
Difference > 0	-4.7801	0.999959	Accept H0	0.000000	0.000000

Difference: (area=1SWMU 74)-(area=2NAPR Background)

Tests of Assumptions Section

Assumption	Value	Probability	Decision(5%)	
Skewness Normality (area=1SWMU 74)	2.5600	0.010467	Reject normality	
Kurtosis Normality (area=1SWMU 74)	2.0236	0.043011	Reject normality	
Omnibus Normality (area=1SWMU 74)	10.6485	0.004872	Reject normality	
Skewness Normality (area=2NAPR Background)		0.0125	0.990060	Cannot reject normality
Kurtosis Normality (area=2NAPR Background)		-0.3987	0.690091	Cannot reject normality
Omnibus Normality (area=2NAPR Background)		0.1591	0.923512	Cannot reject normality
Variance-Ratio Equal-Variance Test	6.9525	0.001013	Reject equal variances	
Modified-Levene Equal-Variance Test	8.2592	0.007382	Reject equal variances	

Two-Sample Test Report

Page/Date/Time 26 6/28/2011 8:30:33 AM
Database
Variable Beryllium

Median Statistics

Variable	Count	Median	95% LCL of Median	95% UCL of Median
area=1SWMU 74	14	0.0785	0.055	0.099
area=2NAPR Background	18	0.32	0.17	0.36

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
area=1SWMU 74	36.5	141.5	231	26.31042
area=2NAPR Background	215.5	386.5	297	26.31042

Number Sets of Ties = 3, Multiplicity Factor = 36

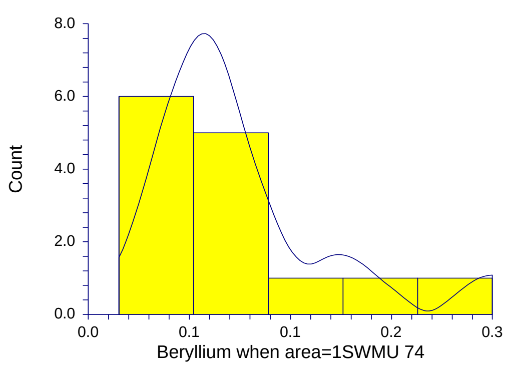
Alternative Hypothesis	Exact Probability Prob Level	Exact Probability Decision (5%)	Approximation Without Correction Z-Value	Approximation Without Correction Prob Level	Approximation Without Correction Decision (5%)	Approximation With Correction Z-Value	Approximation With Correction Prob Level	Approximation With Correction Decision (5%)
Diff<>0			-3.4017	0.000670	Reject H0	-3.3827	0.000718	Reject H0
Diff<0			-3.4017	0.000335	Reject H0	-3.3827	0.000359	Reject H0
Diff>0			-3.4017	0.999665	Accept H0	-3.4207	0.999688	Accept H0

Kolmogorov-Smirnov Test For Different Distributions

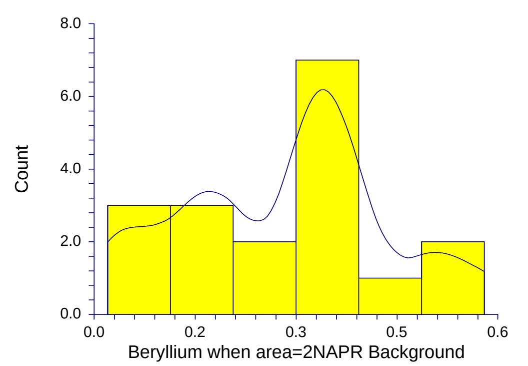
Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Decision (Test Alpha)	Prob Level
D(1)<>D(2)	0.690476	0.4563	.050	Reject H0	0.0004
D(1)<D(2)	0.690476	0.4563	.025	Reject H0	
D(1)>D(2)	0.000000	0.4563	.025	Accept H0	

Plots Section

Histogram of Beryllium when area=1SWMU 74

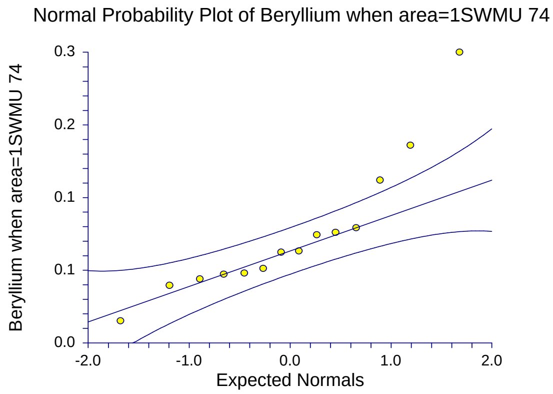


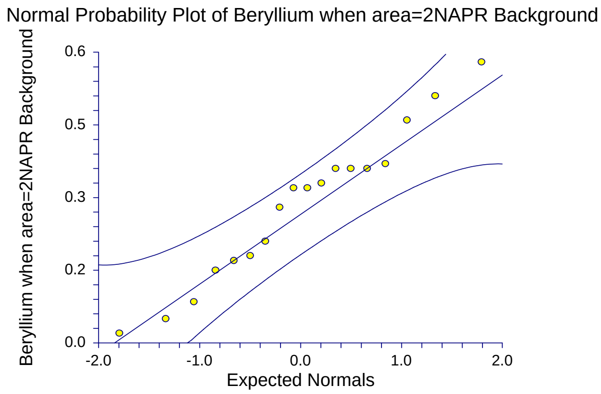
Histogram of Beryllium when area=2NAPR Background

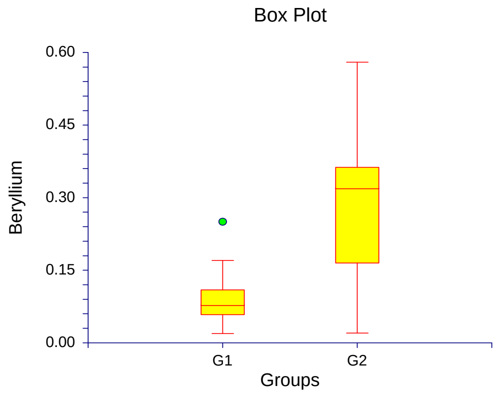


Two-Sample Test Report

Page/Date/Time 27 6/28/2011 8:30:33 AM
Database
Variable Beryllium







APPENDIX H
HHRA DATA SETS

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB231		74SB748		74SB749		74SB750		74SB751		74SB752		74SB753	
Sample ID	74SB231-00		74SB748-00		74SB749-00		74SB750-00		74SB751-00		74SB752-00		74SB753-00	
Date	5/20/2008		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011	
Depth Range	0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0	
Volatile Organic Compounds (ug/kg)														
1,1,1,2-Tetrachloroethane	0.95	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,1,1-Trichloroethane	0.86	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,1,2,2-Tetrachloroethane	2.1	U	NA		NA		NA		NA		NA		NA	
1,1,2-Trichloroethane	1.8	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,1-Dichloroethane	0.74	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,1-Dichloroethene	0.8	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,2,3-Trichloropropane	2.1	UJ	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,2-Dibromo-3-Chloropropane	4.2	UJ	9.8	U	11	U	10	U	10	U	8	U	8.2	U
1,2-Dibromoethane	2.2	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,2-Dichloroethane	1.5	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
1,2-Dichloropropane	1.6	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
2-Butanone (MEK)	7.1	UJ	24	U	27	U	26	U	25	U	20	U	21	U
2-Hexanone	3.1	UJ	24	U	27	U	26	U	25	U	20	U	21	U
3-Chloro-1-propene	2.2	UJ	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
4-Methyl-2-pentanone (MIBK)	4.3	UJ	24	U	27	U	26	U	25	U	20	U	21	U
Acetone	70	U	49	U	55	U	51	U	50	U	40	U	41	U
Acetonitrile	67	UJ	200	U	220	U	210	U	200	U	160	U	160	U
Acrolein	28	R	98	UJ	110	UJ	100	UJ	100	UJ	80	UJ	82	UJ
Acrylonitrile	34	UJ	98	U	110	U	100	U	100	U	80	U	82	U
Benzene	1.2	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Bromodichloromethane	1.2	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Bromoform	1.6	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Bromomethane	2.4	UJ	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Carbon disulfide	0.76	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Carbon tetrachloride	1.5	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Chlorobenzene	1.1	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Chloroethane	1.8	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Chloroform	0.74	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB231		74SB748		74SB749		74SB750		74SB751		74SB752		74SB753	
Sample ID	74SB231-00		74SB748-00		74SB749-00		74SB750-00		74SB751-00		74SB752-00		74SB753-00	
Date	5/20/2008		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011		4/18/2011	
Depth Range	0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0	
Volatile Organic Compounds (ug/kg) (Cont)														
Chloromethane	1.1	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Chloroprene	0.85	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
cis-1,3-Dichloropropene	1.3	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Dibromochloromethane	0.74	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Dibromomethane	1.8	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Dichlorodifluoromethane	1.3	U	4.9	UJ	5.5	UJ	5.1	UJ	5	UJ	4	UJ	4.1	UJ
Ethyl methacrylate	3.3	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Ethylbenzene	1.1	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Iodomethane	1.5	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Isobutyl alcohol	100	R	200	U	220	U	210	U	200	U	160	U	160	U
Methacrylonitrile	36	U	98	U	110	U	100	U	100	U	80	U	82	U
Methyl methacrylate	5.5	U	9.8	U	11	U	10	U	10	U	8	U	8.2	U
Methylene Chloride	1.5	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Pentachloroethane	3.3	UJ	24	U	27	U	26	U	25	U	20	U	21	U
Propionitrile	31	UJ	98	U	110	U	100	U	100	U	80	U	82	U
Styrene	0.98	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Tetrachloroethene	1.1	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Toluene	1.2	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
trans-1,2-Dichloroethene	1.4	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
trans-1,3-Dichloropropene	1.3	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
trans-1,4-Dichloro-2-butene	4.6	U	9.8	U	11	U	10	U	10	U	8	U	8.2	U
Trichloroethene	1.5	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Trichlorofluoromethane	2.2	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Vinyl acetate	2.2	U	9.8	U	11	U	10	U	10	U	8	U	8.2	U
Vinyl chloride	0.86	U	4.9	U	5.5	U	5.1	U	5	U	4	U	4.1	U
Xylenes, Total	3.4	U	9.8	U	11	U	10	U	10	U	8	U	8.2	U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB231	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID	74SB231-00	74SB748-00	74SB749-00	74SB750-00	74SB751-00	74SB752-00	74SB753-00
Date	5/20/2008	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
LLPAHs (ug/kg)							
1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	71 U	72 U	69 U	74 U	72 U	69 U
Acenaphthene	NA	71 U	72 U	69 U	74 U	72 U	69 U
Acenaphthylene	NA	71 U	72 U	69 U	74 U	72 U	69 U
Anthracene	NA	71 U	51 J	69 U	74 U	72 U	69 U
Benzo[a]anthracene	NA	71 U	190	140	78	72 U	69 U
Benzo[a]pyrene	NA	71 U	170	200	90	25 J	120
Benzo[b]fluoranthene	NA	71 U	190	230	74 U	72 U	69 U
Benzo[g,h,i]perylene	NA	43 J	170	92	52 J	72 U	69 U
Benzo[k]fluoranthene	NA	71 U	160	170	130	72 U	69 U
Chrysene	NA	39 J	210	160	100	72 U	74
Dibenz(a,h)anthracene	NA	71 U	57 J	45 J	74 U	72 U	69 U
Fluoranthene	NA	71 U	330	120	110	72 U	69 U
Fluorene	NA	71 U	72 U	69 U	74 U	72 U	69 U
Indeno[1,2,3-cd]pyrene	NA	71 U	110	84	38 J	72 U	69 U
Naphthalene	NA	71 U	72 U	69 U	74 U	72 U	69 U
Phenanthrene	NA	71 U	100	69 U	35 J	26 J	26 J
Pyrene	NA	71 U	320	160	140	72 U	52 J
Metals (mg/kg)							
Antimony	0.39 U	2 U	2.9	2 U	2.1 U	2 U	2 U
Arsenic	4.6	2	4.3	4.2	4.7	1.7	1.6
Barium	25	190 J	29 J	44 J	55 J	150 J	110 J
Beryllium	0.038 U	0.17	0.064 J	0.078 J	0.093 J	0.14	0.25
Cadmium	0.22	0.062 J	1.3	0.18	0.086 J	0.047 J	0.12
Chromium	8.4	7.3	20	13	15	4.2	9.5
Cobalt	2.7	6.3	2.6	3	9.3	6.5	7.3
Copper	14	12	45	16	49	17	22
Lead	35	4.6	120	32	7.6	3.5	8.8

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB231	74SB748	74SB749	74SB750	74SB751	74SB752	74SB753
Sample ID	74SB231-00	74SB748-00	74SB749-00	74SB750-00	74SB751-00	74SB752-00	74SB753-00
Date	5/20/2008	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg) (Cont)							
Mercury	0.01 J	0.021 U	0.022	0.02	0.014 J	0.0092 J	0.016 J
Nickel	2.9	4.8 J	4.3	3.2	8	3.7	6.9
Selenium	0.26 J	1	0.97 U	0.98 U	0.77 J	1.5	1.8
Silver	0.04 J	0.2 U	0.84	0.2 U	0.21 U	0.2 U	0.2 U
Thallium	0.25 U	0.2 U	0.054 J	0.068 J	0.21 U	0.2 U	0.2 U
Tin	8.4 U	20 U	19 U	20 U	21 U	20 U	20 U
Vanadium	18	46 J	21 J	22 J	60 J	40 J	64 J
Zinc	22	34	110	920	36	37	49
TPH DRO and GRO (mg/kg)							
Diesel Range Organics	69	410	150	47	44	78	400
Gasoline Range Organics	0.084 U	2500 J	35 J	26 J	26 J	12 J	16 J

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB760
Sample ID	74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB760-00
Date	4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Volatile Organic Compounds (ug/kg)							
1,1,1,2-Tetrachloroethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1,1-Trichloroethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1-Dichloroethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1-Dichloroethene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2,3-Trichloropropane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2-Dibromo-3-Chloropropane	11 U	12 U	13 U	12 U	11 U	11 U	11 U
1,2-Dibromoethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2-Dichloroethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2-Dichloropropane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
2-Butanone (MEK)	28 U	30 U	31 U	31 U	27 U	28 U	27 U
2-Hexanone	28 U	30 U	31 U	31 U	27 U	28 U	27 U
3-Chloro-1-propene	5.6 U	6 U	6.3 UJ	6.1 UJ	5.3 UJ	5.6 UJ	5.4 UJ
4-Methyl-2-pentanone (MIBK)	28 U	30 U	31 U	31 U	27 U	28 U	27 U
Acetone	56 U	60 U	63 U	61 U	53 U	56 U	54 U
Acetonitrile	220 U	240 U	250 U	240 U	210 U	220 U	220 U
Acrolein	110 U	120 U	130 UJ	120 UJ	110 UJ	110 UJ	110 UJ
Acrylonitrile	110 U	120 U	130 U	120 U	110 U	110 U	110 U
Benzene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Bromodichloromethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Bromoform	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Bromomethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Carbon disulfide	5.9	5.5 J	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Carbon tetrachloride	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Chlorobenzene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Chloroethane	5.6 U	6 U	6.3 UJ	6.1 UJ	5.3 UJ	5.6 UJ	5.4 UJ
Chloroform	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB760
Sample ID	74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB760-00
Date	4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Volatile Organic Compounds (ug/kg) (Co							
Chloromethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Chloroprene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
cis-1,3-Dichloropropene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Dibromochloromethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Dibromomethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Dichlorodifluoromethane	5.6 UJ	6 UJ	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Ethyl methacrylate	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Ethylbenzene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Iodomethane	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Isobutyl alcohol	220 U	240 U	250 U	240 U	210 U	220 U	220 U
Methacrylonitrile	110 U	120 U	130 U	120 U	110 U	110 U	110 U
Methyl methacrylate	11 U	12 U	13 U	12 U	11 U	11 U	11 U
Methylene Chloride	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Pentachloroethane	28 U	30 U	31 U	31 U	27 U	28 U	27 U
Propionitrile	110 U	120 U	130 U	120 U	110 U	110 U	110 U
Styrene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Tetrachloroethene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Toluene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
trans-1,2-Dichloroethene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
trans-1,3-Dichloropropene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
trans-1,4-Dichloro-2-butene	11 U	12 U	13 U	12 U	11 U	11 U	11 U
Trichloroethene	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Trichlorofluoromethane	5.6 U	6 U	6.3 UJ	6.1 UJ	5.3 UJ	5.6 UJ	5.4 UJ
Vinyl acetate	11 U	12 U	13 U	12 U	11 U	11 UJ	11 U
Vinyl chloride	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Xylenes, Total	11 U	12 U	13 U	12 U	11 U	11 U	11 U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB760
Sample ID	74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB760-00
Date	4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
LLPAHs (ug/kg)							
1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	71 U	75 U	4.2 J	7.4 U	7.2 U	7.2 U	7.2 U
Acenaphthene	71 U	75 U	7.2 U	7.4 U	7.2 U	3.8 J	9.4
Acenaphthylene	71 U	75 U	11	7.4 U	7.2 U	17	17
Anthracene	71 U	75 U	25	4 J	4.5 J	26	52
Benzo[a]anthracene	71 U	75 U	63	13	37	160 J	140
Benzo[a]pyrene	44 J	59 J	110	20	50	180 J	140
Benzo[b]fluoranthene	73	68 J	200	36	89	270 J	240
Benzo[g,h,i]perylene	36 J	76	53	7.4 U	24	52	66
Benzo[k]fluoranthene	71 U	56 J	180	33	73	230 J	210
Chrysene	71 U	46 J	110	31	50	200 J	250
Dibenz(a,h)anthracene	71 U	75 U	20	7.4 U	7.2 U	7.2 U	22
Fluoranthene	71 U	43 J	97	32	50	300 J	400
Fluorene	71 U	75 U	7.2 U	7.4 U	7.2 U	3.6 J	7.6
Indeno[1,2,3-cd]pyrene	71 U	44 J	26	5 J	12	26	36
Naphthalene	71 U	75 U	7.2 U	7.4 U	7.2 U	7.2 U	7.2 U
Phenanthrene	71 U	75 U	40	6.2 J	8.6	78 J	180
Pyrene	71 U	51 J	110	33	58	350 J	430
Metals (mg/kg)							
Antimony	2 U	2.2 U	1.8 J	2.1 U	2.1 U	2.1 U	2 U
Arsenic	3.5	2.9	21	3.7	5.1	5.2	6.8
Barium	65 J	54 J	38 J	44 J	17 J	15 J	20 J
Beryllium	0.079 J	0.095 J	0.059 J	0.099 J	0.06 J	0.11 U	0.099 U
Cadmium	0.73	1.8	0.7	0.11	0.51	0.11	0.18
Chromium	11	18	27	19	11	9.4	7.8
Cobalt	4.8	10	10 J	6.5 J	2.9 J	1.9 J	1.7 J
Copper	22	48	59	39	550	9.3	15
Lead	25 R	50 R	58	35	71	6.7	7.3

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, SURFACE SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB754		74SB755		74SB756		74SB757		74SB758		74SB759		74SB760	
Sample ID	74SB754-00		74SB755-00		74SB756-00		74SB757-00		74SB758-00		74SB759-00		74SB760-00	
Date	4/19/2011		4/19/2011		4/29/2011		4/29/2011		4/29/2011		4/29/2011		4/29/2011	
Depth Range	0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0		0.0-1.0	
Metals (mg/kg) (Cont)														
Mercury	0.0093	J	0.012	J	0.21		0.021	U	0.015	J	0.0085	J	0.02	U
Nickel	4		8.5		27		9.1		3.9		4.2		2.2	
Selenium	0.87	J	0.83	J	0.97	U	1.1	U	1.1	U	1.1	U	0.99	U
Silver	0.2	U	0.16	J	0.1	J	0.21	U	0.83		0.21	U	0.2	U
Thallium	0.16	J	0.21	J	0.061	J	0.21	U	0.21	U	0.21	U	0.2	U
Tin	20	U	22	U	19	U	21	U	21	U	21	U	20	U
Vanadium	34		62		29		48		31		18		13	
Zinc	40		100		250		33		230		12		28	
TPH DRO and GRO (mg/kg)														
Diesel Range Organics	56		110		36		24		25		32	J	71	
Gasoline Range Organics	0.12	J	0.26	J	0.31	U	0.31	U	0.3	U	0.32	UJ	0.3	U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB231	74SB231	74SB231	74SB232	74SB232	74SB748	74SB748	74SB749
Sample ID	74SB231-00	74SB231-04	74SB231-05	74SB232-04	74SB232-05	74SB748-00	74SB748-01	74SB749-00
Date	5/20/2008	5/20/2008	5/20/2008	5/20/2008	5/20/2008	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	0.0-1.0	7.0-9.0	9.0-11.0	7.0-9.0	9.0-11.0	0.0-1.0	1.0-3.0	0.0-1.0
Volatile Organic Compounds (ug/kg)								
1,1,1,2-Tetrachloroethane	0.95 U	0.93 U	0.78 U	0.88 U	0.79 U	4.9 U	6.9 U	5.5 U
1,1,1-Trichloroethane	0.86 U	0.84 U	0.71 U	0.79 U	0.72 U	4.9 U	6.9 U	5.5 U
1,1,2,2-Tetrachloroethane	2.1 U	2 U	1.7 U	1.9 U	1.7 U	NA	NA	NA
1,1,2-Trichloroethane	1.8 U	1.7 U	1.5 U	1.6 U	1.5 U	4.9 U	6.9 U	5.5 U
1,1-Dichloroethane	0.74 U	0.73 U	0.61 U	0.68 U	0.62 U	4.9 U	6.9 U	5.5 U
1,1-Dichloroethene	0.8 U	0.79 U	0.66 U	0.74 U	0.67 U	4.9 U	6.9 U	5.5 U
1,2,3-Trichloropropane	2.1 UJ	2 UJ	1.7 UJ	1.9 UJ	1.7 UJ	4.9 U	6.9 U	5.5 U
1,2-Dibromo-3-Chloropropane	4.2 UJ	4.1 UJ	3.4 UJ	3.8 UJ	3.5 UJ	9.8 U	14 U	11 U
1,2-Dibromoethane	2.2 U	2.2 U	1.8 U	2.1 U	1.8 U	4.9 U	6.9 U	5.5 U
1,2-Dichloroethane	1.5 U	1.5 U	1.2 U	1.4 U	1.2 U	4.9 U	6.9 U	5.5 U
1,2-Dichloropropane	1.6 U	1.6 U	1.3 U	1.5 U	1.4 U	4.9 U	6.9 U	5.5 U
2-Butanone (MEK)	7.1 UJ	4.5 UJ	4.7 UJ	4.8 UJ	7.1 UJ	24 U	34 U	27 U
2-Hexanone	3.1 UJ	3.1 UJ	2.6 UJ	2.9 UJ	2.6 UJ	24 U	34 U	27 U
3-Chloro-1-propene	2.2 UJ	2.2 UJ	1.8 UJ	2.1 UJ	1.8 UJ	4.9 U	6.9 U	5.5 U
4-Methyl-2-pentanone (MIBK)	4.3 UJ	4.2 UJ	3.6 UJ	4 UJ	3.6 UJ	24 U	34 U	27 U
Acetone	70 U	34 U	30 U	29 U	41 U	49 U	69 U	55 U
Acetonitrile	67 UJ	65 UJ	55 UJ	62 UJ	55 UJ	200 U	280 U	220 U
Acrolein	28 R	28 R	23 R	26 R	23 R	98 UJ	140 UJ	110 UJ
Acrylonitrile	34 UJ	33 UJ	28 UJ	32 UJ	28 UJ	98 U	140 U	110 U
Benzene	1.2 U	1.1 U	0.97 U	1.1 U	0.97 U	4.9 U	6.9 U	5.5 U
Bromodichloromethane	1.2 U	1.2 U	1 U	1.1 U	1 U	4.9 U	6.9 U	5.5 U
Bromoform	1.6 U	1.6 U	1.3 U	1.5 U	1.4 U	4.9 U	6.9 U	5.5 U
Bromomethane	2.4 UJ	2.3 UJ	2 UJ	2.2 UJ	2 UJ	4.9 U	6.9 U	5.5 U
Carbon disulfide	0.76 U	0.74 U	0.63 U	0.7 U	12	4.9 U	6.9 U	5.5 U
Carbon tetrachloride	1.5 U	1.5 U	1.2 U	1.4 U	1.2 U	4.9 U	6.9 U	5.5 U
Chlorobenzene	1.1 U	1.1 U	0.89 U	1 U	0.9 U	4.9 U	6.9 U	5.5 U
Chloroethane	1.8 U	1.7 U	1.5 U	1.6 U	1.5 U	4.9 U	6.9 U	5.5 U
Chloroform	0.74 U	1 U	0.61 U	0.68 U	0.62 U	4.9 U	6.9 U	5.5 U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB231	74SB231	74SB231	74SB232	74SB232	74SB748	74SB748	74SB749
Sample ID	74SB231-00	74SB231-04	74SB231-05	74SB232-04	74SB232-05	74SB748-00	74SB748-01	74SB749-00
Date	5/20/2008	5/20/2008	5/20/2008	5/20/2008	5/20/2008	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	0.0-1.0	7.0-9.0	9.0-11.0	7.0-9.0	9.0-11.0	0.0-1.0	1.0-3.0	0.0-1.0
Volatile Organic Compounds (ug/kg) (Cont)								
Chloromethane	1.1 U	1 U	0.87 U	0.97 U	0.88 U	4.9 U	6.9 U	5.5 U
Chloroprene	0.85 U	0.83 U	0.7 U	0.78 U	0.7 U	4.9 U	6.9 U	5.5 U
cis-1,3-Dichloropropene	1.3 U	1.3 U	1.1 U	1.2 U	1.1 U	4.9 U	6.9 U	5.5 U
Dibromochloromethane	0.74 U	0.73 U	0.61 U	0.68 U	0.62 U	4.9 U	6.9 U	5.5 U
Dibromomethane	1.8 U	1.7 U	1.5 U	1.6 U	1.5 U	4.9 U	6.9 U	5.5 U
Dichlorodifluoromethane	1.3 U	1.3 U	1.1 U	1.2 U	1.1 U	4.9 UJ	6.9 UJ	5.5 UJ
Ethyl methacrylate	3.3 U	3.2 U	2.7 U	3 U	2.7 U	4.9 U	6.9 U	5.5 U
Ethylbenzene	1.1 U	1.1 U	0.92 U	1 U	0.92 U	4.9 U	6.9 U	5.5 U
Iodomethane	1.5 U	1.5 U	1.2 U	1.4 U	1.2 U	4.9 U	6.9 U	5.5 U
Isobutyl alcohol	100 R	100 R	85 R	95 R	85 R	200 U	280 U	220 U
Methacrylonitrile	36 U	35 U	29 U	33 U	30 U	98 U	140 U	110 U
Methyl methacrylate	5.5 U	5.4 U	4.5 U	5.1 U	4.6 U	9.8 U	14 U	11 U
Methylene Chloride	1.5 U	1.5 U	1.2 U	1.4 U	1.2 U	4.9 U	6.9 U	5.5 U
Pentachloroethane	3.3 UJ	3.2 UJ	2.7 UJ	3 UJ	2.7 UJ	24 U	34 U	27 U
Propionitrile	31 UJ	31 UJ	26 UJ	29 UJ	26 UJ	98 U	140 U	110 U
Styrene	0.98 U	0.96 U	0.81 U	0.9 U	0.81 U	4.9 U	6.9 U	5.5 U
Tetrachloroethene	1.1 U	1.1 U	0.89 U	1 U	0.9 U	4.9 U	6.9 U	5.5 U
Toluene	1.2 U	1.1 U	0.97 U	1.1 U	0.97 U	4.9 U	6.9 U	5.5 U
trans-1,2-Dichloroethene	1.4 U	1.4 U	1.2 U	1.3 U	1.2 U	4.9 U	6.9 U	5.5 U
trans-1,3-Dichloropropene	1.3 U	1.3 U	1.1 U	1.2 U	1.1 U	4.9 U	6.9 U	5.5 U
trans-1,4-Dichloro-2-butene	4.6 U	4.5 U	3.8 U	4.2 U	3.8 U	9.8 U	14 U	11 U
Trichloroethene	1.5 U	1.5 U	1.2 U	1.4 U	1.2 U	4.9 U	6.9 U	5.5 U
Trichlorofluoromethane	2.2 U	2.2 U	1.8 U	2.1 U	1.8 U	4.9 U	6.9 U	5.5 U
Vinyl acetate	2.2 U	2.2 U	1.8 U	2.1 U	1.8 U	9.8 U	14 U	11 U
Vinyl chloride	0.86 U	0.84 U	0.71 U	0.79 U	0.72 U	4.9 U	6.9 U	5.5 U
Xylenes, Total	3.4 U	3.3 U	2.8 U	3.2 U	2.8 U	9.8 U	14 U	11 U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB231	74SB231	74SB231	74SB232	74SB232	74SB748	74SB748	74SB749
Sample ID	74SB231-00	74SB231-04	74SB231-05	74SB232-04	74SB232-05	74SB748-00	74SB748-01	74SB749-00
Date	5/20/2008	5/20/2008	5/20/2008	5/20/2008	5/20/2008	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	0.0-1.0	7.0-9.0	9.0-11.0	7.0-9.0	9.0-11.0	0.0-1.0	1.0-3.0	0.0-1.0
LLPAHs (ug/kg)								
1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	71 U	7.5 U	72 U
Acenaphthene	NA	NA	NA	NA	NA	71 U	7.5 U	72 U
Acenaphthylene	NA	NA	NA	NA	NA	71 U	7.5 U	72 U
Anthracene	NA	NA	NA	NA	NA	71 U	7.5 U	51 J
Benzo[a]anthracene	NA	NA	NA	NA	NA	71 U	7.5 U	190
Benzo[a]pyrene	NA	NA	NA	NA	NA	71 U	7.5 U	170
Benzo[b]fluoranthene	NA	NA	NA	NA	NA	71 U	7.5 U	190
Benzo[g,h,i]perylene	NA	NA	NA	NA	NA	43 J	7.5 U	170
Benzo[k]fluoranthene	NA	NA	NA	NA	NA	71 U	7.5 U	160
Chrysene	NA	NA	NA	NA	NA	39 J	7.5 U	210
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	71 U	7.5 U	57 J
Fluoranthene	NA	NA	NA	NA	NA	71 U	7.5 U	330
Fluorene	NA	NA	NA	NA	NA	71 U	7.5 U	72 U
Indeno[1,2,3-cd]pyrene	NA	NA	NA	NA	NA	71 U	7.5 U	110
Naphthalene	NA	NA	NA	NA	NA	71 U	7.5 U	72 U
Phenanthrene	NA	NA	NA	NA	NA	71 U	7.5 U	100
Pyrene	NA	NA	NA	NA	NA	71 U	7.5 U	320
Metals (mg/kg)								
Antimony	0.39 U	0.2 U	0.32 U	0.21 U	0.31 U	2 U	2.2 U	2.9
Arsenic	4.6	3.9	5.5	4.8	7.2	2	3.5	4.3
Barium	25	8.5	12	8.9	8.4	190 J	11 J	29 J
Beryllium	0.038 U	0.02 U	0.17 J	0.041 U	0.045 U	0.17	0.11 U	0.064 J
Cadmium	0.22	0.035 U	0.46	0.071 U	0.078 U	0.062 J	0.11 U	1.3
Chromium	8.4	1.8	6	2.2 J	5.1	7.3	3.5	20
Cobalt	2.7	1.1	3.4 J	1.3	1.8	6.3	0.37	2.6
Copper	14	1.1 U	5.4	1.7 U	2.8 U	12	1.9	45
Lead	35	0.18 U	1.9 J	0.26 U	0.48 U	4.6	0.32 J	120

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB231	74SB231	74SB231	74SB232	74SB232	74SB748	74SB748	74SB749
Sample ID	74SB231-00	74SB231-04	74SB231-05	74SB232-04	74SB232-05	74SB748-00	74SB748-01	74SB749-00
Date	5/20/2008	5/20/2008	5/20/2008	5/20/2008	5/20/2008	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	0.0-1.0	7.0-9.0	9.0-11.0	7.0-9.0	9.0-11.0	0.0-1.0	1.0-3.0	0.0-1.0
Metals (mg/kg) (Cont)								
Mercury	0.01 J	0.0044 U	0.0063 J	0.0046 U	0.0045 U	0.021 U	0.021 U	0.022
Nickel	2.9	0.86	1.9	1.1	1.7	4.8 J	1.2	4.3
Selenium	0.26 J	0.13 U	0.26 U	0.28 U	0.3 U	1	1.1 U	0.97 U
Silver	0.04 J	0.018 UJ	0.11 J	0.037 UJ	0.04 UJ	0.2 U	0.22 U	0.84
Thallium	0.25 U	0.13 U	0.26 U	0.28 U	0.3 U	0.2 U	0.057 J	0.054 J
Tin	8.4 U	4.5 U	8.8 U	9.2 U	10 U	20 U	22 U	19 U
Vanadium	18	2.9	30 J	4.8	12	46 J	5.1 J	21 J
Zinc	22	0.88 J	6.5 J	1.5 U	3.5 J	34	1.9 J	110
TPH DRO and GRO (mg/kg)								
Diesel Range Organics	69	1.6 U	16 J	1.4 U	3.6 U	410	3.7 U	150
Gasoline Range Organics	0.084 U	0.12 U	0.086 U	0.091 U	0.08 U	2500 J	28 J	35 J

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB749	74SB750	74SB750	74SB751	74SB751	74SB752	74SB752	74SB753
Sample ID	74SB749-01	74SB750-00	74SB750-01	74SB751-00	74SB751-01	74SB752-00	74SB752-01	74SB753-00
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	1.0-2.3	0.0-1.0	1.0-2.5	0.0-1.0	1.0-3.0	0.0-1.0	1.0-3.0	0.0-1.0
Volatile Organic Compounds (ug/kg)								
1,1,1,2-Tetrachloroethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
1,1,1-Trichloroethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
1,1-Dichloroethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
1,1-Dichloroethene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
1,2,3-Trichloropropane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
1,2-Dibromo-3-Chloropropane	12 U	10 U	13 U	10 U	9.7 U	8 U	9.6 U	8.2 U
1,2-Dibromoethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
1,2-Dichloroethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
1,2-Dichloropropane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
2-Butanone (MEK)	31 U	26 U	33 U	25 U	24 U	20 U	24 U	21 U
2-Hexanone	31 U	26 U	33 U	25 U	24 U	20 U	24 U	21 U
3-Chloro-1-propene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
4-Methyl-2-pentanone (MIBK)	31 U	26 U	33 U	25 U	24 U	20 U	24 U	21 U
Acetone	62 U	51 U	66 U	50 U	48 U	40 U	48 U	41 U
Acetonitrile	250 U	210 U	260 U	200 U	190 U	160 U	190 U	160 U
Acrolein	120 UJ	100 UJ	130 UJ	100 UJ	97 UJ	80 UJ	96 UJ	82 UJ
Acrylonitrile	120 U	100 U	130 U	100 U	97 U	80 U	96 U	82 U
Benzene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Bromodichloromethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Bromoform	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Bromomethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Carbon disulfide	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Carbon tetrachloride	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Chlorobenzene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Chloroethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Chloroform	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB749	74SB750	74SB750	74SB751	74SB751	74SB752	74SB752	74SB753
Sample ID	74SB749-01	74SB750-00	74SB750-01	74SB751-00	74SB751-01	74SB752-00	74SB752-01	74SB753-00
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	1.0-2.3	0.0-1.0	1.0-2.5	0.0-1.0	1.0-3.0	0.0-1.0	1.0-3.0	0.0-1.0
Volatile Organic Compounds (ug/kg) (Cont)								
Chloromethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Chloroprene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
cis-1,3-Dichloropropene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Dibromochloromethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Dibromomethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Dichlorodifluoromethane	6.2 UJ	5.1 UJ	6.6 UJ	5 UJ	4.8 UJ	4 UJ	4.8 UJ	4.1 UJ
Ethyl methacrylate	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Ethylbenzene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Iodomethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Isobutyl alcohol	250 U	210 U	260 U	200 U	190 U	160 U	190 U	160 U
Methacrylonitrile	120 U	100 U	130 U	100 U	97 U	80 U	96 U	82 U
Methyl methacrylate	12 U	10 U	13 U	10 U	9.7 U	8 U	9.6 U	8.2 U
Methylene Chloride	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Pentachloroethane	31 U	26 U	33 U	25 U	24 U	20 U	24 U	21 U
Propionitrile	120 U	100 U	130 U	100 U	97 U	80 U	96 U	82 U
Styrene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Tetrachloroethene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Toluene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
trans-1,2-Dichloroethene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
trans-1,3-Dichloropropene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
trans-1,4-Dichloro-2-butene	12 U	10 U	13 U	10 U	9.7 U	8 U	9.6 U	8.2 U
Trichloroethene	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Trichlorofluoromethane	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Vinyl acetate	12 U	10 U	13 U	10 U	9.7 U	8 U	9.6 U	8.2 U
Vinyl chloride	6.2 U	5.1 U	6.6 U	5 U	4.8 U	4 U	4.8 U	4.1 U
Xylenes, Total	12 U	10 U	13 U	10 U	9.7 U	8 U	9.6 U	8.2 U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB749	74SB750	74SB750	74SB751	74SB751	74SB752	74SB752	74SB753
Sample ID	74SB749-01	74SB750-00	74SB750-01	74SB751-00	74SB751-01	74SB752-00	74SB752-01	74SB753-00
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	1.0-2.3	0.0-1.0	1.0-2.5	0.0-1.0	1.0-3.0	0.0-1.0	1.0-3.0	0.0-1.0
LLPAHs (ug/kg)								
1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	72 U	69 U	7.1 U	74 U	74 U	72 U	7.3 U	69 U
Acenaphthene	72 U	69 U	7.1 U	74 U	74 U	72 U	7.3 U	69 U
Acenaphthylene	72 U	69 U	7.1 U	74 U	74 U	72 U	7.3 U	69 U
Anthracene	72 U	69 U	6.1 J	74 U	74 U	72 U	7.3 U	69 U
Benzo[a]anthracene	72 U	140	23	78	72 J	72 U	7.3 U	69 U
Benzo[a]pyrene	66 J	200	45	90	63 J	25 J	7.3 U	120
Benzo[b]fluoranthene	110	230	45	74 U	74 U	72 U	4.7 J	69 U
Benzo[g,h,i]perylene	62 J	92	30	52 J	74 U	72 U	7.3 U	69 U
Benzo[k]fluoranthene	41 J	170	36	130	83	72 U	2.3 J	69 U
Chrysene	42 J	160	24	100	62 J	72 U	7.3 U	74
Dibenz(a,h)anthracene	72 U	45 J	10	74 U	74 U	72 U	7.3 U	69 U
Fluoranthene	72 U	120	10	110	110	72 U	7.3 U	69 U
Fluorene	72 U	69 U	7.1 U	74 U	74 U	72 U	7.3 U	69 U
Indeno[1,2,3-cd]pyrene	46 J	84	27	38 J	74 U	72 U	7.3 U	69 U
Naphthalene	72 U	69 U	7.1 U	74 U	74 U	72 U	7.3 U	69 U
Phenanthrene	72 U	69 U	7.1 U	35 J	32 J	26 J	7.3 U	26 J
Pyrene	72 U	160	15	140	110	72 U	7.3 U	52 J
Metals (mg/kg)								
Antimony	2.9	2 U	2.1 U	2.1 U	2.1 U	2 U	2.1 U	2 U
Arsenic	3.4	4.2	3.3	4.7	4.1	1.7	2	1.6
Barium	21 J	44 J	34 J	55 J	56 J	150 J	9.7 J	110 J
Beryllium	0.11 U	0.078 J	0.11 U	0.093 J	0.054 J	0.14	0.11 U	0.25
Cadmium	2.8	0.18	0.029 J	0.086 J	0.044 J	0.047 J	0.11 U	0.12
Chromium	13	13	4.7	15	10	4.2	11	9.5
Cobalt	1.7	3	0.97	9.3	2	6.5	0.57	7.3
Copper	53	16	4.5	49	7.7	17	2.2	22
Lead	110	32	3.8	7.6	3.7	3.5	0.97	8.8

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB749	74SB750	74SB750	74SB751	74SB751	74SB752	74SB752	74SB753
Sample ID	74SB749-01	74SB750-00	74SB750-01	74SB751-00	74SB751-01	74SB752-00	74SB752-01	74SB753-00
Date	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Depth Range (ft bgs)	1.0-2.3	0.0-1.0	1.0-2.5	0.0-1.0	1.0-3.0	0.0-1.0	1.0-3.0	0.0-1.0
Metals (mg/kg) (Cont)								
Mercury	0.027	0.02	0.0098 J	0.014 J	0.016 J	0.0092 J	0.011 J	0.016 J
Nickel	4.2	3.2	1.7	8	2.6	3.7	1.9	6.9
Selenium	1.1 U	0.98 U	1.1 U	0.77 J	1 U	1.5	1.1 U	1.8
Silver	0.4	0.2 U	0.21 U	0.21 U	0.21 U	0.2 U	0.21 U	0.2 U
Thallium	0.22 U	0.068 J	0.21 U	0.21 U	0.21 U	0.2 U	0.21 U	0.2 U
Tin	22 U	20 U	21 U	21 U	21 U	20 U	21 U	20 U
Vanadium	14 J	22 J	11 J	60 J	20 J	40 J	5.5 J	64 J
Zinc	110	920	39	36	16	37	2.4 J	49
TPH DRO and GRO (mg/kg)								
Diesel Range Organics	37	47	15	44	32	78	20	400
Gasoline Range Organics	31 J	26 J	14 J	26 J	11 J	12 J	23 J	16 J

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB753	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB760
Sample ID	74SB753-01	74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB760-00
Date	4/18/2011	4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	1.0-3.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Volatile Organic Compounds (ug/kg)								
1,1,1,2-Tetrachloroethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1,1-Trichloroethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1-Dichloroethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,1-Dichloroethene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2,3-Trichloropropane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2-Dibromo-3-Chloropropane	10 U	11 U	12 U	13 U	12 U	11 U	11 U	11 U
1,2-Dibromoethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2-Dichloroethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
1,2-Dichloropropane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
2-Butanone (MEK)	25 U	28 U	30 U	31 U	31 U	27 U	28 U	27 U
2-Hexanone	25 U	28 U	30 U	31 U	31 U	27 U	28 U	27 U
3-Chloro-1-propene	5 U	5.6 U	6 U	6.3 UJ	6.1 UJ	5.3 UJ	5.6 UJ	5.4 UJ
4-Methyl-2-pentanone (MIBK)	25 U	28 U	30 U	31 U	31 U	27 U	28 U	27 U
Acetone	50 U	56 U	60 U	63 U	61 U	53 U	56 U	54 U
Acetonitrile	200 U	220 U	240 U	250 U	240 U	210 U	220 U	220 U
Acrolein	100 UJ	110 U	120 U	130 UJ	120 UJ	110 UJ	110 UJ	110 UJ
Acrylonitrile	100 U	110 U	120 U	130 U	120 U	110 U	110 U	110 U
Benzene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Bromodichloromethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Bromoform	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Bromomethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Carbon disulfide	5 U	5.9	5.5 J	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Carbon tetrachloride	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Chlorobenzene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Chloroethane	5 U	5.6 U	6 U	6.3 UJ	6.1 UJ	5.3 UJ	5.6 UJ	5.4 UJ
Chloroform	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB753	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB760
Sample ID	74SB753-01	74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB760-00
Date	4/18/2011	4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	1.0-3.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Volatile Organic Compounds (ug/kg) (Cont)								
Chloromethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Chloroprene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
cis-1,3-Dichloropropene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Dibromochloromethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Dibromomethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Dichlorodifluoromethane	5 UJ	5.6 UJ	6 UJ	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Ethyl methacrylate	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Ethylbenzene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Iodomethane	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Isobutyl alcohol	200 U	220 U	240 U	250 U	240 U	210 U	220 U	220 U
Methacrylonitrile	100 U	110 U	120 U	130 U	120 U	110 U	110 U	110 U
Methyl methacrylate	10 U	11 U	12 U	13 U	12 U	11 U	11 U	11 U
Methylene Chloride	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Pentachloroethane	25 U	28 U	30 U	31 U	31 U	27 U	28 U	27 U
Propionitrile	100 U	110 U	120 U	130 U	120 U	110 U	110 U	110 U
Styrene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Tetrachloroethene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Toluene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
trans-1,2-Dichloroethene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
trans-1,3-Dichloropropene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
trans-1,4-Dichloro-2-butene	10 U	11 U	12 U	13 U	12 U	11 U	11 U	11 U
Trichloroethene	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Trichlorofluoromethane	5 U	5.6 U	6 U	6.3 UJ	6.1 UJ	5.3 UJ	5.6 UJ	5.4 UJ
Vinyl acetate	10 U	11 U	12 U	13 U	12 U	11 U	11 UJ	11 U
Vinyl chloride	5 U	5.6 U	6 U	6.3 U	6.1 U	5.3 U	5.6 U	5.4 U
Xylenes, Total	10 U	11 U	12 U	13 U	12 U	11 U	11 U	11 U

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB753	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB760
Sample ID	74SB753-01	74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB760-00
Date	4/18/2011	4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	1.0-3.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
LLPAHs (ug/kg)								
1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	72 U	71 U	75 U	4.2 J	7.4 U	7.2 U	7.2 U	7.2 U
Acenaphthene	72 U	71 U	75 U	7.2 U	7.4 U	7.2 U	3.8 J	9.4
Acenaphthylene	72 U	71 U	75 U	11	7.4 U	7.2 U	17	17
Anthracene	72 U	71 U	75 U	25	4 J	4.5 J	26	52
Benzo[a]anthracene	72 U	71 U	75 U	63	13	37	160 J	140
Benzo[a]pyrene	25 J	44 J	59 J	110	20	50	180 J	140
Benzo[b]fluoranthene	72 U	73	68 J	200	36	89	270 J	240
Benzo[g,h,i]perylene	72 U	36 J	76	53	7.4 U	24	52	66
Benzo[k]fluoranthene	72 U	71 U	56 J	180	33	73	230 J	210
Chrysene	72 U	71 U	46 J	110	31	50	200 J	250
Dibenz(a,h)anthracene	72 U	71 U	75 U	20	7.4 U	7.2 U	7.2 U	22
Fluoranthene	72 U	71 U	43 J	97	32	50	300 J	400
Fluorene	72 U	71 U	75 U	7.2 U	7.4 U	7.2 U	3.6 J	7.6
Indeno[1,2,3-cd]pyrene	72 U	71 U	44 J	26	5 J	12	26	36
Naphthalene	72 U	71 U	75 U	7.2 U	7.4 U	7.2 U	7.2 U	7.2 U
Phenanthrene	72 U	71 U	75 U	40	6.2 J	8.6	78 J	180
Pyrene	72 U	71 U	51 J	110	33	58	350 J	430
Metals (mg/kg)								
Antimony	2.1 U	2 U	2.2 U	1.8 J	2.1 U	2.1 U	2.1 U	2 U
Arsenic	3.6	3.5	2.9	21	3.7	5.1	5.2	6.8
Barium	35 J	65 J	54 J	38 J	44 J	17 J	15 J	20 J
Beryllium	0.072 J	0.079 J	0.095 J	0.059 J	0.099 J	0.06 J	0.11 U	0.099 U
Cadmium	0.11 U	0.73	1.8	0.7	0.11	0.51	0.11	0.18
Chromium	5.1	11	18	27	19	11	9.4	7.8
Cobalt	2.2	4.8	10	10 J	6.5 J	2.9 J	1.9 J	1.7 J
Copper	28	22	48	59	39	550	9.3	15
Lead	6.4	25 R	50 R	58	35	71	6.7	7.3

APPENDIX H

SUMMARY OF HUMAN HEALTH ANALYTICAL RESULTS, TOTAL SOIL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Site ID	74SB753	74SB754	74SB755	74SB756	74SB757	74SB758	74SB759	74SB760
Sample ID	74SB753-01	74SB754-00	74SB755-00	74SB756-00	74SB757-00	74SB758-00	74SB759-00	74SB760-00
Date	4/18/2011	4/19/2011	4/19/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011	4/29/2011
Depth Range (ft bgs)	1.0-3.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0	0.0-1.0
Metals (mg/kg) (Cont)								
Mercury	0.012 J	0.0093 J	0.012 J	0.21	0.021 U	0.015 J	0.02 U	0.02 U
Nickel	2.9	4	8.5	27	9.1	3.9	4.2	2.2
Selenium	1.1 U	0.87 J	0.83 J	0.97 U	1.1 U	1.1 U	1.1 U	0.99 U
Silver	0.21 U	0.2 U	0.16 J	0.1 J	0.21 U	0.83	0.21 U	0.2 U
Thallium	0.21 U	0.16 J	0.21 J	0.061 J	0.21 U	0.21 U	0.21 U	0.2 U
Tin	21 U	20 U	22 U	19 U	21 U	21 U	21 U	20 U
Vanadium	20 J	34	62	29	48	31	18	13
Zinc	11	40	100	250	33	230	12	28
TPH DRO and GRO (mg/kg)								
Diesel Range Organics	31	56	110	36	24	25	32 J	71
Gasoline Range Organics	19 J	0.12 J	0.26 J	0.31 U	0.31 U	0.3 U	0.32 UJ	0.3 U

APPENDIX I
HHRA STATISTICAL SUMMARY (ProUCL Computational Output)

APPENDIX I

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - SURFACE SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\Documents and Settings\dlanigan\My Documents\00 Projects\Puerto Rico\SWMU 74\Fueling Piers Area\Tables\SSp.xls.w
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo[a]anthracene

General Statistics

Number of Valid Data	13	Number of Detected Data	8
Number of Distinct Detected Data	7	Number of Non-Detect Data	5
		Percent Non-Detects	38.46%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	13	Minimum Detected	2.565
Maximum Detected	190	Maximum Detected	5.247
Mean of Detected	102.6	Mean of Detected	4.36
SD of Detected	63.51	SD of Detected	0.911
Minimum Non-Detect	69	Minimum Non-Detect	4.234
Maximum Non-Detect	75	Maximum Non-Detect	4.317

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	8
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	5
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	61.54%

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

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.94	Shapiro Wilk Test Statistic	0.879
5% Shapiro Wilk Critical Value	0.818	5% Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	76.92	Mean	4.059
SD	59.15	SD	0.801
95% DL/2 (t) UCL	106.2	95% H-Stat (DL/2) UCL	142.9
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	53.91	Mean in Log Scale	4.01
SD	84.77	SD in Log Scale	0.843
95% MLE (t) UCL	95.81	Mean in Original Scale	75.5
95% MLE (Tiku) UCL	114.2	SD in Original Scale	60.36
		95% t UCL	105.3
		95% Percentile Bootstrap UCL	102
		95% BCA Bootstrap UCL	106.3
		95% H UCL	147.8

Benzo[a]anthracene (Continued)

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.331	Data appear Normal at 5% Significance Level	
Theta Star	77.11		
nu star	21.29		
A-D Test Statistic	0.372	Nonparametric Statistics	
5% A-D Critical Value	0.724	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.724	Mean	77.64
5% K-S Critical Value	0.297	SD	57.72
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	18.18
		95% KM (t) UCL	110
Assuming Gamma Distribution		95% KM (z) UCL	107.5
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	111.2
Minimum	11.94	95% KM (bootstrap t) UCL	114.2
Maximum	190	95% KM (BCA) UCL	110.4
Mean	77.25	95% KM (Percentile Bootstrap) UCL	108.6
Median	60.36	95% KM (Chebyshev) UCL	156.9
SD	59.72	97.5% KM (Chebyshev) UCL	191.2
k star	1.35	99% KM (Chebyshev) UCL	258.5
Theta star	57.22		
Nu star	35.1	Potential UCLs to Use	
AppChi2	22.54	95% KM (t) UCL	110
95% Gamma Approximate UCL	120.3	95% KM (Percentile Bootstrap) UCL	108.6
95% Adjusted Gamma UCL	128.4		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

**HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - SURFACE SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO**

Benzo[a]pyrene

General Statistics

Number of Valid Data	13	Number of Detected Data	12
Number of Distinct Detected Data	12	Number of Non-Detect Data	1
		Percent Non-Detects	7.69%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	20	Minimum Detected	2.996
Maximum Detected	200	Maximum Detected	5.298
Mean of Detected	100.7	Mean of Detected	4.379
SD of Detected	62.4	SD of Detected	0.775
Minimum Non-Detect	71	Minimum Non-Detect	4.263
Maximum Non-Detect	71	Maximum Non-Detect	4.263

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.935	Shapiro Wilk Test Statistic	0.923
5% Shapiro Wilk Critical Value	0.859	5% Shapiro Wilk Critical Value	0.859
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	95.65	Mean	4.316
SD	62.42	SD	0.775
95% DL/2 (t) UCL	126.5	95% H-Stat (DL/2) UCL	176.3
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	84.68	Mean in Log Scale	4.326
SD	75.92	SD in Log Scale	0.766
95% MLE (t) UCL	122.2	Mean in Original Scale	96
95% MLE (Tiku) UCL	129.2	SD in Original Scale	62.07
		95% t UCL	126.7
		95% Percentile Bootstrap UCL	123.5
		95% BCA Bootstrap UCL	123.5
		95% H UCL	175

Benzo[a]pyrene (Continued)

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.779	Data appear Normal at 5% Significance Level	
Theta Star	56.58		
nu star	42.7		
A-D Test Statistic	0.306	**Nonparametric Statistics**	
5% A-D Critical Value	0.741	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.741	Mean	95.97
5% K-S Critical Value	0.248	SD	59.81
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	17.37
		95% KM (t) UCL	126.9
Assuming Gamma Distribution		95% KM (z) UCL	124.5
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	126.9
Minimum	20	95% KM (bootstrap t) UCL	130.4
Maximum	200	95% KM (BCA) UCL	123.6
Mean	96.19	95% KM (Percentile Bootstrap) UCL	123
Median	90	95% KM (Chebyshev) UCL	171.7
SD	61.89	97.5% KM (Chebyshev) UCL	204.5
k star	1.798	99% KM (Chebyshev) UCL	268.8
Theta star	53.49		
Nu star	46.75	Potential UCLs to Use	
AppChi2	32.06	95% KM (t) UCL	126.9
95% Gamma Approximate UCL	140.3	95% KM (Percentile Bootstrap) UCL	123
95% Adjusted Gamma UCL	148.2		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - SURFACE SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Benzo[b]fluoranthene

General Statistics

Number of Valid Data	13	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	4
		Percent Non-Detects	30.77%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	36	Minimum Detected	3.584
Maximum Detected	270	Maximum Detected	5.598
Mean of Detected	155.1	Mean of Detected	4.849
SD of Detected	88.13	SD of Detected	0.717
Minimum Non-Detect	69	Minimum Non-Detect	4.234
Maximum Non-Detect	74	Maximum Non-Detect	4.304

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	7
Number treated as Detected	6
Single DL Non-Detect Percentage	53.85%

Warning: There are only 9 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.89	Shapiro Wilk Test Statistic	0.878
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	118.4	Mean	4.458
SD	92.01	SD	0.847
95% DL/2 (t) UCL	163.9	95% H-Stat (DL/2) UCL	232.6
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	72.18	Mean in Log Scale	4.566
SD	142.2	SD in Log Scale	0.735
95% MLE (t) UCL	142.5	Mean in Original Scale	123
95% MLE (Tiku) UCL	162.3	SD in Original Scale	87.69
		95% t UCL	166.4
		95% Percentile Bootstrap UCL	161.9
		95% BCA Bootstrap UCL	163.4
		95% H UCL	210.3

Benzo[b]fluoranthene (Continued)

Gamma Distribution Test with Detected Values Only			**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.889		Data appear Normal at 5% Significance Level	
Theta Star	82.1			
nu star	34.01			
A-D Test Statistic	0.567		**Nonparametric Statistics**	
5% A-D Critical Value	0.728		Kaplan-Meier (KM) Method	
K-S Test Statistic	0.728		Mean	123.7
5% K-S Critical Value	0.282		SD	84.18
Data appear Gamma Distributed at 5% Significance Level			SE of Mean	25.16
			95% KM (t) UCL	168.5
Assuming Gamma Distribution			95% KM (z) UCL	165
Gamma ROS Statistics using Extrapolated Data			95% KM (jackknife) UCL	169.3
Minimum	32.81		95% KM (bootstrap t) UCL	173.6
Maximum	270		95% KM (BCA) UCL	166.6
Mean	118.8		95% KM (Percentile Bootstrap) UCL	167.2
Median	73		95% KM (Chebyshev) UCL	233.3
SD	91.67		97.5% KM (Chebyshev) UCL	280.8
k star	1.393		99% KM (Chebyshev) UCL	374
Theta star	85.31			
Nu star	36.22		**Potential UCLs to Use**	
AppChi2	23.44		95% KM (t) UCL	168.5
95% Gamma Approximate UCL	183.6		95% KM (Percentile Bootstrap) UCL	167.2
95% Adjusted Gamma UCL	195.7			

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

APPENDIX I

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - SURFACE SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Benzo[k]fluoranthene

General Statistics

Number of Valid Data	13	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	4
		Percent Non-Detects	30.77%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	33	Minimum Detected	3.497
Maximum Detected	230	Maximum Detected	5.438
Mean of Detected	138	Mean of Detected	4.763
SD of Detected	69.78	SD of Detected	0.671
Minimum Non-Detect	69	Minimum Non-Detect	4.234
Maximum Non-Detect	72	Maximum Non-Detect	4.277

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	6
Number treated as Detected	7
Single DL Non-Detect Percentage	46.15%

Warning: There are only 9 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.935	Shapiro Wilk Test Statistic	0.876
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	106.4	Mean	4.395
SD	75.35	SD	0.794
95% DL/2 (t) UCL	143.7	95% H-Stat (DL/2) UCL	197.6
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	89.07	Mean in Log Scale	4.481
SD	96.59	SD in Log Scale	0.708
95% MLE (t) UCL	136.8	Mean in Original Scale	110.1
95% MLE (Tiku) UCL	145.7	SD in Original Scale	71.83
		95% t UCL	145.6
		95% Percentile Bootstrap UCL	143.9
		95% BCA Bootstrap UCL	143.3
		95% H UCL	184.8

Benzo[k]fluoranthene (Continued)

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	2.211	Data appear Normal at 5% Significance Level	
Theta Star	62.42		
nu star	39.8		
A-D Test Statistic	0.476	**Nonparametric Statistics**	
5% A-D Critical Value	0.726	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.726	Mean	109.2
5% K-S Critical Value	0.281	SD	70
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	20.85
		95% KM (t) UCL	146.4
Assuming Gamma Distribution		95% KM (z) UCL	143.5
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	146.9
Minimum	6.734	95% KM (bootstrap t) UCL	148.7
Maximum	230	95% KM (BCA) UCL	149.5
Mean	106.5	95% KM (Percentile Bootstrap) UCL	150.5
Median	73	95% KM (Chebyshev) UCL	200.1
SD	76.16	97.5% KM (Chebyshev) UCL	239.4
k star	1.256	99% KM (Chebyshev) UCL	316.7
Theta star	84.77		
Nu star	32.65	Potential UCLs to Use	
AppChi2	20.59	95% KM (t) UCL	146.4
95% Gamma Approximate UCL	168.8	95% KM (Percentile Bootstrap) UCL	150.5
95% Adjusted Gamma UCL	180.7		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Chrysene

General Statistics

Number of Valid Data	13	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	2
		Percent Non-Detects	15.38%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	31	Minimum Detected	3.434
Maximum Detected	250	Maximum Detected	5.521
Mean of Detected	115.5	Mean of Detected	4.517
SD of Detected	77.62	SD of Detected	0.738
Minimum Non-Detect	71	Minimum Non-Detect	4.263
Maximum Non-Detect	72	Maximum Non-Detect	4.277

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	6
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	7
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	46.15%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.896	Shapiro Wilk Test Statistic	0.932
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	103.2	Mean	4.373
SD	76.92	SD	0.761
95% DL/2 (t) UCL	141.2	95% H-Stat (DL/2) UCL	181.7
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	82.98	Mean in Log Scale	4.404
SD	100.4	SD in Log Scale	0.729
95% MLE (t) UCL	132.6	Mean in Original Scale	104.4
95% MLE (Tiku) UCL	141.8	SD in Original Scale	75.8
		95% t UCL	141.9
		95% Percentile Bootstrap UCL	138
		95% BCA Bootstrap UCL	146
		95% H UCL	177.1

Chrysene (Continued)

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.742	Data appear Normal at 5% Significance Level	
Theta Star	66.28		
nu star	38.32		
A-D Test Statistic	0.361	**Nonparametric Statistics**	
5% A-D Critical Value	0.737	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.737	Mean	104.1
5% K-S Critical Value	0.258	SD	73.17
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	21.31
		95% KM (t) UCL	142.1
Assuming Gamma Distribution		95% KM (z) UCL	139.1
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	141.8
Minimum	31	95% KM (bootstrap t) UCL	149.4
Maximum	250	95% KM (BCA) UCL	135.5
Mean	103.7	95% KM (Percentile Bootstrap) UCL	139.9
Median	74	95% KM (Chebyshev) UCL	197
SD	76.48	97.5% KM (Chebyshev) UCL	237.2
k star	1.671	99% KM (Chebyshev) UCL	316.1
Theta star	62.05		
Nu star	43.44	Potential UCLs to Use	
AppChi2	29.33	95% KM (t) UCL	142.1
95% Gamma Approximate UCL	153.6	95% KM (Percentile Bootstrap) UCL	139.9
95% Adjusted Gamma UCL	162.7		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Dibenz(a,h)anthracene

General Statistics

Number of Valid Data	13	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	9
		Percent Non-Detects	69.23%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	20	Minimum Detected	2.996
Maximum Detected	57	Maximum Detected	4.043
Mean of Detected	36	Mean of Detected	3.484
SD of Detected	18.02	SD of Detected	0.519
Minimum Non-Detect	7.2	Minimum Non-Detect	1.974
Maximum Non-Detect	75	Maximum Non-Detect	4.317

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	13
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 4 Distinct Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.88	Shapiro Wilk Test Statistic	0.871
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	28.53	Mean	3.023
SD	16.83	SD	1.023
95% DL/2 (t) UCL	36.85	95% H-Stat (DL/2) UCL	81.4
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	2.839
		SD in Log Scale	0.66
		Mean in Original Scale	20.94
		SD in Original Scale	14.81
		95% t UCL	28.26
		95% Percentile Bootstrap UCL	27.75
		95% BCA Bootstrap UCL	29.19
		95% H-UCL	33.02

Dibenz(a,h)anthracene (Continued)

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.464	Data appear Normal at 5% Significance Level	
Theta Star	24.58		
nu star	11.72		
A-D Test Statistic	0.428	Nonparametric Statistics	
5% A-D Critical Value	0.659	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.659	Mean	29.14
5% K-S Critical Value	0.396	SD	14.21
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	6.2
		95% KM (t) UCL	40.19
Assuming Gamma Distribution		95% KM (z) UCL	39.34
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	39.48
Minimum	0.000001	95% KM (bootstrap t) UCL	42.19
Maximum	57	95% KM (BCA) UCL	N/A
Mean	16.63	95% KM (Percentile Bootstrap) UCL	49.5
Median	10.37	95% KM (Chebyshev) UCL	56.17
SD	18.11	97.5% KM (Chebyshev) UCL	67.86
k star	0.169	99% KM (Chebyshev) UCL	90.84
Theta star	98.38		
Nu star	4.394	Potential UCLs to Use	
AppChi2	0.883	95% KM (t) UCL	40.19
95% Gamma Approximate UCL	82.71	95% KM (Percentile Bootstrap) UCL	49.5
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Indeno[1,2,3-cd]pyrene

General Statistics

Number of Valid Data	13	Number of Detected Data	9
Number of Distinct Detected Data	8	Number of Non-Detect Data	4
		Percent Non-Detects	30.77%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	5	Minimum Detected	1.609
Maximum Detected	110	Maximum Detected	4.7
Mean of Detected	42.33	Mean of Detected	3.416
SD of Detected	33.96	SD of Detected	0.94
Minimum Non-Detect	69	Minimum Non-Detect	4.234
Maximum Non-Detect	72	Maximum Non-Detect	4.277

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	11
Number treated as Detected	2
Single DL Non-Detect Percentage	84.62%

Warning: There are only 9 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.876	Shapiro Wilk Test Statistic	0.949
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	40.19	Mean	3.462
SD	27.93	SD	0.771
95% DL/2 (t) UCL	54	95% H-Stat (DL/2) UCL	74.5
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	3.316
		SD in Log Scale	0.797
		Mean in Original Scale	36.29
		SD in Original Scale	29.46
		95% t UCL	50.86
		95% Percentile Bootstrap UCL	50.74
		95% BCA Bootstrap UCL	53.25
		95% H-UCL	67.5

Indeno[1,2,3-cd]pyrene (Continued)

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**		
k star (bias corrected)	1.185	Data appear Normal at 5% Significance Level		
Theta Star	35.73			
nu star	21.32			
A-D Test Statistic	0.236	**Nonparametric Statistics**		
5% A-D Critical Value	0.733		Kaplan-Meier (KM) Method	
K-S Test Statistic	0.733		Mean	37.53
5% K-S Critical Value	0.283		SD	28.54
Data appear Gamma Distributed at 5% Significance Level			SE of Mean	8.812
			95% KM (t) UCL	53.23
Assuming Gamma Distribution			95% KM (z) UCL	52.02
Gamma ROS Statistics using Extrapolated Data			95% KM (jackknife) UCL	53.18
Minimum	5		95% KM (bootstrap t) UCL	59.83
Maximum	110		95% KM (BCA) UCL	53.08
Mean	38.99		95% KM (Percentile Bootstrap) UCL	51.38
Median	31.6		95% KM (Chebyshev) UCL	75.94
SD	28.86		97.5% KM (Chebyshev) UCL	92.56
k star	1.666		99% KM (Chebyshev) UCL	125.2
Theta star	23.41			
Nu star	43.31	Potential UCLs to Use		
AppChi2	29.22		95% KM (t) UCL	53.23
95% Gamma Approximate UCL	57.79		95% KM (Percentile Bootstrap) UCL	51.38
95% Adjusted Gamma UCL	61.23			

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Arsenic

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	14
Raw Statistics		**Log-transformed Statistics**	
Minimum	1.6	Minimum of Log Data	0.47
Maximum	21	Maximum of Log Data	3.045
Mean	5.093	Mean of log Data	1.395
Median	4.25	SD of log Data	0.644
SD	4.807		
Std. Error of Mean	1.285		
Coefficient of Variation	0.944		
Skewness	3.152		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.587	Shapiro Wilk Test Statistic	0.899
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	7.368	95% H-UCL	7.447
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.699
95% Adjusted-CLT UCL (Chen-1995)	8.362	97.5% Chebyshev (MVUE) UCL	10.35
95% Modified-t UCL (Johnson-1978)	7.548	99% Chebyshev (MVUE) UCL	13.6
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.853	Data appear Lognormal at 5% Significance Level	
Theta Star	2.748		
MLE of Mean	5.093		
MLE of Standard Deviation	3.741		
nu star	51.88		
Approximate Chi Square Value (.05)	36.34	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0312	95% CLT UCL	7.206
Adjusted Chi Square Value	34.62	95% Jackknife UCL	7.368
		95% Standard Bootstrap UCL	7.151
Anderson-Darling Test Statistic	0.907	95% Bootstrap-t UCL	10.97
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	16.55
Kolmogorov-Smirnov Test Statistic	0.257	95% Percentile Bootstrap UCL	7.557
Kolmogorov-Smirnov 5% Critical Value	0.231	95% BCA Bootstrap UCL	8.736
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10.69
		97.5% Chebyshev(Mean, Sd) UCL	13.12
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	17.87
95% Approximate Gamma UCL	7.271		
95% Adjusted Gamma UCL	7.633		
Potential UCL to Use		Use 95% H-UCL	7.447

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - SURFACE SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Cobalt

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	12
Raw Statistics		**Log-transformed Statistics**	
Minimum	1.7	Minimum of Log Data	0.531
Maximum	10	Maximum of Log Data	2.303
Mean	5.393	Mean of log Data	1.519
Median	5.55	SD of log Data	0.622
SD	3.01		
Std. Error of Mean	0.805		
Coefficient of Variation	0.558		
Skewness	0.335		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.894	Shapiro Wilk Test Statistic	0.908
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.818	95% H-UCL	8.156
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.569
95% Adjusted-CLT UCL (Chen-1995)	6.793	97.5% Chebyshev (MVUE) UCL	11.35
95% Modified-t UCL (Johnson-1978)	6.83	99% Chebyshev (MVUE) UCL	14.85
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.531	Data appear Normal at 5% Significance Level	
Theta Star	2.131		
MLE of Mean	5.393		
MLE of Standard Deviation	3.39		
nu star	70.86		
Approximate Chi Square Value (.05)	52.48	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0312	95% CLT UCL	6.716
Adjusted Chi Square Value	50.39	95% Jackknife UCL	6.818
		95% Standard Bootstrap UCL	6.627
Anderson-Darling Test Statistic	0.546	95% Bootstrap-t UCL	6.941
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	6.722
Kolmogorov-Smirnov Test Statistic	0.203	95% Percentile Bootstrap UCL	6.686
Kolmogorov-Smirnov 5% Critical Value	0.23	95% BCA Bootstrap UCL	6.771
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	8.9
		97.5% Chebyshev(Mean, Sd) UCL	10.42
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	13.4
95% Approximate Gamma UCL	7.282		
95% Adjusted Gamma UCL	7.584		
Potential UCL to Use		Use 95% Student's-t UCL	6.818

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Copper

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	9.3	Minimum of Log Data	2.23
Maximum	550	Maximum of Log Data	6.31
Mean	65.52	Mean of log Data	3.391
Median	22	SD of log Data	1.03
SD	140.4		
Std. Error of Mean	37.53		
Coefficient of Variation	2.143		
Skewness	3.653		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.398	Shapiro Wilk Test Statistic	0.827
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	132	95% H-UCL	113.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	110.4
95% Adjusted-CLT UCL (Chen-1995)	166.4	97.5% Chebyshev (MVUE) UCL	137.5
95% Modified-t UCL (Johnson-1978)	138.1	99% Chebyshev (MVUE) UCL	190.6

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.641	Data do not follow a Discernable Distribution (0.05)	
Theta Star	102.2		
MLE of Mean	65.52		
MLE of Standard Deviation	81.82		
nu star	17.95		
Approximate Chi Square Value (.05)	9.357	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0312	95% CLT UCL	127.2
Adjusted Chi Square Value	8.544	95% Jackknife UCL	132
		95% Standard Bootstrap UCL	125.2
Anderson-Darling Test Statistic	1.861	95% Bootstrap-t UCL	467.4
Anderson-Darling 5% Critical Value	0.77	95% Hall's Bootstrap UCL	392.4
Kolmogorov-Smirnov Test Statistic	0.31	95% Percentile Bootstrap UCL	140.1
Kolmogorov-Smirnov 5% Critical Value	0.238	95% BCA Bootstrap UCL	182.1
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	229.1
		97.5% Chebyshev(Mean, Sd) UCL	299.9
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	438.9
95% Approximate Gamma UCL	125.7		
95% Adjusted Gamma UCL	137.7		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	229.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

**HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - SURFACE SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO**

Thallium

General Statistics

Number of Valid Data	14	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	9
		Percent Non-Detects	64.29%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.054	Minimum Detected	-2.919
Maximum Detected	0.21	Maximum Detected	-1.561
Mean of Detected	0.111	Mean of Detected	-2.359
SD of Detected	0.0704	SD of Detected	0.618
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	0.25	Maximum Non-Detect	-1.386

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	14
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 5 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.822	Shapiro Wilk Test Statistic	0.844
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.107	Mean	-2.293
SD	0.0396	SD	0.351
95% DL/2 (t) UCL	0.126	95% H-Stat (DL/2) UCL	0.13
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.493
		SD in Log Scale	0.439
		Mean in Original Scale	0.0912
		SD in Original Scale	0.0463
		95% t UCL	0.113
		95% Percentile Bootstrap UCL	0.112
		95% BCA Bootstrap UCL	0.117
		95% H-UCL	0.116

Thallium (Continued)

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.465	Data appear Normal at 5% Significance Level	
Theta Star	0.0755		
nu star	14.65		
A-D Test Statistic	0.548	**Nonparametric Statistics**	
5% A-D Critical Value	0.682	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.682	Mean	0.0953
5% K-S Critical Value	0.359	SD	0.0531
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0245
		95% KM (t) UCL	0.139
Assuming Gamma Distribution		95% KM (z) UCL	0.136
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.143
Minimum	0.0269	95% KM (bootstrap t) UCL	0.364
Maximum	0.21	95% KM (BCA) UCL	0.142
Mean	0.0984	95% KM (Percentile Bootstrap) UCL	0.141
Median	0.087	95% KM (Chebyshev) UCL	0.202
SD	0.0539	97.5% KM (Chebyshev) UCL	0.248
k star	2.596	99% KM (Chebyshev) UCL	0.339
Theta star	0.0379		
Nu star	72.69	Potential UCLs to Use	
AppChi2	54.06	95% KM (t) UCL	0.139
95% Gamma Approximate UCL	0.132	95% KM (Percentile Bootstrap) UCL	0.141
95% Adjusted Gamma UCL	0.138		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Vanadium

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	13

Raw Statistics		Log-transformed Statistics	
Minimum	13	Minimum of Log Data	2.565
Maximum	64	Maximum of Log Data	4.159
Mean	36.14	Mean of log Data	3.47
Median	32.5	SD of log Data	0.516
SD	17.48		
Std. Error of Mean	4.671		
Coefficient of Variation	0.484		
Skewness	0.404		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.919	Shapiro Wilk Test Statistic	0.945
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	44.42	95% H-UCL	49.08
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	58.83
95% Adjusted-CLT UCL (Chen-1995)	44.37	97.5% Chebyshev (MVUE) UCL	68.56
95% Modified-t UCL (Johnson-1978)	44.5	99% Chebyshev (MVUE) UCL	87.68
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.513	Data appear Normal at 5% Significance Level	
Theta Star	10.29		
MLE of Mean	36.14		
MLE of Standard Deviation	19.28		
nu star	98.37		
Approximate Chi Square Value (.05)	76.49	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0312	95% CLT UCL	43.83
Adjusted Chi Square Value	73.93	95% Jackknife UCL	44.42
		95% Standard Bootstrap UCL	43.58
Anderson-Darling Test Statistic	0.317	95% Bootstrap-t UCL	45.15
Anderson-Darling 5% Critical Value	0.739	95% Hall's Bootstrap UCL	43.46
Kolmogorov-Smirnov Test Statistic	0.145	95% Percentile Bootstrap UCL	43.71
Kolmogorov-Smirnov 5% Critical Value	0.23	95% BCA Bootstrap UCL	43.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	56.51
		97.5% Chebyshev(Mean, Sd) UCL	65.32
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	82.62
95% Approximate Gamma UCL	46.48		
95% Adjusted Gamma UCL	48.09		
Potential UCL to Use		Use 95% Student's-t UCL	44.42

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

APPENDIX I

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - SURFACE SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Diesel Range Organics

General Statistics

Number of Valid Observations	14	Number of Distinct Observations	14
Raw Statistics		**Log-transformed Statistics**	
Minimum	24	Minimum of Log Data	3.178
Maximum	410	Maximum of Log Data	6.016
Mean	110.9	Mean of log Data	4.263
Median	62.5	SD of log Data	0.905
SD	129.3		
Std. Error of Mean	34.56		
Coefficient of Variation	1.166		
Skewness	1.989		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.65	Shapiro Wilk Test Statistic	0.902
Shapiro Wilk Critical Value	0.874	Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	172.1	95% H-UCL	207.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	219.5
95% Adjusted-CLT UCL (Chen-1995)	187.3	97.5% Chebyshev (MVUE) UCL	269.9
95% Modified-t UCL (Johnson-1978)	175.1	99% Chebyshev (MVUE) UCL	369
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.04	Data appear Lognormal at 5% Significance Level	
Theta Star	106.6		
MLE of Mean	110.9		
MLE of Standard Deviation	108.7		
nu star	29.12		
Approximate Chi Square Value (.05)	17.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0312	95% CLT UCL	167.7
Adjusted Chi Square Value	16.63	95% Jackknife UCL	172.1
		95% Standard Bootstrap UCL	165.8
Anderson-Darling Test Statistic	0.999	95% Bootstrap-t UCL	292.2
Anderson-Darling 5% Critical Value	0.755	95% Hall's Bootstrap UCL	453.5
Kolmogorov-Smirnov Test Statistic	0.241	95% Percentile Bootstrap UCL	166.4
Kolmogorov-Smirnov 5% Critical Value	0.234	95% BCA Bootstrap UCL	187
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	261.5
		97.5% Chebyshev(Mean, Sd) UCL	326.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	454.7
95% Approximate Gamma UCL	181.3		
95% Adjusted Gamma UCL	194.1		
Potential UCL to Use		Use 95% H-UCL	207.3

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Gasoline Range Organics

General Statistics

Number of Valid Data	14	Number of Detected Data	8
Number of Distinct Detected Data	7	Number of Non-Detect Data	6
		Percent Non-Detects	42.86%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.12	Minimum Detected	-2.12
Maximum Detected	2500	Maximum Detected	7.824
Mean of Detected	326.9	Mean of Detected	2.461
SD of Detected	878.1	SD of Detected	3.09
Minimum Non-Detect	0.084	Minimum Non-Detect	-2.477
Maximum Non-Detect	0.32	Maximum Non-Detect	-1.139

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	8
Number treated as Detected	6
Single DL Non-Detect Percentage	57.14%

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

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.432	Shapiro Wilk Test Statistic	0.895
5% Shapiro Wilk Critical Value	0.818	5% Shapiro Wilk Critical Value	0.818
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	186.9	Mean	0.511
SD	665.9	SD	3.272
95% DL/2 (t) UCL	502	95% H-Stat (DL/2) UCL	268795
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	0.0348
		SD in Log Scale	3.842
		Mean in Original Scale	186.9
		SD in Original Scale	665.9
		95% t UCL	502
		95% Percentile Bootstrap UCL	542.3
		95% BCA Bootstrap UCL	721.8
		95% H-UCL	14613322

Gasoline Range Organics (Continued)

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.22	Data appear Lognormal at 5% Significance Level	
Theta Star	1489		
nu star	3.514		
A-D Test Statistic	0.979	Nonparametric Statistics	
5% A-D Critical Value	0.829	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.829	Mean	186.9
5% K-S Critical Value	0.322	SD	641.7
Data not Gamma Distributed at 5% Significance Level		SE of Mean	183.3
		95% KM (t) UCL	511.5
Assuming Gamma Distribution		95% KM (z) UCL	488.4
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	502
Minimum	0.000001	95% KM (bootstrap t) UCL	13199
Maximum	2500	95% KM (BCA) UCL	546.8
Mean	186.8	95% KM (Percentile Bootstrap) UCL	541
Median	0.19	95% KM (Chebyshev) UCL	986
SD	665.9	97.5% KM (Chebyshev) UCL	1332
k star	0.114	99% KM (Chebyshev) UCL	2011
Theta star	1633		
Nu star	3.203	Potential UCLs to Use	
AppChi2	0.435	99% KM (Chebyshev) UCL	2011
95% Gamma Approximate UCL	1375		
95% Adjusted Gamma UCL	1822		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	TSp.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzo[a]anthracene

General Statistics

Number of Valid Data	19	Number of Detected Data	10
Number of Distinct Detected Data	9	Number of Non-Detect Data	9
		Percent Non-Detects	47.37%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	13	Minimum Detected	2.565
Maximum Detected	190	Maximum Detected	5.247
Mean of Detected	91.6	Mean of Detected	4.229
SD of Detected	61.73	SD of Detected	0.891
Minimum Non-Detect	7.3	Minimum Non-Detect	1.988
Maximum Non-Detect	75	Maximum Non-Detect	4.317

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	14
Number treated as Detected	5
Single DL Non-Detect Percentage	73.68%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Test Statistic	0.92
5% Shapiro Wilk Critical Value	0.842	5% Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	61.81	Mean	3.682
SD	55.1	SD	1.093
95% DL/2 (t) UCL	83.73	95% H-Stat (DL/2) UCL	146.3
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	15.23	Mean in Log Scale	3.549
SD	98.8	SD in Log Scale	1.036
95% MLE (t) UCL	54.54	Mean in Original Scale	56.98
95% MLE (Tiku) UCL	90.14	SD in Original Scale	57.88
		95% t UCL	80.01
		95% Percentile Bootstrap UCL	80.23
		95% BCA Bootstrap UCL	82.74
		95% H UCL	113.9

Benzo[a]anthracene (Continued)

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.386	Data appear Normal at 5% Significance Level	
Theta Star	66.08		
nu star	27.72		
A-D Test Statistic	0.309	**Nonparametric Statistics**	
5% A-D Critical Value	0.736	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.736	Mean	59.71
5% K-S Critical Value	0.27	SD	55.52
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	14
		95% KM (t) UCL	83.99
Assuming Gamma Distribution		95% KM (z) UCL	82.74
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	82.75
Minimum	0.000001	95% KM (bootstrap t) UCL	86.74
Maximum	190	95% KM (BCA) UCL	89.16
Mean	52.73	95% KM (Percentile Bootstrap) UCL	87.11
Median	31.54	95% KM (Chebyshev) UCL	120.7
SD	61.75	97.5% KM (Chebyshev) UCL	147.1
k star	0.152	99% KM (Chebyshev) UCL	199
Theta star	347.6		
Nu star	5.765	Potential UCLs to Use	
AppChi2	1.521	95% KM (t) UCL	83.99
95% Gamma Approximate UCL	199.9	95% KM (Percentile Bootstrap) UCL	87.11
95% Adjusted Gamma UCL	226.9		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Benzo[a]pyrene

General Statistics

Number of Valid Data	19	Number of Detected Data	16
Number of Distinct Detected Data	15	Number of Non-Detect Data	3
		Percent Non-Detects	15.79%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	20	Minimum Detected	2.996
Maximum Detected	200	Maximum Detected	5.298
Mean of Detected	87.94	Mean of Detected	4.244
SD of Detected	58.7	SD of Detected	0.734
Minimum Non-Detect	7.3	Minimum Non-Detect	1.988
Maximum Non-Detect	71	Maximum Non-Detect	4.263

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	12
Number treated as Detected	7
Single DL Non-Detect Percentage	63.16%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.902	Shapiro Wilk Test Statistic	0.949
5% Shapiro Wilk Critical Value	0.887	5% Shapiro Wilk Critical Value	0.887
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	76.31	Mean	3.899
SD	60.58	SD	1.143
95% DL/2 (t) UCL	100.4	95% H-Stat (DL/2) UCL	202.8
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	44.21	Mean in Log Scale	4.034
SD	93.43	SD in Log Scale	0.857
95% MLE (t) UCL	81.38	Mean in Original Scale	77.35
95% MLE (Tiku) UCL	99.17	SD in Original Scale	59.35
		95% t UCL	101
		95% Percentile Bootstrap UCL	100.7
		95% BCA Bootstrap UCL	102.9
		95% H UCL	132.8

Benzo[a]pyrene (Continued)

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.912	Data appear Normal at 5% Significance Level	
Theta Star	46		
nu star	61.18		
A-D Test Statistic	0.31	Nonparametric Statistics	
5% A-D Critical Value	0.748	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.748	Mean	78.25
5% K-S Critical Value	0.218	SD	57.02
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	13.55
		95% KM (t) UCL	101.7
Assuming Gamma Distribution		95% KM (z) UCL	100.5
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	101.3
Minimum	0.000001	95% KM (bootstrap t) UCL	104.4
Maximum	200	95% KM (BCA) UCL	101.3
Mean	75.93	95% KM (Percentile Bootstrap) UCL	100.9
Median	59	95% KM (Chebyshev) UCL	137.3
SD	61.08	97.5% KM (Chebyshev) UCL	162.8
k star	0.317	99% KM (Chebyshev) UCL	213
Theta star	239.4		
Nu star	12.05	Potential UCLs to Use	
AppChi2	5.261	95% KM (t) UCL	101.7
95% Gamma Approximate UCL	173.9	95% KM (Percentile Bootstrap) UCL	100.9
95% Adjusted Gamma UCL	187.8		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Benzo[b]fluoranthene

General Statistics

Number of Valid Data	19	Number of Detected Data	12
Number of Distinct Detected Data	12	Number of Non-Detect Data	7
		Percent Non-Detects	36.84%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	4.7	Minimum Detected	1.548
Maximum Detected	270	Maximum Detected	5.598
Mean of Detected	129.6	Mean of Detected	4.475
SD of Detected	91.02	SD of Detected	1.146
Minimum Non-Detect	7.5	Minimum Non-Detect	2.015
Maximum Non-Detect	74	Maximum Non-Detect	4.304

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	12
Number treated as Detected	7
Single DL Non-Detect Percentage	63.16%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.916	Shapiro Wilk Test Statistic	0.847
5% Shapiro Wilk Critical Value	0.859	5% Shapiro Wilk Critical Value	0.859
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	93.44	Mean	4.027
SD	86.51	SD	1.187
95% DL/2 (t) UCL	127.9	95% H-Stat (DL/2) UCL	254.4
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	30.41	Mean in Log Scale	3.952
SD	149.5	SD in Log Scale	1.169
95% MLE (t) UCL	89.89	Mean in Original Scale	90.41
95% MLE (Tiku) UCL	118.4	SD in Original Scale	88.78
		95% t UCL	125.7
		95% Percentile Bootstrap UCL	123.4
		95% BCA Bootstrap UCL	128.8
		95% H UCL	226.7

Benzo[b]fluoranthene (Continued)

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.125	Data appear Normal at 5% Significance Level	
Theta Star	115.2		
nu star	27.01		
A-D Test Statistic	0.381	**Nonparametric Statistics**	
5% A-D Critical Value	0.747	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.747	Mean	92.57
5% K-S Critical Value	0.25	SD	85.95
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	21.16
		95% KM (t) UCL	129.3
Assuming Gamma Distribution		95% KM (z) UCL	127.4
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	128
Minimum	0.000001	95% KM (bootstrap t) UCL	134.4
Maximum	270	95% KM (BCA) UCL	133.6
Mean	89.53	95% KM (Percentile Bootstrap) UCL	129.4
Median	62.47	95% KM (Chebyshev) UCL	184.8
SD	90.48	97.5% KM (Chebyshev) UCL	224.7
k star	0.229	99% KM (Chebyshev) UCL	303.1
Theta star	391.2		
Nu star	8.696	Potential UCLs to Use	
AppChi2	3.144	95% KM (t) UCL	129.3
95% Gamma Approximate UCL	247.6	95% KM (Percentile Bootstrap) UCL	129.4
95% Adjusted Gamma UCL	272.3		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Benzo[k]fluoranthene

General Statistics

Number of Valid Data	19	Number of Detected Data	13
Number of Distinct Detected Data	13	Number of Non-Detect Data	6
		Percent Non-Detects	31.58%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	2.3	Minimum Detected	0.833
Maximum Detected	230	Maximum Detected	5.438
Mean of Detected	108	Mean of Detected	4.263
SD of Detected	75.57	SD of Detected	1.238
Minimum Non-Detect	7.5	Minimum Non-Detect	2.015
Maximum Non-Detect	72	Maximum Non-Detect	4.277

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	11
Number treated as Detected	8
Single DL Non-Detect Percentage	57.89%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Test Statistic	0.81
5% Shapiro Wilk Critical Value	0.866	5% Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	83.45	Mean	3.926
SD	72.35	SD	1.232
95% DL/2 (t) UCL	112.2	95% H-Stat (DL/2) UCL	255.1
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	54.33	Mean in Log Scale	3.808
SD	105	SD in Log Scale	1.256
95% MLE (t) UCL	96.1	Mean in Original Scale	79.86
95% MLE (Tiku) UCL	111.1	SD in Original Scale	75.13
		95% t UCL	109.7
		95% Percentile Bootstrap UCL	109.5
		95% BCA Bootstrap UCL	110.6
		95% H UCL	240.6

Benzo[k]fluoranthene (Continued)

Gamma Distribution Test with Detected Values Only			Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.078		Data appear Normal at 5% Significance Level	
Theta Star	100.2			
nu star	28.02			
A-D Test Statistic	0.424		Nonparametric Statistics	
5% A-D Critical Value	0.753		Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753		Mean	81.51
5% K-S Critical Value	0.242		SD	72.55
Data appear Gamma Distributed at 5% Significance Level			SE of Mean	17.63
			95% KM (t) UCL	112.1
Assuming Gamma Distribution			95% KM (z) UCL	110.5
Gamma ROS Statistics using Extrapolated Data			95% KM (jackknife) UCL	111
Minimum	0.000001		95% KM (bootstrap t) UCL	115.5
Maximum	230		95% KM (BCA) UCL	114.9
Mean	80.1		95% KM (Percentile Bootstrap) UCL	111.7
Median	48.01		95% KM (Chebyshev) UCL	158.4
SD	75.79		97.5% KM (Chebyshev) UCL	191.6
k star	0.232		99% KM (Chebyshev) UCL	257
Theta star	346			
Nu star	8.799		Potential UCLs to Use	
AppChi2	3.206		95% KM (t) UCL	112.1
95% Gamma Approximate UCL	219.9		95% KM (Percentile Bootstrap) UCL	111.7
95% Adjusted Gamma UCL	241.6			

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Chrysene

General Statistics

Number of Valid Data	19	Number of Detected Data	14
Number of Distinct Detected Data	14	Number of Non-Detect Data	5
		Percent Non-Detects	26.32%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	24	Minimum Detected	3.178
Maximum Detected	250	Maximum Detected	5.521
Mean of Detected	99.86	Mean of Detected	4.338
SD of Detected	75.17	SD of Detected	0.762
Minimum Non-Detect	7.3	Minimum Non-Detect	1.988
Maximum Non-Detect	72	Maximum Non-Detect	4.277

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	12
Number treated as Detected	7
Single DL Non-Detect Percentage	63.16%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.856	Shapiro Wilk Test Statistic	0.945
5% Shapiro Wilk Critical Value	0.874	5% Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	79.63	Mean	3.899
SD	73.21	SD	1.154
95% DL/2 (t) UCL	108.8	95% H-Stat (DL/2) UCL	207.9
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	33.6	Mean in Log Scale	4.022
SD	119.6	SD in Log Scale	0.887
95% MLE (t) UCL	81.18	Mean in Original Scale	80.45
95% MLE (Tiku) UCL	104.4	SD in Original Scale	72.38
		95% t UCL	109.2
		95% Percentile Bootstrap UCL	108.7
		95% BCA Bootstrap UCL	111
		95% H UCL	138.2

APPENDIX I

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - TOTAL SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Chrysene (Continued)

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.645	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	60.71		
nu star	46.06		
A-D Test Statistic	0.466	Nonparametric Statistics	
5% A-D Critical Value	0.746	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.746	Mean	82.11
5% K-S Critical Value	0.232	SD	69.18
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	16.53
		95% KM (t) UCL	110.8
Assuming Gamma Distribution		95% KM (z) UCL	109.3
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	109.9
Minimum	0.000001	95% KM (bootstrap t) UCL	121.3
Maximum	250	95% KM (BCA) UCL	113.1
Mean	77.74	95% KM (Percentile Bootstrap) UCL	110.6
Median	50	95% KM (Chebyshev) UCL	154.2
SD	75.23	97.5% KM (Chebyshev) UCL	185.3
k star	0.238	99% KM (Chebyshev) UCL	246.6
Theta star	326.3		
Nu star	9.055	Potential UCLs to Use	
AppChi2	3.36	95% KM (Percentile Bootstrap) UCL	110.6
95% Gamma Approximate UCL	209.5		
95% Adjusted Gamma UCL	229.8		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Dibenz(a,h)anthracene

General Statistics

Number of Valid Data	19	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	14
		Percent Non-Detects	73.68%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	10	Minimum Detected	2.303
Maximum Detected	57	Maximum Detected	4.043
Mean of Detected	30.8	Mean of Detected	3.248
SD of Detected	19.46	SD of Detected	0.694
Minimum Non-Detect	7.2	Minimum Non-Detect	1.974
Maximum Non-Detect	75	Maximum Non-Detect	4.317

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	19
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 5 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.917	Shapiro Wilk Test Statistic	0.949
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	26.17	Mean	2.895
SD	16.75	SD	1.044
95% DL/2 (t) UCL	32.84	95% H-Stat (DL/2) UCL	60.21
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	2.202
		SD in Log Scale	0.952
		Mean in Original Scale	14.06
		SD in Original Scale	14.84
		95% t UCL	19.97
		95% Percentile Bootstrap UCL	19.73
		95% BCA Bootstrap UCL	21.11
		95% H-UCL	25.17

Dibenz(a,h)anthracene (Continued)

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.309	Data appear Normal at 5% Significance Level	
Theta Star	23.53		
nu star	13.09		
A-D Test Statistic	0.287	**Nonparametric Statistics**	
5% A-D Critical Value	0.683	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.683	Mean	20.4
5% K-S Critical Value	0.359	SD	16.11
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	5.697
		95% KM (t) UCL	30.28
Assuming Gamma Distribution		95% KM (z) UCL	29.77
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	29.67
Minimum	0.000001	95% KM (bootstrap t) UCL	35.75
Maximum	57	95% KM (BCA) UCL	48.27
Mean	11.74	95% KM (Percentile Bootstrap) UCL	36
Median	0.000001	95% KM (Chebyshev) UCL	45.23
SD	17.2	97.5% KM (Chebyshev) UCL	55.98
k star	0.111	99% KM (Chebyshev) UCL	77.08
Theta star	105.7		
Nu star	4.22	**Potential UCLs to Use**	
AppChi2	0.811	95% KM (t) UCL	30.28
95% Gamma Approximate UCL	61.14	95% KM (Percentile Bootstrap) UCL	36
95% Adjusted Gamma UCL	71.56		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Indeno[1,2,3-cd]pyrene

	General Statistics		
Number of Valid Data	19	Number of Detected Data	11
Number of Distinct Detected Data	10	Number of Non-Detect Data	8
		Percent Non-Detects	42.11%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	5	Minimum Detected	1.609
Maximum Detected	110	Maximum Detected	4.7
Mean of Detected	41.27	Mean of Detected	3.443
SD of Detected	30.76	SD of Detected	0.851
Minimum Non-Detect	7.3	Minimum Non-Detect	1.988
Maximum Non-Detect	74	Maximum Non-Detect	4.304
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	17
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	89.47%
	UCL Statistics		
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.866	Shapiro Wilk Test Statistic	0.935
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	35.57	Mean	3.26
SD	25.66	SD	0.938
95% DL/2 (t) UCL	45.78	95% H-Stat (DL/2) UCL	70.69
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	3.152
		SD in Log Scale	0.796
		Mean in Original Scale	31.29
		SD in Original Scale	26.41
		95% t UCL	41.79
		95% Percentile Bootstrap UCL	41.67
		95% BCA Bootstrap UCL	45.12
		95% H-UCL	49.78

Indeno[1,2,3-cd]pyrene (Continued)

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.481	Data appear Normal at 5% Significance Level	
Theta Star	27.87		
nu star	32.58		
A-D Test Statistic	0.301	**Nonparametric Statistics**	
5% A-D Critical Value	0.739	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.739	Mean	32.17
5% K-S Critical Value	0.259	SD	26.7
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	6.899
		95% KM (t) UCL	44.14
Assuming Gamma Distribution		95% KM (z) UCL	43.52
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	43.66
Minimum	0.000001	95% KM (bootstrap t) UCL	46.5
Maximum	110	95% KM (BCA) UCL	45.68
Mean	32.57	95% KM (Percentile Bootstrap) UCL	45.04
Median	27.94	95% KM (Chebyshev) UCL	62.24
SD	27.43	97.5% KM (Chebyshev) UCL	75.25
k star	0.327	99% KM (Chebyshev) UCL	100.8
Theta star	99.47		
Nu star	12.44	Potential UCLs to Use	
AppChi2	5.519	95% KM (t) UCL	44.14
95% Gamma Approximate UCL	73.41	95% KM (Percentile Bootstrap) UCL	45.04
95% Adjusted Gamma UCL	79.13		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

APPENDIX I

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - TOTAL SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Arsenic

General Statistics

Number of Valid Observations	24	Number of Distinct Observations	22

Raw Statistics		Log-transformed Statistics	
Minimum	1.6	Minimum of Log Data	0.47
Maximum	21	Maximum of Log Data	3.045
Mean	4.692	Mean of log Data	1.383
Median	4	SD of log Data	0.529
SD	3.753		
Std. Error of Mean	0.766		
Coefficient of Variation	0.8		
Skewness	3.813		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.564	Shapiro Wilk Test Statistic	0.903
Shapiro Wilk Critical Value	0.916	Shapiro Wilk Critical Value	0.916
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.005	95% H-UCL	5.723
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6.798
95% Adjusted-CLT UCL (Chen-1995)	6.589	97.5% Chebyshev (MVUE) UCL	7.769
95% Modified-t UCL (Johnson-1978)	6.104	99% Chebyshev (MVUE) UCL	9.674
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.852	Data do not follow a Discernable Distribution (0.05)	
Theta Star	1.645		
MLE of Mean	4.692		
MLE of Standard Deviation	2.778		
nu star	136.9		
Approximate Chi Square Value (.05)	110.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0392	95% CLT UCL	5.952
Adjusted Chi Square Value	109.2	95% Jackknife UCL	6.005
		95% Standard Bootstrap UCL	5.932
Anderson-Darling Test Statistic	1.197	95% Bootstrap-t UCL	7.665
Anderson-Darling 5% Critical Value	0.751	95% Hall's Bootstrap UCL	11.37
Kolmogorov-Smirnov Test Statistic	0.191	95% Percentile Bootstrap UCL	6.067
Kolmogorov-Smirnov 5% Critical Value	0.179	95% BCA Bootstrap UCL	6.858
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	8.031
		97.5% Chebyshev(Mean, Sd) UCL	9.476
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	12.31
95% Approximate Gamma UCL	5.793		
95% Adjusted Gamma UCL	5.881		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	8.031

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - TOTAL SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Cobalt

General Statistics

Number of Valid Observations	24	Number of Distinct Observations	21

Raw Statistics		Log-transformed Statistics	
Minimum	0.37	Minimum of Log Data	-0.994
Maximum	10	Maximum of Log Data	2.303
Mean	3.788	Mean of log Data	0.994
Median	2.65	SD of log Data	0.89
SD	3.032		
Std. Error of Mean	0.619		
Coefficient of Variation	0.8		
Skewness	0.97		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.854	Shapiro Wilk Test Statistic	0.96
Shapiro Wilk Critical Value	0.916	Shapiro Wilk Critical Value	0.916
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	4.849	95% H-UCL	6.268
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	7.382
95% Adjusted-CLT UCL (Chen-1995)	4.937	97.5% Chebyshev (MVUE) UCL	8.877
95% Modified-t UCL (Johnson-1978)	4.869	99% Chebyshev (MVUE) UCL	11.81

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.451	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	2.61		
MLE of Mean	3.788		
MLE of Standard Deviation	3.145		
nu star	69.65		
Approximate Chi Square Value (.05)	51.44	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0392	95% CLT UCL	4.806
Adjusted Chi Square Value	50.34	95% Jackknife UCL	4.849
		95% Standard Bootstrap UCL	4.784
Anderson-Darling Test Statistic	0.448	95% Bootstrap-t UCL	4.989
Anderson-Darling 5% Critical Value	0.76	95% Hall's Bootstrap UCL	4.898
Kolmogorov-Smirnov Test Statistic	0.132	95% Percentile Bootstrap UCL	4.832
Kolmogorov-Smirnov 5% Critical Value	0.181	95% BCA Bootstrap UCL	4.956
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	6.486
		97.5% Chebyshev(Mean, Sd) UCL	7.653
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	9.946
95% Approximate Gamma UCL	5.129		
95% Adjusted Gamma UCL	5.241		

Potential UCL to Use		Use 95% Approximate Gamma UCL	5.129

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

APPENDIX I

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - TOTAL SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Copper

General Statistics

Number of Valid Data	24	Number of Detected Data	21
Number of Distinct Detected Data	20	Number of Non-Detect Data	3
		Percent Non-Detects	12.50%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.9	Minimum Detected	0.642
Maximum Detected	550	Maximum Detected	6.31
Mean of Detected	48.57	Mean of Detected	2.925
SD of Detected	116.3	SD of Detected	1.269
Minimum Non-Detect	1.1	Minimum Non-Detect	0.0953
Maximum Non-Detect	2.8	Maximum Non-Detect	1.03

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	19
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	20.83%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.357	Shapiro Wilk Test Statistic	0.951
5% Shapiro Wilk Critical Value	0.908	5% Shapiro Wilk Critical Value	0.908
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	42.62	Mean	2.542
SD	109.6	SD	1.579
95% DL/2 (t) UCL	80.98	95% H-Stat (DL/2) UCL	135.3
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	23.73	Mean in Log Scale	2.585
SD	124.5	SD in Log Scale	1.502
95% MLE (t) UCL	67.28	Mean in Original Scale	42.66
95% MLE (Tiku) UCL	66.35	SD in Original Scale	109.6
		95% t UCL	81.01
		95% Percentile Bootstrap UCL	85.38
		95% BCA Bootstrap UCL	107.9
		95% H UCL	114.5

Copper (Continued)

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.58	Data appear Lognormal at 5% Significance Level	
Theta Star	83.78		
nu star	24.35		
A-D Test Statistic	1.422	Nonparametric Statistics	
5% A-D Critical Value	0.793	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.793	Mean	42.74
5% K-S Critical Value	0.198	SD	107.3
Data not Gamma Distributed at 5% Significance Level		SE of Mean	22.44
		95% KM (t) UCL	81.2
Assuming Gamma Distribution		95% KM (z) UCL	79.65
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	81.05
Minimum	0.000001	95% KM (bootstrap t) UCL	223.6
Maximum	550	95% KM (BCA) UCL	89.34
Mean	42.5	95% KM (Percentile Bootstrap) UCL	86.31
Median	15.5	95% KM (Chebyshev) UCL	140.6
SD	109.7	97.5% KM (Chebyshev) UCL	182.9
k star	0.242	99% KM (Chebyshev) UCL	266
Theta star	175.9		
Nu star	11.6	Potential UCLs to Use	
AppChi2	4.964	97.5% KM (Chebyshev) UCL	182.9
95% Gamma Approximate UCL	99.31		
95% Adjusted Gamma UCL	105.8		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Thallium

General Statistics

Number of Valid Data	24	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	18
		Percent Non-Detects	75.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.054	Minimum Detected	-2.919
Maximum Detected	0.21	Maximum Detected	-1.561
Mean of Detected	0.102	Mean of Detected	-2.444
SD of Detected	0.0666	SD of Detected	0.59
Minimum Non-Detect	0.13	Minimum Non-Detect	-2.04
Maximum Non-Detect	0.3	Maximum Non-Detect	-1.204

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	24
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

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

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.76	Shapiro Wilk Test Statistic	0.79
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.107	Mean	-2.284
SD	0.035	SD	0.327
95% DL/2 (t) UCL	0.119	95% H-Stat (DL/2) UCL	0.122
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.591
		SD in Log Scale	0.383
		Mean in Original Scale	0.0811
		SD in Original Scale	0.0381
		95% t UCL	0.0944
		95% Percentile Bootstrap UCL	0.0936
		95% BCA Bootstrap UCL	0.099
		95% H-UCL	0.0937

Thallium (Continued)

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.776	Data appear Lognormal at 5% Significance Level	
Theta Star	0.0572		
nu star	21.32		
A-D Test Statistic	0.772	Nonparametric Statistics	
5% A-D Critical Value	0.701	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.701	Mean	0.0837
5% K-S Critical Value	0.334	SD	0.0472
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0176
		95% KM (t) UCL	0.114
Assuming Gamma Distribution		95% KM (z) UCL	0.113
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.115
Minimum	0.00462	95% KM (bootstrap t) UCL	0.252
Maximum	0.21	95% KM (BCA) UCL	0.118
Mean	0.0909	95% KM (Percentile Bootstrap) UCL	0.116
Median	0.0946	95% KM (Chebyshev) UCL	0.16
SD	0.0456	97.5% KM (Chebyshev) UCL	0.194
k star	2.58	99% KM (Chebyshev) UCL	0.259
Theta star	0.0352		
Nu star	123.8	Potential UCLs to Use	
AppChi2	99.12	95% KM (t) UCL	0.114
95% Gamma Approximate UCL	0.114	95% KM (% Bootstrap) UCL	0.116
95% Adjusted Gamma UCL	0.115		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - TOTAL SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Vanadium

General Statistics

Number of Valid Observations	24	Number of Distinct Observations	22

Raw Statistics		Log-transformed Statistics	
Minimum	2.9	Minimum of Log Data	1.065
Maximum	64	Maximum of Log Data	4.159
Mean	26.3	Mean of log Data	2.977
Median	20.5	SD of log Data	0.855
SD	18.54		
Std. Error of Mean	3.784		
Coefficient of Variation	0.705		
Skewness	0.778		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.909	Shapiro Wilk Test Statistic	0.945
Shapiro Wilk Critical Value	0.916	Shapiro Wilk Critical Value	0.916
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	32.79	95% H-UCL	43.09
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	51.05
95% Adjusted-CLT UCL (Chen-1995)	33.17	97.5% Chebyshev (MVUE) UCL	61.13
95% Modified-t UCL (Johnson-1978)	32.89	99% Chebyshev (MVUE) UCL	80.93

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.656	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	15.89		
MLE of Mean	26.3		
MLE of Standard Deviation	20.44		
nu star	79.47		
Approximate Chi Square Value (.05)	59.93	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0392	95% CLT UCL	32.53
Adjusted Chi Square Value	58.73	95% Jackknife UCL	32.79
		95% Standard Bootstrap UCL	32.46
Anderson-Darling Test Statistic	0.24	95% Bootstrap-t UCL	33.75
Anderson-Darling 5% Critical Value	0.757	95% Hall's Bootstrap UCL	33.3
Kolmogorov-Smirnov Test Statistic	0.0904	95% Percentile Bootstrap UCL	32.61
Kolmogorov-Smirnov 5% Critical Value	0.18	95% BCA Bootstrap UCL	32.73
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	42.8
		97.5% Chebyshev(Mean, Sd) UCL	49.93
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	63.95
95% Approximate Gamma UCL	34.88		
95% Adjusted Gamma UCL	35.59		

Potential UCL to Use		Use 95% Approximate Gamma UCL	34.88

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - TOTAL SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Diesel Range Organics

General Statistics

Number of Valid Data	24	Number of Detected Data	20
Number of Distinct Detected Data	19	Number of Non-Detect Data	4
		Percent Non-Detects	16.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	15	Minimum Detected	2.708
Maximum Detected	410	Maximum Detected	6.016
Mean of Detected	85.15	Mean of Detected	3.933
SD of Detected	114.4	SD of Detected	0.931
Minimum Non-Detect	1.4	Minimum Non-Detect	0.336
Maximum Non-Detect	3.7	Maximum Non-Detect	1.308

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	4
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	20
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	16.67%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.587	Shapiro Wilk Test Statistic	0.909
5% Shapiro Wilk Critical Value	0.905	5% Shapiro Wilk Critical Value	0.905
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	71.17	Mean	3.304
SD	108.8	SD	1.679
95% DL/2 (t) UCL	109.2	95% H-Stat (DL/2) UCL	387.2
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	58.4	Mean in Log Scale	3.585
SD	120.9	SD in Log Scale	1.162
95% MLE (t) UCL	100.7	Mean in Original Scale	72.01
95% MLE (Tiku) UCL	99.47	SD in Original Scale	108.2
		95% t UCL	109.9
		95% Percentile Bootstrap UCL	109.6
		95% BCA Bootstrap UCL	124.1
		95% H UCL	138.3

Diesel Range Organics (Continued)

Gamma Distribution Test with Detected Values Only			Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.981		Data appear Lognormal at 5% Significance Level	
Theta Star	86.77			
nu star	39.25			
A-D Test Statistic	1.443		Nonparametric Statistics	
5% A-D Critical Value	0.766		Kaplan-Meier (KM) Method	
K-S Test Statistic	0.766		Mean	73.46
5% K-S Critical Value	0.199		SD	105.1
Data not Gamma Distributed at 5% Significance Level			SE of Mean	22.01
			95% KM (t) UCL	111.2
Assuming Gamma Distribution			95% KM (z) UCL	109.7
Gamma ROS Statistics using Extrapolated Data			95% KM (jackknife) UCL	110.9
Minimum	0.000001		95% KM (bootstrap t) UCL	189
Maximum	410		95% KM (BCA) UCL	114.3
Mean	70.96		95% KM (Percentile Bootstrap) UCL	112.4
Median	34		95% KM (Chebyshev) UCL	169.4
SD	108.9		97.5% KM (Chebyshev) UCL	210.9
k star	0.221		99% KM (Chebyshev) UCL	292.4
Theta star	321.5			
Nu star	10.59		Potential UCLs to Use	
AppChi2	4.316		95% KM (Chebyshev) UCL	169.4
95% Gamma Approximate UCL	174.2			
95% Adjusted Gamma UCL	186.2			

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

APPENDIX I

HHRA STATISTICAL SUMMARY (PROUCL COMPUTATIONAL OUTPUT) - TOTAL SOIL
SWMU 74 (FUELING PIERA AREA)
CORRECTIVE MEASURES STUDY REPORT
NAVAL ACTIVITY PUERTO RICO, CIEBA, PUERTO RICO

Gasoline Range Organics

General Statistics

Number of Valid Data	24	Number of Detected Data	14
Number of Distinct Detected Data	13	Number of Non-Detect Data	10
		Percent Non-Detects	41.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.12	Minimum Detected	-2.12
Maximum Detected	2500	Maximum Detected	7.824
Mean of Detected	195.8	Mean of Detected	2.683
SD of Detected	663.3	SD of Detected	2.296
Minimum Non-Detect	0.08	Minimum Non-Detect	-2.526
Maximum Non-Detect	0.32	Maximum Non-Detect	-1.139

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	12
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	12
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	50.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.311	Shapiro Wilk Test Statistic	0.793
5% Shapiro Wilk Critical Value	0.874	5% Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	114.3	Mean	0.532
SD	508.3	SD	3.147
95% DL/2 (t) UCL	292.1	95% H-Stat (DL/2) UCL	13098
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	0.696
		SD in Log Scale	2.992
		Mean in Original Scale	114.3
		SD in Original Scale	508.3
		95% t UCL	292.1
		95% Percentile Bootstrap UCL	321.4
		95% BCA Bootstrap UCL	426.3
		95% H-UCL	6605

Gasoline Range Organics (Continued)

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.26	Data do not follow a Discernable Distribution (0.05)	
Theta Star	752.9		
nu star	7.282		
A-D Test Statistic	2.488	**Nonparametric Statistics**	
5% A-D Critical Value	0.844	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.844	Mean	114.3
5% K-S Critical Value	0.249	SD	497.6
Data not Gamma Distributed at 5% Significance Level		SE of Mean	105.4
		95% KM (t) UCL	294.9
Assuming Gamma Distribution		95% KM (z) UCL	287.7
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	292.1
Minimum	0.000001	95% KM (bootstrap t) UCL	5811
Maximum	2500	95% KM (BCA) UCL	327.1
Mean	114.2	95% KM (Percentile Bootstrap) UCL	322.9
Median	5.63	95% KM (Chebyshev) UCL	573.7
SD	508.3	97.5% KM (Chebyshev) UCL	772.5
k star	0.108	99% KM (Chebyshev) UCL	1163
Theta star	1056		
Nu star	5.193	Potential UCLs to Use	
AppChi2	1.243	99% KM (Chebyshev) UCL	1163
95% Gamma Approximate UCL	477.4		
95% Adjusted Gamma UCL	532.6		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

APPENDIX J
CHEMICAL INTAKE EQUATIONS

Soil

Incidental Ingestion of Soil

The following equation is used in the calculation of a CDI (mg/kg/day) for a human receptor who incidentally ingests soil at the site:

$$CDI = \frac{Cs \times IR \times FI \times CF \times EF \times ED}{BW \times AT_c \ or \ AT_{nc}}$$

Where:

Cs	=	chemical concentration in total soil/sediment (mg/kg)
IR	=	ingestion rate (mg/day)
FI	=	fraction of total soil/sediment ingested from the source (unitless)
CF	=	conversion factor (10^{-06} kg/mg)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yrs)
BW	=	adult body weight (kg)
AT_c	=	averaging time carcinogens (days)
AT_{nc}	=	averaging time, noncarcinogens (days)

Dermal Contact with Soil

The absorbed dose associated with the potential dermal contact of COPCs in soil was calculated using the following equation (USEPA, 1989):

$$DAD = \frac{Cs \times SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT}$$

Where:

DAD	=	Dermally Absorbed Dose, mg/kg-day
Cs	=	Chemical concentration in the total soil/sediment, mg/kg
AF	=	Adherence Factor, milligram per square centimeter day (mg/cm^{2} - d)
ABS	=	Absorbed fraction, unitless
CF	=	Conversion Factor, 10^{-06} mg/kg
SA	=	Surface Area of exposed skin, cm^2
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
BW	=	average Body Weight, kg
AT	=	Averaging Time, days

Inhalation of Fugitive Dust/Volatiles from Soil

The daily intake resulting from the inhalation of COPCs adsorbed onto fugitive dust particulate and/or volatiles was estimated using the following equation (USEPA, 2009):

$$CDI = \frac{Ca \times ET \times EF \times ED}{AT}$$

Where:

CDI	=	Chronic Daily Intake, mg/kg-day
Ca	=	Chemical concentration in air as fugitive dust, milligrams per cubic meter (mg/m^3)
ET	=	Exposure Time, hours/day
EF	=	Exposure Frequency, days/year
ED	=	Exposure Duration, years
AT	=	Averaging Time, days

The air concentration (Ca) of a chemical in fugitive dust emissions was estimated from the following equation, adapted from Cowherd (1985).

$$Ca = Cs \times (1/PEF + 1/VF)$$

Where:

Ca	=	Chemical concentration in air as fugitive dust, mg/m^3
Cs	=	Concentration of chemical in the soil, mg/kg
PEF	=	Particulate Emission Factor, m^3/kg
VF	=	Volatilization Factor, m^3/kg

Volatilization factors used in this HHRA were calculated (USEPA, 2002).

APPENDIX K
RISK CALCULATION SPREADSHEETS

ADULT AND YOUTH TRESPASSERS - CURRENT AND FUTURE SCENARIOS
ACCIDENTAL INGESTION OF SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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

Parameter	Units	Description	Adult	Youth	
CDI	mg/kg/d	Chronic daily intake	CS	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	CS	
CSFo	1/(mg/kg/d)	Oral cancer slope factor	CS	CS	
HQ	NA	Hazard quotient	CS	CS	
RfDo	mg/kg/d	Oral reference dose	CS	CS	
C	mg/kg	Concentration of chemical in soil	CS	CS	
IR-S	mg/day	Ingestion rate of soil	100	100	
CF	kg/mg	Conversion factor	1.00E-06	1.00E-06	
FI	NA	Fraction of soil ingested from site	1	1	
EF	days/year	Exposure frequency	52	52	
ED	years	Exposure duration	24	11	
BW	kg	Body weight	70	45	
AT-C	days	Averaging time, carcinogens	25,550	25,550	
AT-N	days	Averaging time, noncarcinogens	8,760	4,015	

				Adult						Youth					
				Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	C (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	0.110	7.3E-01	NA	7.7E-09	5.6E-09	0.6%	2.2E-08	--	--	5.5E-09	4.0E-09	0.6%	3.5E-08	--	--
Benzo[a]pyrene	0.127	7.3E+00	NA	8.9E-09	6.5E-08	6.9%	2.6E-08	--	--	6.3E-09	4.6E-08	6.9%	4.0E-08	--	--
Benzo[b]fluoranthene	0.169	7.3E-01	NA	1.2E-08	8.6E-09	0.9%	3.4E-08	--	--	8.4E-09	6.1E-09	0.9%	5.4E-08	--	--
Benzo[k]fluoranthene	0.146	7.3E-02	NA	1.0E-08	7.4E-10	0.1%	3.0E-08	--	--	7.3E-09	5.3E-10	0.1%	4.6E-08	--	--
Chrysene	0.142	7.3E-03	NA	9.9E-09	7.2E-11	0.0%	2.9E-08	--	--	7.1E-09	5.2E-11	0.0%	4.5E-08	--	--
Dibenz(a,h)anthracene	0.0402	7.3E+00	NA	2.8E-09	2.0E-08	2.2%	8.2E-09	--	--	2.0E-09	1.5E-08	2.2%	1.3E-08	--	--
Indeno[1,2,3-cd]pyrene	0.0532	7.3E-01	NA	3.7E-09	2.7E-09	0.3%	1.1E-08	--	--	2.6E-09	1.9E-09	0.3%	1.7E-08	--	--
Diesel Range Organics	207	NA	NA	1.4E-05	--	--	4.2E-05	--	--	1.0E-05	--	--	6.6E-05	--	--
Gasoline Range Organics	2,011	NA	NA	1.4E-04	--	--	4.1E-04	--	--	1.0E-04	--	--	6.4E-04	--	--
Arsenic	8.03	1.5E+00	3.0E-04	5.6E-07	8.4E-07	89.1%	1.6E-06	5.4E-03	34.3%	4.0E-07	6.0E-07	89.1%	2.5E-06	8.5E-03	34.3%
Cobalt	6.82	NA	3.0E-04	4.8E-07	--	--	1.4E-06	4.6E-03	29.1%	3.4E-07	--	--	2.2E-06	7.2E-03	29.1%
Copper	229	NA	4.0E-02	1.6E-05	--	--	4.7E-05	1.2E-03	7.3%	1.1E-05	--	--	7.2E-05	1.8E-03	7.3%
Thallium	0.139	NA	1.0E-05	9.7E-09	--	--	2.8E-08	2.8E-03	17.8%	6.9E-09	--	--	4.4E-08	4.4E-03	17.8%
Vanadium	44.4	NA	5.0E-03	3.1E-06	--	--	9.0E-06	1.8E-03	11.4%	2.2E-06	--	--	1.4E-05	2.8E-03	11.4%
				Total ILCR:	9.4E-07	100.0%	Total HI:	1.6E-02	100.0%	Total ILCR:	6.7E-07	100.0%	Total HI:	2.5E-02	100.0%

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

ADULT AND YOUTH TRESPASSERS - CURRENT AND FUTURE SCENARIOS
DERMAL CONTACT WITH SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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

Parameter	Units	Description	Adult	Youth	
DAD	mg/kg/d	Dermally absorbed dose	CS	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	CS	
CSFd	1/(mg/kg/d)	Dermal cancer slope factor	CS	CS	
HQ	NA	Hazard quotient	CS	CS	
RfDd	mg/kg/d	Dermal reference dose	CS	CS	
C	mg/kg	Concentration of chemical in soil	CS	CS	
CF	kg/mg	Conversion factor	1.00E-06	1.00E-06	
AF	mg/cm2	Soil to skin adherence factor	0.07	0.2	
ABS	NA	Absorption fraction	CS	CS	
SA	cm2/day	Skin surface area available for contact	5,700	3,200	
EF	days/year	Exposure frequency	52	52	
ED	years	Exposure duration	24	11	
BW	kg	Body weight	70	45	
AT-C	days	Averaging time, carcinogens	25,550	25,550	
AT-N	days	Averaging time, noncarcinogens	8,760	4,015	

					Adult						Youth					
					Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	C (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	0.110	1.3E-01	7.3E-01	NA	4.0E-09	2.9E-09	1.9%	1.2E-08	--	--	4.6E-09	3.3E-09	1.9%	2.9E-08	--	--
Benzo[a]pyrene	0.127	1.3E-01	7.3E+00	NA	4.6E-09	3.4E-08	21.8%	1.3E-08	--	--	5.3E-09	3.8E-08	21.8%	3.3E-08	--	--
Benzo[b]fluoranthene	0.169	1.3E-01	7.3E-01	NA	6.1E-09	4.5E-09	2.9%	1.8E-08	--	--	7.0E-09	5.1E-09	2.9%	4.5E-08	--	--
Benzo[k]fluoranthene	0.146	1.3E-01	7.3E-02	NA	5.3E-09	3.9E-10	0.3%	1.5E-08	--	--	6.0E-09	4.4E-10	0.3%	3.8E-08	--	--
Chrysene	0.142	1.3E-01	7.3E-03	NA	5.1E-09	3.8E-11	0.0%	1.5E-08	--	--	5.9E-09	4.3E-11	0.0%	3.7E-08	--	--
Dibenz(a,h)anthracene	0.0402	1.3E-01	7.3E+00	NA	1.5E-09	1.1E-08	6.9%	4.2E-09	--	--	1.7E-09	1.2E-08	6.9%	1.1E-08	--	--
Indeno[1,2,3-cd]pyrene	0.0532	1.3E-01	7.3E-01	NA	1.9E-09	1.4E-09	0.9%	5.6E-09	--	--	2.2E-09	1.6E-09	0.9%	1.4E-08	--	--
Diesel Range Organics	207	NA	NA	NA	5.8E-05	--	--	1.7E-04	--	--	6.6E-05	--	--	4.2E-04	--	--
Gasoline Range Organics	2,011	NA	NA	NA	5.6E-04	--	--	1.6E-03	--	--	6.4E-04	--	--	4.1E-03	--	--
Arsenic	8.03	3.0E-02	1.5E+00	3.0E-04	6.7E-08	1.0E-07	65.3%	2.0E-07	6.5E-04	61.0%	7.7E-08	1.2E-07	65.3%	4.9E-07	1.6E-03	61.0%
Cobalt	6.82	1.0E-02	NA	3.0E-04	1.9E-08	--	--	5.5E-08	1.8E-04	17.3%	2.2E-08	--	--	1.4E-07	4.6E-04	17.3%
Copper	229	1.0E-02	NA	4.0E-02	6.4E-07	--	--	1.9E-06	4.6E-05	4.4%	7.3E-07	--	--	4.6E-06	1.2E-04	4.4%
Thallium	0.139	1.0E-02	NA	1.0E-05	3.9E-10	--	--	1.1E-09	1.1E-04	10.6%	4.4E-10	--	--	2.8E-09	2.8E-04	10.6%
Vanadium	44.4	1.0E-02	NA	5.0E-03	1.2E-07	--	--	3.6E-07	7.2E-05	6.8%	1.4E-07	--	--	9.0E-07	1.8E-04	6.8%
					Total ILCR:	1.5E-07	100.0%	Total HI:	1.1E-03	100.0%	Total ILCR:	1.8E-07	100.0%	Total HI:	2.7E-03	100.0%

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

ADULT AND YOUTH TRESPASSERS - CURRENT AND FUTURE SCENARIOS
INHALATION OF FUGITIVE DUSTS EMANATING FROM SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

EC (mg/m3) = (Ca*ET*EF*ED)/AT
Where: Ca = C/VF + C/PEF

ILCR = EC*IUR*1000 ug/mg
HQ = EC/RfC

Parameter	Units	Description	Adult	Youth	
EC	mg/m3	Exposure Concentration	CS	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	CS	
IUR	1/(µg/m3)	Inhalation Unit Risk	CS	CS	
HQ	NA	Hazard quotient	CS	CS	
RfC	mg/kg/d	Inhalation Reference Concentration	CS	CS	
Ca	mg/m3	Concentration of chemical in air as fugitive dusts	CS	CS	
C	mg/kg	Concentration of chemical in soil	CS	CS	
VF	m3/kg	Volatilization Factor	CS	CS	
PEF	m3/kg	Particulate emission factor	1.36E+09	1.36E+09	
ET	hours/day	Exposure time	2.0	2.0	
EF	days/year	Exposure frequency	52	52	
ED	years	Exposure duration	24	11	
AT-C	hours	Averaging time, carcinogens	613,200	613,200	
AT-N	hours	Averaging time, noncarcinogens	210,240	96,360	

						Adult						Youth					
						Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	C (mg/kg)	VF (m3/kg)	Ca (mg/m3)	IUR 1/(µg/m3)	RfC (mg/m3)	EC (mg/m3)	ILCR	% Contrib. Total ILCR	EC (mg/m3)	HQ	% Contrib. HI	EC (mg/m3)	ILCR	% Contrib. Total ILCR	EC (mg/m3)	HQ	% Contrib. HI
Benzo[a]anthracene	0.110	1.8E+07	6.15E-09	1.1E-04	NA	2.5E-11	2.8E-12	0.9%	7.3E-11	--	--	1.1E-11	1.3E-12	0.9%	7.3E-11	--	--
Benzo[a]pyrene	0.127	3.5E+07	3.70E-09	1.1E-03	NA	1.5E-11	1.7E-11	5.2%	4.4E-11	--	--	6.9E-12	7.6E-12	5.2%	4.4E-11	--	--
Benzo[b]fluoranthene	0.169	2.1E+07	8.11E-09	1.1E-04	NA	3.3E-11	3.6E-12	1.1%	9.6E-11	--	--	1.5E-11	1.7E-12	1.1%	9.6E-11	--	--
Benzo[k]fluoranthene	0.146	4.5E+07	3.34E-09	1.1E-04	NA	1.4E-11	1.5E-12	0.5%	4.0E-11	--	--	6.2E-12	6.9E-13	0.5%	4.0E-11	--	--
Chrysene	0.142	2.7E+06	5.22E-08	1.1E-05	NA	2.1E-10	2.3E-12	0.7%	6.2E-10	--	--	9.7E-11	1.1E-12	0.7%	6.2E-10	--	--
Dibenz(a,h)anthracene	0.0402	8.7E+07	4.94E-10	1.2E-03	NA	2.0E-12	2.4E-12	0.8%	5.9E-12	--	--	9.2E-13	1.1E-12	0.8%	5.9E-12	--	--
Indeno[1,2,3-cd]pyrene	0.0532	8.2E+07	6.88E-10	1.1E-04	NA	2.8E-12	3.1E-13	0.1%	8.2E-12	--	--	1.3E-12	1.4E-13	0.1%	8.2E-12	--	--
Diesel Range Organics	207	NA	1.52E-07	NA	NA	6.2E-10	--	--	1.8E-09	--	--	2.8E-10	--	--	1.8E-09	--	--
Gasoline Range Organics	2,011	NA	1.48E-06	NA	NA	6.0E-09	--	--	1.8E-08	--	--	2.8E-09	--	--	1.8E-08	--	--
Arsenic	8.03	NA	5.90E-09	4.3E-03	1.5E-05	2.4E-11	1.0E-10	32.6%	7.0E-11	4.7E-06	32.0%	1.1E-11	4.7E-11	32.6%	7.0E-11	4.7E-06	32.0%
Cobalt	6.82	NA	5.01E-09	9.0E-03	6.0E-06	2.0E-11	1.8E-10	58.0%	6.0E-11	9.9E-06	68.0%	9.4E-12	8.4E-11	58.0%	6.0E-11	9.9E-06	68.0%
Copper	229	NA	1.68E-07	NA	NA	6.9E-10	--	--	2.0E-09	--	--	3.1E-10	--	--	2.0E-09	--	--
Thallium	0.139	NA	1.02E-10	NA	NA	4.2E-13	--	--	1.2E-12	--	--	1.9E-13	--	--	1.2E-12	--	--
Vanadium	44.4	NA	3.26E-08	NA	NA	1.3E-10	--	--	3.9E-10	--	--	6.1E-11	--	--	3.9E-10	--	--
						Total ILCR:	3.2E-10	100.0%	Total HI:	1.5E-05	100.0%	Total ILCR:	1.5E-10	100.0%	Total HI:	1.5E-05	100.0%

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

ADULT ON-SITE WORKERS - CURRENT AND FUTURE SCENARIOS
ACCIDENTAL INGESTION OF SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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

Parameter	Units	Description	Adult	
CDI	mg/kg/d	Chronic daily intake	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	
CSFo	1/(mg/kg/d)	Oral cancer slope factor	CS	
HQ	NA	Hazard quotient	CS	
RfDo	mg/kg/d	Oral reference dose	CS	
C	mg/kg	Concentration of chemical in soil	CS	
IR-S	mg/day	Ingestion rate of soil	100	
CF	kg/mg	Conversion factor	1.00E-06	
FI	NA	Fraction of soil ingested from site	1	
EF	days/year	Exposure frequency	250	
ED	years	Exposure duration	25	
BW	kg	Body weight	70	
AT-C	days	Averaging time, carcinogens	25,550	
AT-N	days	Averaging time, noncarcinogens	9,125	

				Carcinogens			Noncarcinogens		
Parameter	C (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	0.110	7.3E-01	NA	3.8E-08	2.8E-08	0.6%	1.1E-07	--	--
Benzo[a]pyrene	0.127	7.3E+00	NA	4.4E-08	3.2E-07	6.9%	1.2E-07	--	--
Benzo[b]fluoranthene	0.169	7.3E-01	NA	5.9E-08	4.3E-08	0.9%	1.7E-07	--	--
Benzo[k]fluoranthene	0.146	7.3E-02	NA	5.1E-08	3.7E-09	0.1%	1.4E-07	--	--
Chrysene	0.142	7.3E-03	NA	5.0E-08	3.6E-10	0.0%	1.4E-07	--	--
Dibenz(a,h)anthracene	0.0402	7.3E+00	NA	1.4E-08	1.0E-07	2.2%	3.9E-08	--	--
Indeno[1,2,3-cd]pyrene	0.0532	7.3E-01	NA	1.9E-08	1.4E-08	0.3%	5.2E-08	--	--
Diesel Range Organics	207	NA	NA	7.2E-05	--	--	2.0E-04	--	--
Gasoline Range Organics	2,011	NA	NA	7.0E-04	--	--	2.0E-03	--	--
Arsenic	8.03	1.5E+00	3.0E-04	2.8E-06	4.2E-06	89.1%	7.9E-06	2.6E-02	34.3%
Cobalt	6.82	NA	3.0E-04	2.4E-06	--	--	6.7E-06	2.2E-02	29.1%
Copper	229	NA	4.0E-02	8.0E-05	--	--	2.2E-04	5.6E-03	7.3%
Thallium	0.139	NA	1.0E-05	4.9E-08	--	--	1.4E-07	1.4E-02	17.8%
Vanadium	44.4	NA	5.0E-03	1.6E-05	--	--	4.3E-05	8.7E-03	11.4%
				Total ILCR:	4.7E-06	100.0%	Total HI:	7.6E-02	100.0%

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

ADULT ON-SITE WORKERS - CURRENT AND FUTURE SCENARIOS
DERMAL CONTACT WITH SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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

Parameter	Units	Description	Adult	
DAD	mg/kg/d	Dermally absorbed dose	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	
CSFd	1/(mg/kg/d)	Dermal cancer slope factor	CS	
HQ	NA	Hazard quotient	CS	
RfDd	mg/kg/d	Dermal reference dose	CS	
C	mg/kg	Concentration of chemical in soil	CS	
CF	kg/mg	Conversion factor	1.00E-06	
AF	mg/cm2	Soil to skin adherence factor	0.2	
ABS	NA	Absorption fraction	CS	
SA	cm2/day	Skin surface area available for contact	3,300	
EF	days/year	Exposure frequency	250	
ED	years	Exposure duration	25	
BW	kg	Body weight	70	
AT-C	days	Averaging time, carcinogens	25,550	
AT-N	days	Averaging time, noncarcinogens	9,125	

					Carcinogens			Noncarcinogens		
Parameter	C (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	0.110	1.3E-01	7.3E-01	NA	3.3E-08	2.4E-08	1.9%	9.2E-08	--	--
Benzo[a]pyrene	0.127	1.3E-01	7.3E+00	NA	3.8E-08	2.8E-07	21.8%	1.1E-07	--	--
Benzo[b]fluoranthene	0.169	1.3E-01	7.3E-01	NA	5.1E-08	3.7E-08	2.9%	1.4E-07	--	--
Benzo[k]fluoranthene	0.146	1.3E-01	7.3E-02	NA	4.4E-08	3.2E-09	0.3%	1.2E-07	--	--
Chrysene	0.142	1.3E-01	7.3E-03	NA	4.3E-08	3.1E-10	0.0%	1.2E-07	--	--
Dibenz(a,h)anthracene	0.0402	1.3E-01	7.3E+00	NA	1.2E-08	8.8E-08	6.9%	3.4E-08	--	--
Indeno[1,2,3-cd]pyrene	0.0532	1.3E-01	7.3E-01	NA	1.6E-08	1.2E-08	0.9%	4.5E-08	--	--
Diesel Range Organics	207	NA	NA	NA	4.8E-04	--	--	1.3E-03	--	--
Gasoline Range Organics	2,011	NA	NA	NA	4.6E-03	--	--	1.3E-02	--	--
Arsenic	8.03	3.0E-02	1.5E+00	3.0E-04	5.6E-07	8.3E-07	65.3%	1.6E-06	5.2E-03	61.0%
Cobalt	6.82	1.0E-02	NA	3.0E-04	1.6E-07	--	--	4.4E-07	1.5E-03	17.3%
Copper	229	1.0E-02	NA	4.0E-02	5.3E-06	--	--	1.5E-05	3.7E-04	4.4%
Thallium	0.139	1.0E-02	NA	1.0E-05	3.2E-09	--	--	9.0E-09	9.0E-04	10.6%
Vanadium	44.4	1.0E-02	NA	5.0E-03	1.0E-06	--	--	2.9E-06	5.7E-04	6.8%
					Total ILCR:	1.3E-06	100.0%	Total HI:	8.5E-03	100.0%

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

ADULT ON-SITE WORKERS - CURRENT AND FUTURE SCENARIOS
INHALATION OF FUGITIVE DUSTS EMANATING FROM SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

EC (mg/m3) = (Ca*ET*EF*ED)/AT
Where: Ca = C/VF + C/PEF

ILCR = EC*IUR*1000 ug/mg
HQ = EC/RfC

Parameter	Units	Description	Adult	
EC	mg/m3	Exposure Concentration	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	
IUR	1/(µg/m3)	Inhalation Unit Risk	CS	
HQ	NA	Hazard quotient	CS	
RfC	mg/m3	Inhalation Reference Concentration	CS	
Ca	mg/m3	Concentration of chemical in air as fugitive dusts	CS	
C	mg/kg	Concentration of chemical in soil	CS	
VF	m3/kg	Volatilization Factor	CS	
PEF	m3/kg	Particulate emission factor	1.36E+09	
ET	hours/day	Exposure time	8.0	
EF	days/year	Exposure frequency	250	
ED	years	Exposure duration	25	
AT-C	hours	Averaging time, carcinogens	613,200	
AT-N	hours	Averaging time, noncarcinogens	219,000	

						Carcinogens			Noncarcinogens		
Parameter	C (mg/kg)	VF (m3/kg)	Ca (mg/m3)	IUR 1/(µg/m3)	RfC (mg/m3)	EC (mg/m3)	ILCR	% Contrib. Total ILCR	EC (mg/m3)	HQ	% Contrib. HI
Benzo[a]anthracene	0.110	1.8E+07	6.15E-09	1.1E-04	NA	5.0E-10	5.5E-11	0.9%	1.4E-09	--	--
Benzo[a]pyrene	0.127	3.5E+07	3.70E-09	1.1E-03	NA	3.0E-10	3.3E-10	5.2%	8.4E-10	--	--
Benzo[b]fluoranthene	0.169	2.1E+07	8.11E-09	1.1E-04	NA	6.6E-10	7.3E-11	1.1%	1.9E-09	--	--
Benzo[k]fluoranthene	0.146	4.5E+07	3.34E-09	1.1E-04	NA	2.7E-10	3.0E-11	0.5%	7.6E-10	--	--
Chrysene	0.142	2.7E+06	5.22E-08	1.1E-05	NA	4.3E-09	4.7E-11	0.7%	1.2E-08	--	--
Dibenz(a,h)anthracene	0.0402	8.7E+07	4.94E-10	1.2E-03	NA	4.0E-11	4.8E-11	0.8%	1.1E-10	--	--
Indeno[1,2,3-cd]pyrene	0.0532	8.2E+07	6.88E-10	1.1E-04	NA	5.6E-11	6.2E-12	0.1%	1.6E-10	--	--
Diesel Range Organics	207	NA	1.52E-07	NA	NA	1.2E-08	--	--	3.5E-08	--	--
Gasoline Range Organics	2,011	NA	1.48E-06	NA	NA	1.2E-07	--	--	3.4E-07	--	--
Arsenic	8.03	NA	5.90E-09	4.3E-03	1.5E-05	4.8E-10	2.1E-09	32.6%	1.3E-09	9.0E-05	32.0%
Cobalt	6.82	NA	5.01E-09	9.0E-03	6.0E-06	4.1E-10	3.7E-09	58.0%	1.1E-09	1.9E-04	68.0%
Copper	229	NA	1.68E-07	NA	NA	1.4E-08	--	--	3.8E-08	--	--
Thallium	0.139	NA	1.02E-10	NA	NA	8.3E-12	--	--	2.3E-11	--	--
Vanadium	44.4	NA	3.26E-08	NA	NA	2.7E-09	--	--	7.5E-09	--	--
						Total ILCR:	6.3E-09	100.0%	Total HI:	2.8E-04	100.0%

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

ADULT AND YOUNG CHILD RESIDENTS - FUTURE SCENARIC
ACCIDENTAL INGESTION OF SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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

CS - Chemical Specific

Parameter	Units	Description	Adult	Young Child
CDI	mg/kg/d	Chronic daily intake	CS	CS
ILCR	NA	Incremental lifetime cancer risk	CS	CS
CSFo	1/(mg/kg/d)	Oral cancer slope factor	CS	CS
HQ	NA	Hazard quotient	CS	CS
RfDo	mg/kg/d	Oral reference dose	CS	CS
C	mg/kg	Concentration of chemical in soil	CS	CS
IR-S	mg/day	Ingestion rate of soil	100	200
CF	kg/mg	Conversion factor	1.00E-06	1.00E-06
FI	NA	Fraction of soil ingested from site	1	1
EF	days/year	Exposure frequency	350	350
ED	years	Exposure duration	24	6
BW	kg	Body weight	70	15
AT-C	days	Averaging time, carcinogens	25,550	25,550
AT-N	days	Averaging time, noncarcinogens	8,760	2,190

		Age Adjusted CDIs			
		Ages 16-24	Ages 6-15	Ages 2-5	Ages 0-1
Parameter	C (mg/kg)	CDI (mg/kg/d)	CDI (mg/kg/d)	CDI (mg/kg/d)	CDI (mg/kg/d)
Benzo[a]anthracene	0.110	5.2E-08	1.5E-07	3.6E-07	1.2E-06
Benzo[a]pyrene	0.127	6.0E-08	1.8E-07	4.2E-07	1.4E-06
Benzo[b]fluoranthene	0.169	7.9E-08	2.4E-07	5.6E-07	1.9E-06
Benzo[k]fluoranthene	0.146	6.9E-08	2.1E-07	4.8E-07	1.6E-06
Chrysene	0.142	6.7E-08	2.0E-07	4.7E-07	1.6E-06
Dibenz(a,h)anthracene	0.0402	1.9E-08	5.7E-08	1.3E-07	4.4E-07
Indeno[1,2,3-cd]pyrene	0.0532	2.5E-08	7.5E-08	1.7E-07	5.8E-07

				Adult						Young Child					
				Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	C (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	0.110	7.3E-01	NA	8.6E-07	6.3E-07	10.0%	1.5E-07	--	--	7.6E-07	5.5E-07	4.0%	1.4E-06	--	--
Benzo[a]pyrene	0.127	7.3E+00	NA	0.0E+00	0.0E+00	0.0%	1.7E-07	--	--	0.0E+00	0.0E+00	0.0%	1.6E-06	--	--
Benzo[b]fluoranthene	0.169	7.3E-01	NA	0.0E+00	0.0E+00	0.0%	2.3E-07	--	--	0.0E+00	0.0E+00	0.0%	2.2E-06	--	--
Benzo[k]fluoranthene	0.146	7.3E-02	NA	0.0E+00	0.0E+00	0.0%	2.0E-07	--	--	0.0E+00	0.0E+00	0.0%	1.9E-06	--	--
Chrysene	0.142	7.3E-03	NA	0.0E+00	0.0E+00	0.0%	1.9E-07	--	--	0.0E+00	0.0E+00	0.0%	1.8E-06	--	--
Dibenz(a,h)anthracene	0.0402	7.3E+00	NA	0.0E+00	0.0E+00	0.0%	5.5E-08	--	--	0.0E+00	0.0E+00	0.0%	5.1E-07	--	--
Indeno[1,2,3-cd]pyrene	0.0532	7.3E-01	NA	0.0E+00	0.0E+00	0.0%	7.3E-08	--	--	0.0E+00	0.0E+00	0.0%	6.8E-07	--	--
Diesel Range Organics	207	NA	NA	9.7E-05	--	--	2.8E-04	--	--	2.3E-04	--	--	2.6E-03	--	--
Gasoline Range Organics	2,011	NA	NA	9.4E-04	--	--	2.8E-03	--	--	2.2E-03	--	--	2.6E-02	--	--
Arsenic	8.03	1.5E+00	3.0E-04	3.8E-06	5.7E-06	90.0%	1.1E-05	3.7E-02	34.3%	8.8E-06	1.3E-05	96.0%	1.0E-04	3.4E-01	34.3%
Cobalt	6.82	NA	3.0E-04	3.2E-06	--	--	9.3E-06	3.1E-02	29.1%	7.5E-06	--	--	8.7E-05	2.9E-01	29.1%
Copper	229	NA	4.0E-02	1.1E-04	--	--	3.1E-04	7.8E-03	7.3%	2.5E-04	--	--	2.9E-03	7.3E-02	7.3%
Thallium	0.139	NA	1.0E-05	6.5E-08	--	--	1.9E-07	1.9E-02	17.8%	1.5E-07	--	--	1.8E-06	1.8E-01	17.8%
Vanadium	44.4	NA	5.0E-03	2.1E-05	--	--	6.1E-05	1.2E-02	11.4%	4.9E-05	--	--	5.7E-04	1.1E-01	11.4%
				Total ILCR:	6.3E-06	100.0%	Total HI:	1.1E-01	100.0%	Total ILCR:	1.4E-05	100.0%	Total HI:	1.0E+00	100.0%

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

ADULT AND YOUNG CHILD RESIDENTS - FUTURE SCENARIO
DERMAL CONTACT WITH SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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

CS - Chemical Specific

Parameter	Units	Description	Adult	Young Child
DAD	mg/kg/d	Dermally absorbed dose	CS	CS
ILCR	NA	Incremental lifetime cancer risk	CS	CS
CSFd	1/(mg/kg/d)	Dermal cancer slope factor	CS	CS
HQ	NA	Hazard quotient	CS	CS
RfDd	mg/kg/d	Dermal reference dose	CS	CS
C	mg/kg	Concentration of chemical in soil	CS	CS
CF	kg/mg	Conversion factor	1.00E-06	1.00E-06
AF	mg/cm2	Soil to skin adherence factor	0.07	0.2
ABS	NA	Absorption fraction	CS	CS
SA	cm2/day	Skin surface area available for contact	5,700	2,800
EF	days/year	Exposure frequency	350	350
ED	years	Exposure duration	24	6
BW	kg	Body weight	70	15
AT-C	days	Averaging time, carcinogens	25,550	25,550
AT-N	days	Averaging time, noncarcinogens	8,760	2,190

			Age Adjusted DADs			
			Ages 16-24	Ages 6-15	Ages 2-5	Ages 0-1
Parameter	C (mg/kg)	ABS	DAD (mg/kg/d)	DAD (mg/kg/d)	DAD (mg/kg/d)	DAD (mg/kg/d)
Benzo[a]anthracene	0.110	1.3E-01	2.7E-08	8.0E-08	1.3E-07	4.4E-07
Benzo[a]pyrene	0.127	1.3E-01	3.1E-08	9.3E-08	1.5E-07	5.1E-07
Benzo[b]fluoranthene	0.169	1.3E-01	4.1E-08	1.2E-07	2.0E-07	6.7E-07
Benzo[k]fluoranthene	0.146	1.3E-01	3.6E-08	1.1E-07	1.7E-07	5.8E-07
Chrysene	0.142	1.3E-01	3.5E-08	1.0E-07	1.7E-07	5.7E-07
Dibenz(a,h)anthracene	0.0402	1.3E-01	9.8E-09	2.9E-08	4.8E-08	1.6E-07
Indeno[1,2,3-cd]pyrene	0.0532	1.3E-01	1.3E-08	3.9E-08	6.4E-08	2.1E-07

					Adult						Young Child					
					Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	C (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	0.110	1.3E-01	7.3E-01	NA	3.3E-07	2.4E-07	26.1%	7.8E-08	--	--	2.8E-07	2.0E-07	15.4%	5.1E-07	--	--
Benzo[a]pyrene	0.127	1.3E-01	7.3E+00	NA	0.0E+00	0.0E+00	0.0%	9.0E-08	--	--	0.0E+00	0.0E+00	0.0%	5.9E-07	--	--
Benzo[b]fluoranthene	0.169	1.3E-01	7.3E-01	NA	0.0E+00	0.0E+00	0.0%	1.2E-07	--	--	0.0E+00	0.0E+00	0.0%	7.9E-07	--	--
Benzo[k]fluoranthene	0.146	1.3E-01	7.3E-02	NA	0.0E+00	0.0E+00	0.0%	1.0E-07	--	--	0.0E+00	0.0E+00	0.0%	6.8E-07	--	--
Chrysene	0.142	1.3E-01	7.3E-03	NA	0.0E+00	0.0E+00	0.0%	1.0E-07	--	--	0.0E+00	0.0E+00	0.0%	6.6E-07	--	--
Dibenz(a,h)anthracene	0.0402	1.3E-01	7.3E+00	NA	0.0E+00	0.0E+00	0.0%	2.9E-08	--	--	0.0E+00	0.0E+00	0.0%	1.9E-07	--	--
Indeno[1,2,3-cd]pyrene	0.0532	1.3E-01	7.3E-01	NA	0.0E+00	0.0E+00	0.0%	3.8E-08	--	--	0.0E+00	0.0E+00	0.0%	2.5E-07	--	--
Diesel Range Organics	207	NA	NA	NA	3.9E-04	--	--	1.1E-03	--	--	6.4E-04	--	--	7.4E-03	--	--
Gasoline Range Organics	2,011	NA	NA	NA	3.8E-03	--	--	1.1E-02	--	--	6.2E-03	--	--	7.2E-02	--	--
Arsenic	8.03	3.0E-02	1.5E+00	3.0E-04	4.5E-07	6.8E-07	73.9%	1.3E-06	4.4E-03	61.0%	7.4E-07	1.1E-06	84.6%	8.6E-06	2.9E-02	61.0%
Cobalt	6.82	1.0E-02	NA	3.0E-04	1.3E-07	--	--	3.7E-07	1.2E-03	17.3%	2.1E-07	--	--	2.4E-06	8.1E-03	17.3%
Copper	229	1.0E-02	NA	4.0E-02	4.3E-06	--	--	1.3E-05	3.1E-04	4.4%	7.0E-06	--	--	8.2E-05	2.0E-03	4.4%
Thallium	0.139	1.0E-02	NA	1.0E-05	2.6E-09	--	--	7.6E-09	7.6E-04	10.6%	4.3E-09	--	--	5.0E-08	5.0E-03	10.6%
Vanadium	44.4	1.0E-02	NA	5.0E-03	8.3E-07	--	--	2.4E-06	4.9E-04	6.8%	1.4E-06	--	--	1.6E-05	3.2E-03	6.8%
					Total ILCR:	9.2E-07	100.0%	Total HI:	7.2E-03	100.0%	Total ILCR:	1.3E-06	100.0%	Total HI:	4.7E-02	100.0%

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

ADULT AND YOUNG CHILD RESIDENTS - FUTURE SCENARIO
INHALATION OF FUGITIVE DUSTS EMANATING FROM SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

EC (mg/m3) = (Ca*ET*EF*ED)/AT   ILCR = EC*IUR*1000 ug/mg
Where: Ca = C/VF + C/PEF   HQ = EC/RfC   CS - Chemical Specific

Parameter	Units	Description	Adult	Young Child
EC	mg/m3	Exposure Concentration	CS	CS
ILCR	NA	Incremental lifetime cancer risk	CS	CS
IUR	1/(µg/m3)	Inhalation Unit Risk	CS	CS
HQ	NA	Hazard quotient	CS	CS
RfC	mg/m3	Inhalation Reference Concentration	CS	CS
Ca	mg/m3	Concentration of chemical in air as fugitive dusts	CS	CS
C	mg/kg	Concentration of chemical in soil	CS	CS
VF	m3/kg	Volatilization Factor	CS	CS
PEF	m3/kg	Particulate emission factor	1.36E+09	1.36E+09
ET	hours/day	Exposure time	24	24
EF	days/year	Exposure frequency	350	350
ED	years	Exposure duration	24	6
AT-C	hours	Averaging time, carcinogens	613,200	613,200
AT-N	hours	Averaging time, noncarcinogens	210,240	52,560

		Age Adjusted ECs			
		Ages 16-24	Ages 6-15	Ages 2-5	Ages 0-1
Parameter	Ca (mg/m3)	EC (mg/m3)	EC (mg/m3)	EC (mg/m3)	EC (mg/m3)
Benzo[a]anthracene	6.2E-09	2.0E-09	6.1E-09	1.5E-09	5.1E-09
Benzo[a]pyrene	3.7E-09	1.2E-09	3.6E-09	9.1E-10	3.0E-09
Benzo[b]fluoranthene	8.1E-09	2.7E-09	8.0E-09	2.0E-09	6.7E-09
Benzo[k]fluoranthene	3.3E-09	1.1E-09	3.3E-09	8.2E-10	2.7E-09
Chrysene	5.2E-08	1.7E-08	5.1E-08	1.3E-08	4.3E-08
Dibenz(a,h)anthracene	4.9E-10	1.6E-10	4.9E-10	1.2E-10	4.1E-10
Indeno[1,2,3-cd]pyrene	6.9E-10	2.3E-10	6.8E-10	1.7E-10	5.7E-10

						Adult						Young Child					
						Carcinogens			Noncarcinogens			Carcinogens			Noncarcinogens		
Parameter	C (mg/kg)	VF (m3/kg)	Ca (mg/m3)	IUR 1/(µg/m3)	RfC mg/m3	EC (mg/m3)	ILCR	% Contrib. Total ILCR	EC (mg/m3)	HQ	% Contrib. HI	EC (mg/m3)	ILCR	% Contrib. Total ILCR	EC (mg/m3)	HQ	% Contrib. HI
Benzo[a]anthracene	0.110	1.8E+07	6.15E-09	1.1E-04	NA	1.6E-09	1.8E-10	0.8%	5.9E-09	--	--	7.4E-10	8.1E-11	1.4%	5.9E-09	--	--
Benzo[a]pyrene	0.127	3.5E+07	3.70E-09	1.1E-03	NA	0.0E+00	0.0E+00	0.0%	3.5E-09	--	--	0.0E+00	0.0E+00	0.0%	3.5E-09	--	--
Benzo[b]fluoranthene	0.169	2.1E+07	8.11E-09	1.1E-04	NA	0.0E+00	0.0E+00	0.0%	7.8E-09	--	--	0.0E+00	0.0E+00	0.0%	7.8E-09	--	--
Benzo[k]fluoranthene	0.146	4.5E+07	3.34E-09	1.1E-04	NA	0.0E+00	0.0E+00	0.0%	3.2E-09	--	--	0.0E+00	0.0E+00	0.0%	3.2E-09	--	--
Chrysene	0.142	2.7E+06	5.22E-08	1.1E-05	NA	0.0E+00	0.0E+00	0.0%	5.0E-08	--	--	0.0E+00	0.0E+00	0.0%	5.0E-08	--	--
Dibenz(a,h)anthracene	0.0402	8.7E+07	4.94E-10	1.2E-03	NA	0.0E+00	0.0E+00	0.0%	4.7E-10	--	--	0.0E+00	0.0E+00	0.0%	4.7E-10	--	--
Indeno[1,2,3-cd]pyrene	0.0532	8.2E+07	6.88E-10	1.1E-04	NA	0.0E+00	0.0E+00	0.0%	6.6E-10	--	--	0.0E+00	0.0E+00	0.0%	6.6E-10	--	--
Diesel Range Organics	207	NA	1.52E-07	NA	NA	5.0E-08	--	--	1.5E-07	--	--	1.3E-08	--	--	1.5E-07	--	--
Gasoline Range Organics	2,011	NA	1.48E-06	NA	NA	4.9E-07	--	--	1.4E-06	--	--	1.2E-07	--	--	1.4E-06	--	--
Arsenic	8.03	NA	5.90E-09	4.3E-03	1.5E-05	1.9E-09	8.3E-09	35.7%	5.7E-09	3.8E-04	32.0%	4.9E-10	2.1E-09	35.5%	5.7E-09	3.8E-04	32.0%
Cobalt	6.82	NA	5.01E-09	9.0E-03	6.0E-06	1.6E-09	1.5E-08	63.5%	4.8E-09	8.0E-04	68.0%	4.1E-10	3.7E-09	63.1%	4.8E-09	8.0E-04	68.0%
Copper	229	NA	1.68E-07	NA	NA	5.5E-08	--	--	1.6E-07	--	--	1.4E-08	--	--	1.6E-07	--	--
Thallium	0.139	NA	1.02E-10	NA	NA	3.4E-11	--	--	9.8E-11	--	--	8.4E-12	--	--	9.8E-11	--	--
Vanadium	44.4	NA	3.26E-08	NA	NA	1.1E-08	--	--	3.1E-08	--	--	2.7E-09	--	--	3.1E-08	--	--
						Total ILCR:	2.3E-08	100.0%	Total HI:	1.2E-03	100.0%	Total ILCR:	5.9E-09	100.0%	Total HI:	1.2E-03	100.0%

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

ADULT INDUSTRIAL / COMMERCIAL WORKERS - FUTURE SCENARIO
ACCIDENTAL INGESTION OF SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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

Parameter	Units	Description	Adult	
CDI	mg/kg/d	Chronic daily intake	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	
CSFo	1/(mg/kg/d)	Oral cancer slope factor	CS	
HQ	NA	Hazard quotient	CS	
RfDo	mg/kg/d	Oral reference dose	CS	
C	mg/kg	Concentration of chemical in soil	CS	
IR-S	mg/day	Ingestion rate of soil	100	
CF	kg/mg	Conversion factor	1.00E-06	
FI	NA	Fraction of soil ingested from site	1	
EF	days/year	Exposure frequency	250	
ED	years	Exposure duration	25	
BW	kg	Body weight	70	
AT-C	days	Averaging time, carcinogens	25,550	
AT-N	days	Averaging time, noncarcinogens	9,125	

				Carcinogens			Noncarcinogens		
Parameter	C (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	0.110	7.3E-01	NA	3.8E-08	2.8E-08	0.6%	1.1E-07	--	--
Benzo[a]pyrene	0.127	7.3E+00	NA	4.4E-08	3.2E-07	6.9%	1.2E-07	--	--
Benzo[b]fluoranthene	0.169	7.3E-01	NA	5.9E-08	4.3E-08	0.9%	1.7E-07	--	--
Benzo[k]fluoranthene	0.146	7.3E-02	NA	5.1E-08	3.7E-09	0.1%	1.4E-07	--	--
Chrysene	0.142	7.3E-03	NA	5.0E-08	3.6E-10	0.0%	1.4E-07	--	--
Dibenz(a,h)anthracene	0.0402	7.3E+00	NA	1.4E-08	1.0E-07	2.2%	3.9E-08	--	--
Indeno[1,2,3-cd]pyrene	0.0532	7.3E-01	NA	1.9E-08	1.4E-08	0.3%	5.2E-08	--	--
Diesel Range Organics	207	NA	NA	7.2E-05	--	--	2.0E-04	--	--
Gasoline Range Organics	2,011	NA	NA	7.0E-04	--	--	2.0E-03	--	--
Arsenic	8.03	1.5E+00	3.0E-04	2.8E-06	4.2E-06	89.1%	7.9E-06	2.6E-02	34.3%
Cobalt	6.82	NA	3.0E-04	2.4E-06	--	--	6.7E-06	2.2E-02	29.1%
Copper	229	NA	4.0E-02	8.0E-05	--	--	2.2E-04	5.6E-03	7.3%
Thallium	0.139	NA	1.0E-05	4.9E-08	--	--	1.4E-07	1.4E-02	17.8%
Vanadium	44.4	NA	5.0E-03	1.6E-05	--	--	4.3E-05	8.7E-03	11.4%
				Total ILCR:	4.7E-06	100.0%	Total HI:	7.6E-02	100.0%

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

ADULT INDUSTRIAL / COMMERCIAL WORKERS - FUTURE SCENARIO
DERMAL CONTACT WITH SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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

Parameter	Units	Description	Adult	
DAD	mg/kg/d	Dermally absorbed dose	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	
CSFd	1/(mg/kg/d)	Dermal cancer slope factor	CS	
HQ	NA	Hazard quotient	CS	
RfDd	mg/kg/d	Dermal reference dose	CS	
C	mg/kg	Concentration of chemical in soil	CS	
CF	kg/mg	Conversion factor	1.00E-06	
AF	mg/cm2	Soil to skin adherence factor	0.2	
ABS	NA	Absorption fraction	CS	
SA	cm2/day	Skin surface area available for contact	3,300	
EF	days/year	Exposure frequency	250	
ED	years	Exposure duration	25	
BW	kg	Body weight	70	
AT-C	days	Averaging time, carcinogens	25,550	
AT-N	days	Averaging time, noncarcinogens	9,125	

					Carcinogens			Noncarcinogens		
Parameter	C (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	0.110	1.3E-01	7.3E-01	NA	3.3E-08	2.4E-08	1.9%	9.2E-08	--	--
Benzo[a]pyrene	0.127	1.3E-01	7.3E+00	NA	3.8E-08	2.8E-07	21.8%	1.1E-07	--	--
Benzo[b]fluoranthene	0.169	1.3E-01	7.3E-01	NA	5.1E-08	3.7E-08	2.9%	1.4E-07	--	--
Benzo[k]fluoranthene	0.146	1.3E-01	7.3E-02	NA	4.4E-08	3.2E-09	0.3%	1.2E-07	--	--
Chrysene	0.142	1.3E-01	7.3E-03	NA	4.3E-08	3.1E-10	0.0%	1.2E-07	--	--
Dibenz(a,h)anthracene	0.0402	1.3E-01	7.3E+00	NA	1.2E-08	8.8E-08	6.9%	3.4E-08	--	--
Indeno[1,2,3-cd]pyrene	0.0532	1.3E-01	7.3E-01	NA	1.6E-08	1.2E-08	0.9%	4.5E-08	--	--
Diesel Range Organics	207	NA	NA	NA	4.8E-04	--	--	1.3E-03	--	--
Gasoline Range Organics	2,011	NA	NA	NA	4.6E-03	--	--	1.3E-02	--	--
Arsenic	8.03	3.0E-02	1.5E+00	3.0E-04	5.6E-07	8.3E-07	65.3%	1.6E-06	5.2E-03	61.0%
Cobalt	6.82	1.0E-02	NA	3.0E-04	1.6E-07	--	--	4.4E-07	1.5E-03	17.3%
Copper	229	1.0E-02	NA	4.0E-02	5.3E-06	--	--	1.5E-05	3.7E-04	4.4%
Thallium	0.139	1.0E-02	NA	1.0E-05	3.2E-09	--	--	9.0E-09	9.0E-04	10.6%
Vanadium	44.4	1.0E-02	NA	5.0E-03	1.0E-06	--	--	2.9E-06	5.7E-04	6.8%
					Total ILCR:	1.3E-06	100.0%	Total HI:	8.5E-03	100.0%

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

ADULT INDUSTRIAL / COMMERCIAL WORKERS - FUTURE SCENARIO
INHALATION OF FUGITIVE DUSTS EMANATING FROM SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

EC (mg/m3) = (Ca*ET*EF*ED)/AT
Where: Ca = C/VF + C/PEF

ILCR = EC*IUR*1000 ug/mg
HQ = EC/RfC

Parameter	Units	Description	Adult	
EC	mg/m3	Exposure Concentration	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	
IUR	1/(μg/m3)	Inhalation Unit Risk	CS	
HQ	NA	Hazard quotient	CS	
RfC	mg/m3	Inhalation Reference Concentration	CS	
Ca	mg/m3	Concentration of chemical in air as fugitive dusts	CS	
C	mg/kg	Concentration of chemical in soil	CS	
VF	m3/kg	Volatilization Factor	CS	
PEF	m3/kg	Particulate emission factor	1.36E+09	
ET	hours/day	Exposure time	8.0	
EF	days/year	Exposure frequency	250	
ED	years	Exposure duration	25	
AT-C	hours	Averaging time, carcinogens	613,200	
AT-N	hours	Averaging time, noncarcinogens	219,000	

						Carcinogens			Noncarcinogens		
Parameter	C (mg/kg)	VF (m3/kg)	Ca (mg/m3)	IUR 1/(μg/m3)	RfC (mg/m3)	EC (mg/m3)	ILCR	% Contrib. Total ILCR	EC (mg/m3)	HQ	% Contrib. HI
Benzo[a]anthracene	0.110	1.8E+07	6.15E-09	1.1E-04	NA	5.0E-10	5.5E-11	0.9%	1.4E-09	--	--
Benzo[a]pyrene	0.127	3.5E+07	3.70E-09	1.1E-03	NA	3.0E-10	3.3E-10	5.2%	8.4E-10	--	--
Benzo[b]fluoranthene	0.169	2.1E+07	8.11E-09	1.1E-04	NA	6.6E-10	7.3E-11	1.1%	1.9E-09	--	--
Benzo[k]fluoranthene	0.146	4.5E+07	3.34E-09	1.1E-04	NA	2.7E-10	3.0E-11	0.5%	7.6E-10	--	--
Chrysene	0.142	2.7E+06	5.22E-08	1.1E-05	NA	4.3E-09	4.7E-11	0.7%	1.2E-08	--	--
Dibenz(a,h)anthracene	0.0402	8.7E+07	4.94E-10	1.2E-03	NA	4.0E-11	4.8E-11	0.8%	1.1E-10	--	--
Indeno[1,2,3-cd]pyrene	0.0532	8.2E+07	6.88E-10	1.1E-04	NA	5.6E-11	6.2E-12	0.1%	1.6E-10	--	--
Diesel Range Organics	207	NA	1.52E-07	NA	NA	1.2E-08	--	--	3.5E-08	--	--
Gasoline Range Organics	2,011	NA	1.48E-06	NA	NA	1.2E-07	--	--	3.4E-07	--	--
Arsenic	8.03	NA	5.90E-09	4.3E-03	1.5E-05	4.8E-10	2.1E-09	32.6%	1.3E-09	9.0E-05	32.0%
Cobalt	6.82	NA	5.01E-09	9.0E-03	6.0E-06	4.1E-10	3.7E-09	58.0%	1.1E-09	1.9E-04	68.0%
Copper	229	NA	1.68E-07	NA	NA	1.4E-08	--	--	3.8E-08	--	--
Thallium	0.139	NA	1.02E-10	NA	NA	8.3E-12	--	--	2.3E-11	--	--
Vanadium	44.4	NA	3.26E-08	NA	NA	2.7E-09	--	--	7.5E-09	--	--
						Total ILCR:	6.3E-09	100.0%	Total HI:	2.8E-04	100.0%

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

ADULT CONSTRUCTION WORKERS - FUTURE SCENARIO
ACCIDENTAL INGESTION OF SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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

Parameter	Units	Description	Adult	
CDI	mg/kg/d	Chronic daily intake	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	
CSFo	1/(mg/kg/d)	Oral cancer slope factor	CS	
HQ	NA	Hazard quotient	CS	
RfDo	mg/kg/d	Oral reference dose	CS	
C	mg/kg	Concentration of chemical in soil	CS	
IR-S	mg/day	Ingestion rate of soil	330	
CF	kg/mg	Conversion factor	1.00E-06	
FI	NA	Fraction of soil ingested from site	1	
EF	days/year	Exposure frequency	250	
ED	years	Exposure duration	1	
BW	kg	Body weight	70	
AT-C	days	Averaging time, carcinogens	25,550	
AT-N	days	Averaging time, noncarcinogens	365	

				Carcinogens			Noncarcinogens		
Parameter	C (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	0.110	7.3E-01	NA	5.1E-09	3.7E-09	0.6%	3.6E-07	--	--
Benzo[a]pyrene	0.127	7.3E+00	NA	5.9E-09	4.3E-08	6.9%	4.1E-07	--	--
Benzo[b]fluoranthene	0.169	7.3E-01	NA	7.8E-09	5.7E-09	0.9%	5.5E-07	--	--
Benzo[k]fluoranthene	0.146	7.3E-02	NA	6.7E-09	4.9E-10	0.1%	4.7E-07	--	--
Chrysene	0.142	7.3E-03	NA	6.6E-09	4.8E-11	0.0%	4.6E-07	--	--
Dibenz(a,h)anthracene	0.0402	7.3E+00	NA	1.9E-09	1.4E-08	2.2%	1.3E-07	--	--
Indeno[1,2,3-cd]pyrene	0.0532	7.3E-01	NA	2.5E-09	1.8E-09	0.3%	1.7E-07	--	--
Diesel Range Organics	207	NA	NA	9.5E-06	--	--	6.7E-04	--	--
Gasoline Range Organics	2,011	NA	NA	9.3E-05	--	--	6.5E-03	--	--
Arsenic	8.03	1.5E+00	3.0E-04	3.7E-07	5.6E-07	89.1%	2.6E-05	8.6E-02	34.3%
Cobalt	6.82	NA	3.0E-04	3.1E-07	--	--	2.2E-05	7.3E-02	29.1%
Copper	229	NA	4.0E-02	1.1E-05	--	--	7.4E-04	1.8E-02	7.3%
Thallium	0.139	NA	1.0E-05	6.4E-09	--	--	4.5E-07	4.5E-02	17.8%
Vanadium	44.4	NA	5.0E-03	2.0E-06	--	--	1.4E-04	2.9E-02	11.4%
				Total ILCR:	6.2E-07	100.0%	Total HI:	2.5E-01	100.0%

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

ADULT CONSTRUCTION WORKERS - FUTURE SCENARIO
DERMAL CONTACT WITH SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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

Parameter	Units	Description	Adult	
DAD	mg/kg/d	Dermally absorbed dose	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	
CSFd	1/(mg/kg/d)	Dermal cancer slope factor	CS	
HQ	NA	Hazard quotient	CS	
RfDd	mg/kg/d	Dermal reference dose	CS	
C	mg/kg	Concentration of chemical in soil	CS	
CF	kg/mg	Conversion factor	1.00E-06	
AF	mg/cm2	Soil to skin adherence factor	0.3	
ABS	NA	Absorption fraction	CS	
SA	cm2/day	Skin surface area available for contact	3,300	
EF	days/year	Exposure frequency	250	
ED	years	Exposure duration	1	
BW	kg	Body weight	70	
AT-C	days	Averaging time, carcinogens	25,550	
AT-N	days	Averaging time, noncarcinogens	365	

					Carcinogens			Noncarcinogens		
Parameter	C (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	0.110	1.3E-01	7.3E-01	NA	2.0E-09	1.4E-09	1.9%	1.4E-07	--	--
Benzo[a]pyrene	0.127	1.3E-01	7.3E+00	NA	2.3E-09	1.7E-08	21.8%	1.6E-07	--	--
Benzo[b]fluoranthene	0.169	1.3E-01	7.3E-01	NA	3.0E-09	2.2E-09	2.9%	2.1E-07	--	--
Benzo[k]fluoranthene	0.146	1.3E-01	7.3E-02	NA	2.6E-09	1.9E-10	0.3%	1.8E-07	--	--
Chrysene	0.142	1.3E-01	7.3E-03	NA	2.6E-09	1.9E-11	0.0%	1.8E-07	--	--
Dibenz(a,h)anthracene	0.0402	1.3E-01	7.3E+00	NA	7.2E-10	5.3E-09	6.9%	5.1E-08	--	--
Indeno[1,2,3-cd]pyrene	0.0532	1.3E-01	7.3E-01	NA	9.6E-10	7.0E-10	0.9%	6.7E-08	--	--
Diesel Range Organics	207	NA	NA	NA	2.9E-05	--	--	2.0E-03	--	--
Gasoline Range Organics	2,011	NA	NA	NA	2.8E-04	--	--	1.9E-02	--	--
Arsenic	8.03	3.0E-02	1.5E+00	3.0E-04	3.3E-08	5.0E-08	65.3%	2.3E-06	7.8E-03	61.0%
Cobalt	6.82	1.0E-02	NA	3.0E-04	9.4E-09	--	--	6.6E-07	2.2E-03	17.3%
Copper	229	1.0E-02	NA	4.0E-02	3.2E-07	--	--	2.2E-05	5.5E-04	4.4%
Thallium	0.139	1.0E-02	NA	1.0E-05	1.9E-10	--	--	1.3E-08	1.3E-03	10.6%
Vanadium	44.4	1.0E-02	NA	5.0E-03	6.1E-08	--	--	4.3E-06	8.6E-04	6.8%
					Total ILCR:	7.7E-08	100.0%	Total HI:	1.3E-02	100.0%

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

ADULT CONSTRUCTION WORKERS - FUTURE SCENARIO
INHALATION OF FUGITIVE DUSTS EMANATING FROM SOIL - FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
REASONABLE MAXIMUM EXPOSURE
POTENTIAL CARCINOGENIC AND NONCARCINOGENIC RISKS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

EC (mg/m3) = (Ca*ET*EF*ED)/AT
Where: Ca = C/VF + C/PEF

ILCR = EC*IUR*1000 ug/mg
HQ = EC/RfC

Parameter	Units	Description	Adult	
EC	mg/m3	Exposure Concentration	CS	(Chemical Specific)
ILCR	NA	Incremental lifetime cancer risk	CS	
IUR	1/(μg/m3)	Inhalation Unit Risk	CS	
HQ	NA	Hazard quotient	CS	
RfC	mg/m3	Inhalation Reference Concentration	CS	
Ca	mg/m3	Concentration of chemical in air as fugitive dusts	CS	
C	mg/kg	Concentration of chemical in soil	CS	
VF	m3/kg	Volatilization Factor	CS	
PEF	m3/kg	Particulate emission factor	1.31E+06	
ET	hours/day	Exposure time	8.0	
EF	days/year	Exposure frequency	250	
ED	years	Exposure duration	1	
AT-C	hours	Averaging time, carcinogens	613,200	
AT-N	hours	Averaging time, noncarcinogens	8,760	

						Carcinogens			Noncarcinogens		
Parameter	C (mg/kg)	VF (m3/kg)	Ca (mg/m3)	IUR 1/(μg/m3)	RfC (mg/m3)	EC (mg/m3)	ILCR	% Contrib. Total ILCR	EC (mg/m3)	HQ	% Contrib. HI
Benzo[a]anthracene	0.110	1.8E+07	8.98E-08	1.1E-04	NA	2.9E-10	3.2E-11	0.0%	2.1E-08	--	--
Benzo[a]pyrene	0.127	3.5E+07	1.00E-07	1.1E-03	NA	3.3E-10	3.6E-10	0.2%	2.3E-08	--	--
Benzo[b]fluoranthene	0.169	2.1E+07	1.37E-07	1.1E-04	NA	4.5E-10	4.9E-11	0.0%	3.1E-08	--	--
Benzo[k]fluoranthene	0.146	4.5E+07	1.14E-07	1.1E-04	NA	3.7E-10	4.1E-11	0.0%	2.6E-08	--	--
Chrysene	0.142	2.7E+06	1.60E-07	1.1E-05	NA	5.2E-10	5.7E-12	0.0%	3.7E-08	--	--
Dibenz(a,h)anthracene	0.0402	8.7E+07	3.11E-08	1.2E-03	NA	1.0E-10	1.2E-10	0.1%	7.1E-09	--	--
Indeno[1,2,3-cd]pyrene	0.0532	8.2E+07	4.12E-08	1.1E-04	NA	1.3E-10	1.5E-11	0.0%	9.4E-09	--	--
Diesel Range Organics	207	NA	1.58E-04	NA	NA	5.1E-07	--	--	3.6E-05	--	--
Gasoline Range Organics	2,011	NA	1.53E-03	NA	NA	5.0E-06	--	--	3.5E-04	--	--
Arsenic	8.03	NA	6.11E-06	4.3E-03	1.5E-05	2.0E-08	8.6E-08	35.9%	1.4E-06	9.3E-02	32.0%
Cobalt	6.82	NA	5.19E-06	9.0E-03	6.0E-06	1.7E-08	1.5E-07	63.8%	1.2E-06	2.0E-01	68.0%
Copper	229	NA	1.74E-04	NA	NA	5.7E-07	--	--	4.0E-05	--	--
Thallium	0.139	NA	1.06E-07	NA	NA	3.5E-10	--	--	2.4E-08	--	--
Vanadium	44.4	NA	3.38E-05	NA	NA	1.1E-07	--	--	7.7E-06	--	--
						Total ILCR:	2.4E-07	100.0%	Total HI:	2.9E-01	100.0%

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

PARTICULATE EMISSION FACTOR - CONSTRUCTION WORKERS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT - NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

$$PEF = Q/C_{sr} \times 1/F_D \times \left[\frac{T \times A_R}{556 \times (W/3)^{0.4} \times (365-p)/365 \times Sum(VKT)} \right]$$

$$Q/C_{sr} = A \times \exp\left((\ln A_S - B)^2/C\right)$$

Symbol	Definition (units)	Default	Reference
Q/C_{sr}	Inverse of a 1-h avg. air concentration along a straight road bisecting a 3 acre square site (g/m2 -s/kg/m3)	17.5	USEPA 2001
A	Constant (unitless)	12.9351	USEPA 2001
A_S	Arial extent of site surface soil contamination (acres)	3	Site-specific
B	Constant (unitless)	5.7383	USEPA 2001
C	Constant (unitless)	71.7711	USEPA 2001
F_D	Dispersion correction factor	0.185	USEPA 2001
T	Total time over which construction occurs (s)	7.20E+06	USEPA 2001
A_R	Surface area of contaminated road segment (m^2)	1,679	Site-specific
W	Mean vehicle weight (tons)	11	USEPA 2001
p	Number of days with at least 0.01 inches of precipitation (days/year)	120	USEPA 2001
Sum(VKT)	Sum of fleet vehicle kilometers traveled during the exposure duration (km)	550	USEPA 2001
PEF	Particulate Emission Factor (m^3/kg)	3.31E+06	Site-specific

Q/C_{sr} Calculation

$\ln A_S$	1.099	
$(\ln A_S - B)^2$	21.5	
$(\ln A_S - B)^2/C$	0.300	
$e^{(\ln A_S - B)2/C}$	1.35	
$A \times e^{(\ln A_S - B)2/C}$	17.5	Q/C_{sr}

PEF Calculation

$Q/C_{sr} \times 1/F_D$	94	
$T \times A_R$	12,090,250,604	
$(W/3)^{0.4}$	1.68	
(365-p)/365	0.671	
$556 \times (W/3)^{0.4} \times (365-p)/365 \times Sum(VKT)$	345,159	
$T \times A_R/556 \times (W/3)^{0.4} \times (365-p)/365 \times Sum(VKT)$	35,028	
PEF	3,305,784	
3 acres / 0.000247 acres / m2 =	12,146	m^2
sqrt (12146) / 1000 =	0.11	km

Assumptions

W assumptions: 10 - 2-ton cars and 10 - 20-ton trucks = 20 vehicles

Sum(VKT) assumptions:

Assume that the site is 3 acres configured as a square with the unpaved road segment dividing the square evenly. The road length equals the square root of the 3 acres (0.11 km). Assume that each vehicle travels the length of the road 1 time per day, 5 days per week, for a total of 12 months (1 year) = 20 vehicles x 0.11 km/day x 50 weeks/yr x 5 days/week = 550 km

A_R assumptions:

Based on VKT, the road length is 110 m and assume the road width is 50 ft. (15.24).

Reference

USEPA 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

APPENDIX L
RAGS PART D TABLES

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Soil	Soil	Soil	On-Site Workers	Adult	Ingestion Dermal	Quantitative	Current landscaping, outdoor work-related activities for site.
				Industrial / Commercial Workers	Adult	Ingestion Dermal	NA	Not a current receptor.
				Construction Workers	Adult	Ingestion Dermal	NA	Not a current receptor.
				Trespassers	Adult and Youth	Ingestion Dermal	Quantitative	Current access of the site without permission
				Residents	Adult and Young Child	Ingestion Dermal	NA	Not a current receptor.
		Air	Fugitive Dusts	On-Site Workers	Adult	Inhalation	Quantitative	Current landscaping, outdoor work-related activities for site.
				Industrial / Commercial Workers	Adult	Inhalation	NA	Not a current receptor.
				Construction Workers	Adult	Inhalation	NA	Not a current receptor.
				Trespassers	Adult and Youth	Inhalation	Quantitative	Current access of the site without permission
				Residents	Adult and Young Child	Inhalation	NA	Not a current receptor.
Future	Soil	Soil	Soil	On-Site Workers	Adult	Ingestion Dermal	Quantitative	Future potential landscaping, outdoor work-related activities for site.
				Industrial / Commercial Workers	Adult	Ingestion Dermal	Quantitative	Future potential indoor workers walking around the site.
				Construction Workers	Adult	Ingestion Dermal	Quantitative	Future potential excavation or construction activities for development.
				Trespassers	Adult and Youth	Ingestion Dermal	Quantitative	Future potential access of the site without permission
				Residents	Adult and Young Child	Ingestion Dermal	Quantitative	Future potential residential development.

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
	Soil (continued)	Air	Fugitive Dusts	On-Site Workers	Adult	Inhalation	Quantitative	Future potential landscaping, outdoor work-related activities for site.
				Industrial / Commercial Workers	Adult	Inhalation	Quantitative	Future potential indoor workers walking around the site.
				Construction Workers	Adult	Inhalation	Quantitative	Future potential excavation or construction activities for development.
				Trespassers	Adult and Youth	Inhalation	Quantitative	Future potential access of the site without permission
				Residents	Adult and Young Child	Inhalation	Quantitative	Future potential residential development.

TABLE 2.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits (1)	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Surface Soil		**Volatile Organic Compounds (ug/kg)**													
	75-15-0	Carbon disulfide	5.5 J	5.9	µg/kg	74SB754-00	2/14	0.76U - 6.3U	5.9	ND	8.20E+04	N/A	N/A	NO	BSL
		LLPAHs (ug/kg)													
	91-57-6	2-Methylnaphthalene	4.2 J	4.2 J	µg/kg	74SB756-00	1/13	7.2U - 75U	4.2	ND	3.10E+04	N/A	N/A	NO	BSL
	83-32-9	Acenaphthene	3.8 J	9.4	µg/kg	74SB760-00	2/13	7.2U - 75U	9.4	ND	3.40E+05	N/A	N/A	NO	BSL
	208-96-8	Acenaphthylene	11	17	µg/kg	74SB759-00, 74SB760-00	3/13	7.2U - 75U	17	ND	3.40E+05 (7)(8)	N/A	N/A	NO	BSL
	120-12-7	Anthracene	4 J	52	µg/kg	74SB760-00	6/13	69U - 75U	52	ND	1.70E+06	N/A	N/A	NO	BSL
	56-55-3	Benzo[a]anthracene	13	190	µg/kg	74SB749-00	8/13	69U - 75U	190	ND	1.50E+02	N/A	N/A	YES	ASL
	50-32-8	Benzo[a]pyrene	20	200	µg/kg	74SB750-00	12/13	71U - 71U	200	ND	1.50E+01	N/A	N/A	YES	ASL
	205-99-2	Benzo[b]fluoranthene	36	270 J	µg/kg	74SB759-00	9/13	69U - 74U	270	ND	1.50E+02	N/A	N/A	YES	ASL
	191-24-2	Benzo[g,h,i]perylene	24	170	µg/kg	74SB749-00	10/13	7.4U - 72U	170	ND	1.70E+05 (7)(9)	N/A	N/A	NO	BSL
	207-08-9	Benzo[k]fluoranthene	33	230 J	µg/kg	74SB759-00	9/13	69U - 72U	230	ND	1.50E+03	N/A	N/A	YES	CHEM
	218-01-9	Chrysene	31	250	µg/kg	74SB760-00	11/13	71U - 72U	250	ND	1.50E+04	N/A	N/A	YES	CHEM
	53-70-3	Dibenz(a,h)anthracene	20	57 J	µg/kg	74SB749-00	4/13	7.2U - 75U	57	ND	1.50E+01	N/A	N/A	YES	ASL
	206-44-0	Fluoranthene	32	400	µg/kg	74SB760-00	9/13	69U - 72U	400	ND	2.30E+05	N/A	N/A	NO	BSL
	86-73-7	Fluorene	3.6 J	7.6	µg/kg	74SB760-00	2/13	7.2U - 75U	7.6	ND	2.30E+05	N/A	N/A	NO	BSL
	193-39-5	Indeno[1,2,3-cd]pyrene	5 J	110	µg/kg	74SB749-00	9/13	69U - 72U	110	ND	1.50E+02	N/A	N/A	YES	CHEM
	85-01-8	Phenanthrene	6.2 J	180	µg/kg	74SB760-00	9/13	69U - 75U	180	ND	1.70E+05 (7)(9)	N/A	N/A	NO	BSL
	129-00-0	Pyrene	33	430	µg/kg	74SB760-00	10/13	71U - 72U	430	ND	1.70E+05	N/A	N/A	NO	BSL
		TPH DRO and GRO (mg/kg)													
	68334-30-5	Diesel Range Organics	24	410	mg/kg	74SB748-00	14/14	(6)	410	ND	1.00E+02 (10)	N/A	N/A	YES	ASL
	8006-61-9	Gasoline Range Organics	0.12 J	2,500 J	mg/kg	74SB748-00	8/14	0.084U - 0.32UJ	2,500	ND	1.00E+02 (10)	N/A	N/A	YES	ASL
		Metals (mg/kg)													
	7440-36-0	Antimony	1.8 J	2.9	mg/kg	74SB749-00	2/14	0.39U - 2.2U	2.9	2.46	3.10E+00	N/A	N/A	NO	BSL
	7440-38-2	Arsenic	1.6	21	mg/kg	74SB756-00	14/14	(6)	21	2.70	3.90E-01	N/A	N/A	YES	ASL
	7440-39-3	Barium	15 J	190 J	mg/kg	74SB748-00	14/14	(6)	190	203	1.50E+03	N/A	N/A	NO	BSL
	7440-41-7	Beryllium	0.059 J	0.25	mg/kg	74SB753-00	11/14	0.038U - 0.11U	0.25	0.595	1.60E+01	N/A	N/A	NO	BSL
	7440-43-9	Cadmium	0.047 J	1.8	mg/kg	74SB755-00	14/14	(6)	1.8	5.53	7.00E+00	N/A	N/A	NO	BSL
	7440-47-3	Chromium	4.2	27	mg/kg	74SB756-00	14/14	(6)	27	50.1	1.20E+04 (7)(11)	N/A	N/A	NO	BSL
	7440-48-4	Cobalt	1.7 J	10 J	mg/kg	74SB755-00, 74SB756-00	14/14	(6)	10	23.6	2.30E+00	N/A	N/A	YES	ASL
	7440-50-8	Copper	9.3	550	mg/kg	74SB758-00	14/14	(6)	550	171	3.10E+02	N/A	N/A	YES	ASL
	7439-92-1	Lead	3.5	120	mg/kg	74SB749-00	12/12	(6)	120	10.9	4.00E+02 (12)	N/A	N/A	NO	BSL
	7439-97-6	Mercury	0.0085 J	0.21	mg/kg	74SB756-00	11/14	0.02U - 0.021U	0.21	0.111	1.00E+00	N/A	N/A	NO	BSL
	7440-02-0	Nickel	2.2	27	mg/kg	74SB756-00	14/14	(6)	27	12.7	1.50E+02	N/A	N/A	NO	BSL
	7782-49-2	Selenium	0.26 J	1.8	mg/kg	74SB753-00	7/14	0.97U - 1.1U	1.8	1.12	3.90E+01	N/A	N/A	NO	BSL
	7440-22-4	Silver	0.04 J	0.84	mg/kg	74SB749-00	5/14	0.2U - 0.21U	0.84	ND	3.90E+01	N/A	N/A	NO	BSL
	7440-28-0	Thallium	0.054 J	0.21 J	mg/kg	74SB755-00	5/14	0.2U - 0.25U	0.21	--	7.80E-02	N/A	N/A	YES	ASL
	7440-62-2	Vanadium	13	64 J	mg/kg	74SB753-00	14/14	(6)	64	259	3.90E+01	N/A	N/A	YES	ASL
	7440-66-6	Zinc	12	920	mg/kg	74SB750-00	14/14	(6)	920	117	2.30E+03	N/A	N/A	NO	BSL

TABLE 2.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

(1) J - Analyte present - Reported value is estimated
U - Not detected
UJ - Reported quantitation limit is qualified as estimated
(2) Maximum concentration used for screening
(3) Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2010): Upper Limit of Mean (Mean+2 Std Dev)
(4) All non-carcinogenic criteria were divided by 10 to account for potential additive effects of chemicals
USEPA Regional Screening Levels, Residential Soil (June 2011)

mg/kg = milligrams per kilogram
ug/kg = microgram per kilogram

Definitions:
N/A = Not Applicable
ND = Not Detected
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered

(5) Rationale Codes
Selection Reason: Same chemical class (CHEM)
Above Screening Levels (ASL)
Deletion Reason: Below Screening Level (BSL)
(6) No detection limits given; analyte detected in every sample.

(7) Noncarcinogenic Regional Screening Levels based on a target hazard quotient of 0.1 for conservative screening purposes.
(8) Value for **acenaphthene** used as a surrogate.
(9) Value for **pyrene** used as a surrogate.
(10) Puerto Rico specific value
(11) Value for **chromium III** used as a surrogate.
(12) USEPA Residential Soil Action Level

TABLE 2.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Total Soil
Exposure Medium: Total Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1)	Maximum Concentration (Qualifier) (1)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits (1)	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Total Soil		**Volatile Organic Compounds (ug/kg)**													
	75-15-0	Carbon disulfide	5.5 J	12	µg/kg	74SB232-05	3/24	0.63U - 6.9U	12	ND	8.20E+04	N/A	N/A	NO	BSL
	0	**LLPAHs (ug/kg)**													
	91-57-6	2-Methylnaphthalene	4.2 J	4.2 J	µg/kg	74SB756-00	1/19	7.1U - 75U	4.2	ND	3.10E+04	N/A	N/A	NO	BSL
	83-32-9	Acenaphthene	3.8 J	9.4	µg/kg	74SB760-00	2/19	7.1U - 75U	9.4	ND	3.40E+05	N/A	N/A	NO	BSL
	208-96-8	Acenaphthylene	11	17	µg/kg	74SB759-00, 74SB760-00	3/19	7.1U - 75U	17	ND	3.40E+05 (7)(8)	N/A	N/A	NO	BSL
	120-12-7	Anthracene	4 J	52	µg/kg	74SB760-00	7/19	7.3U - 75U	52	ND	1.70E+06	N/A	N/A	NO	BSL
	56-55-3	Benzo[a]anthracene	13	190	µg/kg	74SB749-00	10/19	7.3U - 75U	190	ND	1.50E+02	N/A	N/A	YES	ASL
	50-32-8	Benzo[a]pyrene	20	200	µg/kg	74SB750-00	16/19	7.3U - 71U	200	ND	1.50E+01	N/A	N/A	YES	ASL
	205-99-2	Benzo[b]fluoranthene	4.7 J	270 J	µg/kg	74SB759-00	12/19	7.5U - 74U	270	ND	1.50E+02	N/A	N/A	YES	ASL
	191-24-2	Benzo[g,h,i]perylene	24	170	µg/kg	74SB749-00	12/19	7.3U - 74U	170	ND	1.70E+05 (7)(9)	N/A	N/A	NO	BSL
	207-08-9	Benzo[k]fluoranthene	2.3 J	230 J	µg/kg	74SB759-00	13/19	7.5U - 72U	230	ND	1.50E+03	N/A	N/A	YES	CHEM
	218-01-9	Chrysene	24	250	µg/kg	74SB760-00	14/19	7.3U - 72U	250	ND	1.50E+04	N/A	N/A	YES	CHEM
	53-70-3	Dibenz(a,h)anthracene	10	57 J	µg/kg	74SB749-00	5/19	7.2U - 75U	57	ND	1.50E+01	N/A	N/A	YES	ASL
	206-44-0	Fluoranthene	10	400	µg/kg	74SB760-00	11/19	7.3U - 72U	400	ND	2.30E+05	N/A	N/A	NO	BSL
	86-73-7	Fluorene	3.6 J	7.6	µg/kg	74SB760-00	2/19	7.1U - 75U	7.6	ND	2.30E+05	N/A	N/A	NO	BSL
	193-39-5	Indeno[1,2,3-cd]pyrene	5 J	110	µg/kg	74SB749-00	11/19	7.3U - 74U	110	ND	1.50E+02	N/A	N/A	YES	CHEM
	85-01-8	Phenanthrene	6.2 J	180	µg/kg	74SB760-00	10/19	7.1U - 75U	180	ND	1.70E+05 (7)(9)	N/A	N/A	NO	BSL
	129-00-0	Pyrene	15	430	µg/kg	74SB760-00	12/19	7.3U - 72U	430	ND	1.70E+05	N/A	N/A	NO	BSL
		TPH DRO and GRO (mg/kg)													
	68334-30-5	Diesel Range Organics	15	410	mg/kg	74SB748-00	20/24	1.4U - 3.7U	410	ND	1.00E+02 (10)	N/A	N/A	YES	ASL
	8006-61-9	Gasoline Range Organics	0.12 J	2,500 J	mg/kg	74SB748-00	14/24	0.08U - 0.32UJ	2,500	ND	1.00E+02 (10)	N/A	N/A	YES	ASL
	0	**Metals (mg/kg)**													
	7440-36-0	Antimony	1.8 J	2.9	mg/kg	74SB749-00, 74SB749-01	3/24	0.2U - 2.2U	2.9	3.94	3.10E+00	N/A	N/A	NO	BSL
	7440-38-2	Arsenic	1.6	21	mg/kg	74SB756-00	24/24	(6)	21	2.92	3.90E-01	N/A	N/A	YES	ASL
	7440-39-3	Barium	8.4	190 J	mg/kg	74SB748-00	24/24	(6)	190	203	1.50E+03	N/A	N/A	NO	BSL
	7440-41-7	Beryllium	0.054 J	0.25	mg/kg	74SB753-00	14/24	0.02U - 0.11U	0.25	0.760	1.60E+01	N/A	N/A	NO	BSL
	7440-43-9	Cadmium	0.029 J	2.8	mg/kg	74SB749-01	18/24	0.035U - 0.11U	2.8	0.679	7.00E+00	N/A	N/A	NO	BSL
	7440-47-3	Chromium	1.8	27	mg/kg	74SB756-00	24/24	(6)	27	49.1	1.20E+04 (7)(11)	N/A	N/A	NO	BSL
	7440-48-4	Cobalt	0.37	10 J	mg/kg	74SB755-00, 74SB756-00	24/24	(6)	10	53.8	2.30E+00	N/A	N/A	YES	ASL
	7440-50-8	Copper	1.9	550	mg/kg	74SB758-00	21/24	1.1U - 2.8U	550	152	3.10E+02	N/A	N/A	YES	ASL
	7439-92-1	Lead	0.32 J	120	mg/kg	74SB749-00	19/22	0.18U - 0.48U	120	18.2	4.00E+02 (12)	N/A	N/A	NO	BSL
	7439-97-6	Mercury	0.0063 J	0.21	mg/kg	74SB756-00	16/24	0.0044U - 0.021U	0.21	0.0998	1.00E+00	N/A	N/A	NO	BSL
	7440-02-0	Nickel	0.86	27	mg/kg	74SB756-00	24/24	(6)	27	23.5	1.50E+02	N/A	N/A	NO	BSL
	7782-49-2	Selenium	0.26 J	1.8	mg/kg	74SB753-00	7/24	0.13U - 1.1U	1.8	1.14	3.90E+01	N/A	N/A	NO	BSL
	7440-22-4	Silver	0.04 J	0.84	mg/kg	74SB749-00	7/24	0.018UJ - 0.22U	0.84	0.605	3.90E+01	N/A	N/A	NO	BSL
	7440-28-0	Thallium	0.054 J	0.21 J	mg/kg	74SB755-00	6/24	0.13U - 0.3U	0.21	0.644	7.80E-02	N/A	N/A	YES	ASL
	7440-62-2	Vanadium	2.9	64 J	mg/kg	74SB753-00	24/24	(6)	64	257	3.90E+01	N/A	N/A	YES	ASL
	7440-66-6	Zinc	0.88 J	920	mg/kg	74SB750-00	23/24	1.5U - 1.5U	920	107	2.30E+03	N/A	N/A	NO	BSL

TABLE 2.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

(1) J - Analyte present - Reported value is estimated
U - Not detected
UJ - Reported quantitation limit is qualified as estimated

mg/kg = milligrams per kilogram
ug/kg = microgram per kilogram

Definitions: N/A = Not Applicable
ND = Not Detected
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered

(2) Maximum concentration used for screening
(3) Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2010): Upper Limit of Mean (Mean+2 Std Dev)
(4) All non-carcinogenic criteria were divided by 10 to account for potential additive effects of chemicals
USEPA Regional Screening Levels, Residential Soil (June 2011)

(5) Rationale Codes
Selection Reason: Same chemical class (CHEM)
Above Screening Levels (ASL)
Deletion Reason: Below Screening Level (BSL)
(6) No detection limits given; analyte detected in every sample.
(7) Noncarcinogenic Regional Screening Levels based on a target hazard quotient of 0.1 for conservative screening purposes.
(8) Value for **acenaphthene** used as a surrogate.
(9) Value for **pyrene** used as a surrogate.
(10) Puerto Rico specific value
(11) Value for **chromium III** used as a surrogate.
(12) USEPA Residential Soil Action Level

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale (ProUCL)
Surface Soil									
	Benzo[a]anthracene	µg/kg	76.9	110 (NP)	190	0.110	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Benzo[a]pyrene	µg/kg	95.7	127 (NP)	200	0.127	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Benzo[b]fluoranthene	µg/kg	118	169 (NP)	270 J	0.169	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Benzo[k]fluoranthene	µg/kg	106	146 (NP)	230 J	0.146	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Chrysene	µg/kg	103	142 (NP)	250	0.142	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Dibenz(a,h)anthracene	µg/kg	28.5	40.2 (NP)	57 J	0.0402	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Indeno[1,2,3-cd]pyrene	µg/kg	40.2	53.2 (NP)	110	0.0532	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Diesel Range Organics	mg/kg	111	207 (L)	410	207	mg/kg	95% UCL (L)	95% H-UCL
	Gasoline Range Organics	mg/kg	187	2,011 (NP)	2,500 J	2,011	mg/kg	95% UCL (NP)	99% KM (Chebyshev) UCL
	Arsenic	mg/kg	5.09	7.45 (L)	21	7.45	mg/kg	95% UCL (L)	95% H-UCL
	Cobalt	mg/kg	5.39	6.82 (N)	10 J	6.82	mg/kg	95% UCL (N)	95% Student's-t UCL
	Copper	mg/kg	65.5	229 (NP)	550	229	mg/kg	95% UCL (NP)	95% Chebyshev (Mean, Sd) UCL
	Thallium	mg/kg	0.107	0.139 (NP)	0.21 J	0.139	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Vanadium	mg/kg	36.1	44.4 (N)	64 J	44.4	mg/kg	95% UCL (N)	95% Student's-t UCL

Notes:

UCL = Upper Confidence Level

(1) Distribution and 95% UCL were calculated by ProUCL for data sets with greater than 8 samples and greater than 4 detections.
(N) - Normal distribution and 95% UCL
(NP) - Non-parametric distribution and 95% UCL
(L) - Lognormal distribution and 95% UCL

(2) Exposure point concentration statistic will be the 95% UCL (as calculated by ProUCL) or the maximum detected.

TABLE 3.2.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Total Soil
Exposure Medium: Total Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution) (1)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic (2)	Rationale (ProUCL)
Total Soil									
	Benzo[a]anthracene	µg/kg	61.8	84.0 (NP)	190	0.0840	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Benzo[a]pyrene	µg/kg	76.3	102 (NP)	200	0.102	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Benzo[b]fluoranthene	µg/kg	93.4	129 (NP)	270 J	0.129	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Benzo[k]fluoranthene	µg/kg	83.5	112 (NP)	230 J	0.112	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Chrysene	µg/kg	79.6	111 (NP)	250	0.111	mg/kg	95% UCL (NP)	95% KM (Percentile Bootstrap) UCL
	Dibenz(a,h)anthracene	µg/kg	26.2	30.3 (NP)	57 J	0.0303	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Indeno[1,2,3-cd]pyrene	µg/kg	35.6	44.1 (NP)	110	0.0441	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Diesel Range Organics	mg/kg	71.2	169 (NP)	410	169	mg/kg	95% UCL (NP)	95% KM (Chebyshev) UCL
	Gasoline Range Organics	mg/kg	114	1,163 (NP)	2,500 J	1,163	mg/kg	95% UCL (NP)	99% KM (Chebyshev) UCL
	Arsenic	mg/kg	4.69	8.03 (NP)	21	8.03	mg/kg	95% UCL (NP)	95% Chebyshev (Mean, Sd) UCL
	Cobalt	mg/kg	3.79	5.13 (G)	10 J	5.13	mg/kg	95% UCL (G)	95% Approximate Gamma UCL
	Copper	mg/kg	42.6	183 (NP)	550	183	mg/kg	95% UCL (NP)	97.5% KM (Chebyshev) UCL
	Thallium	mg/kg	0.107	0.114 (NP)	0.21 J	0.114	mg/kg	95% UCL (NP)	95% KM (t) UCL
	Vanadium	mg/kg	26.3	34.9 (G)	64 J	34.9	mg/kg	95% UCL (G)	95% Approximate Gamma UCL

Notes:

UCL = Upper Confidence Level

(1) Distribution and 95% UCL were calculated by ProUCL for data sets with greater than 8 samples and greater than 4 detections.
(NP) - Non-parametric distribution and 95% UCL
(G) - Gamma distribution and 95% UCL

(2) Exposure point concentration statistic will be the 95% UCL (as calculated by ProUCL) or the maximum detected.

TABLE 3.3.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Soil
Exposure Medium: Soil

Exposure Point Soil	Chemical of Potential Concern	Exposure Point Concentration			
		Value	Units	Statistic (2)	Rationale (ProUCL)
SS	Benzo[a]anthracene	0.110	mg/kg	95% UCL (NP)	95% KM (t) UCL
SS	Benzo[a]pyrene	0.127	mg/kg	95% UCL (NP)	95% KM (t) UCL
SS	Benzo[b]fluoranthene	0.169	mg/kg	95% UCL (NP)	95% KM (t) UCL
SS	Benzo[k]fluoranthene	0.146	mg/kg	95% UCL (NP)	95% KM (t) UCL
SS	Chrysene	0.142	mg/kg	95% UCL (NP)	95% KM (t) UCL
SS	Dibenz(a,h)anthracene	0.0402	mg/kg	95% UCL (NP)	95% KM (t) UCL
SS	Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	95% UCL (NP)	95% KM (t) UCL
SS	Diesel Range Organics	207	mg/kg	95% UCL (L)	95% H-UCL
SS	Gasoline Range Organics	2,011	mg/kg	95% UCL (NP)	99% KM (Chebyshev) UCL
TS	Arsenic	8.03	mg/kg	95% UCL (NP)	95% Chebyshev (Mean, Sd) UCL
SS	Cobalt	6.82	mg/kg	95% UCL (N)	95% Student's-t UCL
SS	Copper	229	mg/kg	95% UCL (NP)	95% Chebyshev (Mean, Sd) UCL
SS	Thallium	0.139	mg/kg	95% UCL (NP)	95% KM (t) UCL
SS	Vanadium	44.4	mg/kg	95% UCL (N)	95% Student's-t UCL

Notes:

UCL = Upper Confidence Level

(1) Distribution and 95% UCL were calculated by ProUCL for data sets with greater than 8 samples and greater than 4 detections.
(N) - Normal distribution and 95% UCL
(NP) - Non-parametric distribution and 95% UCL
(L) - Lognormal distribution and 95% UCL

(2) Exposure point concentration statistic will be the 95% UCL (as calculated by ProUCL) or the maximum detected.

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion									Chronic Daily Intake (CDI) Equations
	Current and Future Trespassers	Adult	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				IR-S	Ingestion Rate of Soil	100	mg/day	USEPA, 1991	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				FI	Fraction Ingested from Source	1	NA	Prof Judge (1)	CDI (mg/kg-day) =
				EF	Exposure Frequency	52	days/year	Prof Judge (2)	C x IR x CF x Fi x EF x ED x 1/BW x 1/AT
				ED	Exposure Duration	24	years	USEPA, 1991	
				BW	Body Weight	70	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	USEPA, 1989	
		Youth	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				IR-S	Ingestion Rate of Soil	100	mg/day	USEPA, 1991	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				FI	Fraction Ingested from Source	1	NA	Prof Judge (1)	CDI (mg/kg-day) =
				EF	Exposure Frequency	52	days/year	Prof Judge (2)	C x IR x CF x Fi x EF x ED x 1/BW x 1/AT
				ED	Exposure Duration	11	years	USEPA, 1991	
				BW	Body Weight	45	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	4,015	days	USEPA, 1989	
	Current and Future On-Site Workers	Adult	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				IR-S	Ingestion Rate of Soil	100	mg/day	USEPA, 2002	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				FI	Fraction Ingested from Source	1	NA	Prof Judge (1)	CDI (mg/kg-day) =
				EF	Exposure Frequency	250	days/year	USEPA, 2004	C x IR x CF x Fi x EF x ED x 1/BW x 1/AT
				ED	Exposure Duration	25	years	USEPA, 2004	
				BW	Body Weight	70	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	USEPA, 1989	

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Future Residents	Adult	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				IR-S	Ingestion Rate of Soil	100	mg/day	USEPA, 1991	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				FI	Fraction Ingested from Source	1	NA	Prof Judge (1)	CDI (mg/kg-day) =
				EF	Exposure Frequency	350	days/year	USEPA, 2004	C x IR x CF x Fi x EF x ED x 1/BW x 1/AT
				ED	Exposure Duration	24	years	USEPA, 1991	
				BW	Body Weight	70	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	USEPA, 1989	
		Young Child	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				IR-S	Ingestion Rate of Soil	200	mg/day	USEPA, 1991	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				FI	Fraction Ingested from Source	1	NA	Prof Judge (1)	CDI (mg/kg-day) =
				EF	Exposure Frequency	350	days/year	USEPA, 2004	C x IR x CF x Fi x EF x ED x 1/BW x 1/AT
				ED	Exposure Duration	6	years	USEPA, 1991	
				BW	Body Weight	15	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	USEPA, 1989	
	Future Industrial / Commercial Workers	Adult	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				IR-S	Ingestion Rate of Soil	100	mg/day	USEPA, 2002	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				FI	Fraction Ingested from Source	1	NA	Prof Judge (1)	CDI (mg/kg-day) =
				EF	Exposure Frequency	250	days/year	USEPA, 2004	C x IR x CF x Fi x EF x ED x 1/BW x 1/AT
				ED	Exposure Duration	25	years	USEPA, 2004	
				BW	Body Weight	70	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	USEPA, 1989	

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Future Construction Workers	Adult	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				IR-S	Ingestion Rate of Soil	330	mg/day	USEPA, 2002	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				FI	Fraction Ingested from Source	1	NA	Prof Judge (1)	CDI (mg/kg-day) =
				EF	Exposure Frequency	250	days/year	USEPA, 2004	C x IR x CF x Fi x EF x ED x 1/BW x 1/AT
				ED	Exposure Duration	1	years	Prof Judge (3)	
				BW	Body Weight	70	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	USEPA, 1989	
Dermal									Dermally Adjusted Dose (DAD) Equations
	Current and Future Trespassers	Adult	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				SA	Surface Area Available for Contact	5,700	cm2/day	USEPA, 2004	
				AF	Soil to Skin Adherence Factor	0.07	mg/cm2	USEPA, 2004	DAD (mg/kg-day) =
				ABS	Absorption Factor	CS	NA	USEPA, 2004	C x CF x SA x AF x ABS x EF x ED x
				EF	Exposure Frequency	52	days/year	Prof Judge (2)	1/BW x1/AT
				ED	Exposure Duration	24	years	USEPA, 1991	
				BW	Body Weight	70	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	USEPA, 1989	
		Youth	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				SA	Surface Area Available for Contact	3,200	cm2/day	USEPA, 1997	
				AF	Soil to Skin Adherence Factor	0.2	mg/cm2	USEPA, 2004	DAD (mg/kg-day) =
				ABS	Absorption Factor	CS	NA	USEPA, 2004	C x CF x SA x AF x ABS x EF x ED x
				EF	Exposure Frequency	52	days/year	Prof Judge (2)	1/BW x1/AT
				ED	Exposure Duration	11	years	USEPA, 1991	
				BW	Body Weight	45	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	4,015	days	USEPA, 1989	

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Current and Future On-Site Workers	Adult	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				SA	Surface Area Available for Contact	3,300	cm2/day	USEPA, 2004	
				AF	Soil to Skin Adherence Factor	0.2	mg/cm2	USEPA, 2004	DAD (mg/kg-day) =
				ABS	Absorption Factor	CS	NA	USEPA, 2004	C x CF x SA x AF x ABS x EF x ED x
				EF	Exposure Frequency	250	days/year	USEPA, 2004	1/BW x1/AT
				ED	Exposure Duration	25	years	USEPA, 2004	
				BW	Body Weight	70	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	USEPA, 1989	
	Future Residents	Adult	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				SA	Surface Area Available for Contact	5,700	cm2/day	USEPA, 2004	
				AF	Soil to Skin Adherence Factor	0.07	mg/cm2	USEPA, 2004	DAD (mg/kg-day) =
				ABS	Absorption Factor	CS	NA	USEPA, 2004	C x CF x SA x AF x ABS x EF x ED x
				EF	Exposure Frequency	350	days/year	USEPA, 2004	1/BW x1/AT
				ED	Exposure Duration	24	years	USEPA, 1991	
				BW	Body Weight	70	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	USEPA, 1989	
		Young Child	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				SA	Surface Area Available for Contact	2,800	cm2/day	USEPA, 2004	
				AF	Soil to Skin Adherence Factor	0.2	mg/cm2	USEPA, 2004	DAD (mg/kg-day) =
				ABS	Absorption Factor	CS	NA	USEPA, 2004	C x CF x SA x AF x ABS x EF x ED x
				EF	Exposure Frequency	350	days/year	USEPA, 2004	1/BW x1/AT
				ED	Exposure Duration	6	years	USEPA, 1991	
				BW	Body Weight	15	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	USEPA, 1989	

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Future Industrial / Commercial Workers	Adult	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	DAD (mg/kg-day) = C x CF x SA x AF x ABS x EF x ED x 1/BW x1/AT
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				SA	Surface Area Available for Contact	3,300	cm2/day	USEPA, 2004	
				AF	Soil to Skin Adherence Factor	0.2	mg/cm2	USEPA, 2004	
				ABS	Absorption Factor	CS	NA	USEPA, 2004	
				EF	Exposure Frequency	250	days/year	USEPA, 2004	
				ED	Exposure Duration	25	years	USEPA, 2004	
				BW	Body Weight	70	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	USEPA, 1989	
	Future Construction Workers	Adult	Soil	C	Contaminant Concentration in Soil	Chemical Specific	mg/kg	Chemical Specific	DAD (mg/kg-day) = C x CF x SA x AF x ABS x EF x ED x 1/BW x1/AT
				CF	Conversion Factor	1.00E-06	kg/mg	USEPA, 1989	
				SA	Surface Area Available for Contact	3,300	cm2/day	USEPA, 2004	
				AF	Soil to Skin Adherence Factor	0.3	mg/cm2	USEPA, 2002	
				ABS	Absorption Factor	CS	NA	USEPA, 2004	
				EF	Exposure Frequency	250	days/year	USEPA, 2004	
				ED	Exposure Duration	1	years	Prof Judge (3)	
				BW	Body Weight	70	kg	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	USEPA, 1989	

Notes

Chemical Specific - See Table 3.1
NA - Not Applicable
Prof Judge - Professional Judgment

(1) Conservative assumption of 100% ingested from source.
(2) Assumes individuals trespass on site 1 day/week. This value represents the default value for NAPR but may be revised based on site-specific factors such as accessibility and attractiveness to trespassers
(3) Assumes a construction period of 1 year.

Sources:

USEPA, 1989: Risk Assessment Guidance for Superfund Vol 1, Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002
USEPA, 1991: Risk Assessment Guidance for Superfund Vol 1, Human Health Evaluation Manual Supplemental Guidance: Standard Default Exposure Factors
USEPA, 1997: Exposure Factors Handbook. Vol. 1: General Factors. ORD. EPA/600/P-95/002Fa.
USEPA, 2002. Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24
USEPA, 2004: Risk Assessment Guidance for Superfund Vol 1, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA/540/R-99/005

TABLE 4.1a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Soil
Exposure Medium: Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation									Exposure Concentration (EC) Equations
	Current and Future Trespassers	Adult	Fugitive dust	Ca	Contaminant Concentration in Air	Chemical Specific	mg/m3	Chemical Specific	
				ET	Exposure Time	2	hours/day	USEPA, 1997 (6)	
				EF	Exposure Frequency	52	days/year	Prof Judge (3)	
				ED	Exposure Duration	24	years	USEPA, 1991	EC (mg/m3) =
				PEF	Particulate Emission Factor	1.36E+09	m3/kg	USEPA, 2002	(Ca*ET*EF*ED)/AT
				AT-C	Averaging Time (Cancer)	613,200	hours	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	210,240	hours	USEPA, 1989	
		Youth	Fugitive dust	Ca	Contaminant Concentration in Air	Chemical Specific	mg/m3	Chemical Specific	
				ET	Exposure Time	2	hours/day	USEPA, 1997 (6)	
				EF	Exposure Frequency	52	days/year	Prof Judge (3)	
				ED	Exposure Duration	11	years	USEPA, 1991	EC (mg/m3) =
				PEF	Particulate Emission Factor	1.36E+09	m3/kg	USEPA, 2002	(Ca*ET*EF*ED)/AT
				AT-C	Averaging Time (Cancer)	613,200	hours	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	96,360	hours	USEPA, 1989	
	Current and Future On-Site Workers	Adult	Fugitive dust	Ca	Contaminant Concentration in Air	Chemical Specific	mg/m3	Chemical Specific	
				ET	Exposure Time	8	hours/day	Prof Judge (7)	
				EF	Exposure Frequency	250	days/year	USEPA, 2004	
				ED	Exposure Duration	25	years	USEPA, 2004	EC (mg/m3) =
				PEF	Particulate Emission Factor	1.36E+09	m3/kg	USEPA, 2002	(Ca*ET*EF*ED)/AT
				AT-C	Averaging Time (Cancer)	613,200	hours	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	219,000	hours	USEPA, 1989	
	Future Residents	Adult	Fugitive dust	Ca	Contaminant Concentration in Air	Chemical Specific	mg/m3	Chemical Specific	
				ET	Exposure Time	24	hours/day	Prof Judge (8)	
				EF	Exposure Frequency	350	days/year	USEPA, 2004	
				ED	Exposure Duration	24	years	USEPA, 1991	EC (mg/m3) =
				PEF	Particulate Emission Factor	1.36E+09	m3/kg	USEPA, 2002	(Ca*ET*EF*ED)/AT
				AT-C	Averaging Time (Cancer)	613,200	hours	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	210,240	hours	USEPA, 1989	

TABLE 4.1a.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Medium: Soil
Exposure Medium: Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Future Residents	Young Child	Fugitive dust	Ca	Contaminant Concentration in Air	Chemical Specific	mg/m3	Chemical Specific	
				ET	Exposure Time	24	hours/day	Prof Judge (8)	
				EF	Exposure Frequency	350	days/year	USEPA, 2004	
				ED	Exposure Duration	6	years	USEPA, 1991	EC (mg/m3) =
				PEF	Particulate Emission Factor	1.36E+09	m3/kg	USEPA, 2002	(Ca*ET*EF*ED)/AT
				AT-C	Averaging Time (Cancer)	613,200	hours	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	52,560	hours	USEPA, 1989	
	Future Industrial / Commercial Workers	Adult	Fugitive dust	Ca	Contaminant Concentration in Air	Chemical Specific	mg/m3	Chemical Specific	
				ET	Exposure Time	8	hours/day	Prof Judge (7)	
				EF	Exposure Frequency	250	days/year	USEPA, 2004	
				ED	Exposure Duration	25	years	USEPA, 2004	EC (mg/m3) =
				PEF	Particulate Emission Factor	1.36E+09	m3/kg	USEPA, 2002	(Ca*ET*EF*ED)/AT
				AT-C	Averaging Time (Cancer)	613,200	hours	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	219,000	hours	USEPA, 1989	
	Future Construction Workers	Adult	Fugitive dust	Ca	Contaminant Concentration in Air	Chemical Specific	mg/m3	Chemical Specific	
				ET	Exposure Time	8	hours/day	Prof Judge (7)	
				EF	Exposure Frequency	250	days/year	USEPA, 2004	
				ED	Exposure Duration	1	years	Prof Judge (5)	EC (mg/m3) =
				PEF	Particulate Emission Factor	3.31E+06	m3/kg	USEPA, 2002	(Ca*ET*EF*ED)/AT
				AT-C	Averaging Time (Cancer)	613,200	hours	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	hours	USEPA, 1989	

Notes

Chemical Specific - See Table 3.1

Prof Judge - Professional Judgment

(3) Assumes individuals trespass on site 1 day/week. This value represents the default value for NAPR but may be revised based on site-specific factors such as accessibility and attractiveness to trespassers.
(5) Assumes a construction period of 1 year.
(6) Recommended outdoor activity factor for adults.
(7) Assumes an 8 hour work day.
(8) Conservatively assumes receptor remains at residence 24 hours/day.

Sources:

USEPA, 1989: Risk Assessment Guidance for Superfund Vol 1, Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
USEPA, 1991: Risk Assessment Guidance for Superfund Vol 1, Human Health Evaluation Manual Supplemental Guidance: Standard Default Exposure Factors.
USEPA, 1997: Exposure Factors Handbook. Vol. 1: General Factors. ORD. EPA/600/P-95/002Fa.
USEPA, 2002. Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.
USEPA, 2004: Risk Assessment Guidance for Superfund Vol 1, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA/540/R-99/005.

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal (2)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s)
Benzo[a]anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo[a]pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo[b]fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo[k]fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno[1,2,3-cd]pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diesel Range Organics	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gasoline Range Organics	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	Chronic	3.00E-04	mg/kg/day	100%	3.00E-04	mg/kg/day	Skin / CVS	3/1	IRIS	4/3/2011
Cobalt	Chronic	3.00E-04	mg/kg/day	100%	3.00E-04	mg/kg/day	CVS	10/1	PPRTV	3/16/2001
Copper	Chronic	4.00E-02	mg/kg/day	100%	4.00E-02	mg/kg/day	GIS	NA	HEAST	7/1/1997
Thallium	Chronic	1.00E-05	mg/kg/day	100%	1.00E-05	mg/kg/day	Liver / CVS / Skin	3000/1	PPRTV Appendix	3/29/1999
Vanadium	Chronic	5.00E-03	mg/kg/day	100%	5.00E-03	mg/kg/day	GIS / Kidney	100/1	Lookup	7/1/1997

Notes:

(1) Refer to RAGS, Part E
(2) Adjusted dermal RfD = Oral RfD * Adj Factor

NA = Not Applicable / Not Available

Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System

Sources:
IRIS = Integrated Risk Information System
PPRTV = Provisional Peer Reviewed Toxicity Values
HEAST= Health Effects Assessment Summary Tables

TABLE 5.2
NON-CANCER TOXICITY DATA -- INHALATION
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s)
Benzo[a]anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo[a]pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo[b]fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo[k]fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno[1,2,3-cd]pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diesel Range Organics	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gasoline Range Organics	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	Chronic	1.50E-05	mg/m3	NA	NA	NA	NA	Cal EPA	NA
Cobalt	Chronic	6.00E-06	mg/m3	NA	NA	RsS	NA	PPRTV	3/16/2001
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA = Not Applicable / Not Available

Target Organ Abbreviations:
RsS = Respiratory System

Sources:
PPRTV = Provisional Peer Reviewed Toxicity Values
Cal EPA = California Environmental Protection Agency

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal (2)		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s)
Benzo[a]anthracene	7.30E-01	1 / (mg/kg/day)	100%	7.30E-01	1 / (mg/kg/day)	B2	ECAO	4/26/2000
Benzo[a]pyrene	7.30E+00	1 / (mg/kg/day)	100%	7.30E+00	1 / (mg/kg/day)	B2	IRIS	11/1/2010
Benzo[b]fluoranthene	7.30E-01	1 / (mg/kg/day)	100%	7.30E-01	1 / (mg/kg/day)	B2	ECAO	4/26/2000
Benzo[k]fluoranthene	7.30E-02	1 / (mg/kg/day)	100%	7.30E-02	1 / (mg/kg/day)	B2	ECAO	4/26/2000
Chrysene	7.30E-03	1 / (mg/kg/day)	100%	7.30E-03	1 / (mg/kg/day)	B2	ECAO	4/26/2000
Dibenz(a,h)anthracene	7.30E+00	1 / (mg/kg/day)	100%	7.30E+00	1 / (mg/kg/day)	B2	ECAO	4/26/2000
Indeno[1,2,3-cd]pyrene	7.30E-01	1 / (mg/kg/day)	100%	7.30E-01	1 / (mg/kg/day)	B2	ECAO	4/26/2000
Diesel Range Organics	NA	NA	NA	NA	NA	NA	NA	NA
Gasoline Range Organics	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	1.50E+00	1 / (mg/kg/day)	100%	1.50E+00	1 / (mg/kg/day)	A	IRIS	4/3/2011
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

(1) Refer to RAGS, Part E
(2) Adjusted dermal CSF = Oral CSF / Adj Factor

NA = Not Applicable / Not Available

Sources:
IRIS = Integrated Risk Information System
ECAO = Environmental Criteria and Assessment Office

EPA Group:
- A - Human carcinogen
- B1 - Probable human carcinogen - indicates that limited human data are available
- B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D - Not classifiable as a human carcinogen
- E - Evidence of noncarcinogenicity

Weight of Evidence:
- Known/Likely (EPA classes A, B1, B2, C)
- Cannot be Determined (EPA class D)
- Not Likely (EPA class E)

TABLE 6.2
CANCER TOXICITY DATA -- INHALATION
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s)
Benzo[a]anthracene	1.10E-04	1/(µg/m3)	NA	NA	D	Cal EPA	NA
Benzo[a]pyrene	1.10E-03	1/(µg/m3)	NA	NA	B2	Cal EPA	4/26/2000
Benzo[b]fluoranthene	1.10E-04	1/(µg/m3)	NA	NA	B2	Cal EPA	NA
Benzo[k]fluoranthene	1.10E-04	1/(µg/m3)	NA	NA	B2	Cal EPA	NA
Chrysene	1.10E-05	1/(µg/m3)	NA	NA	B2	Cal EPA	9/20/2002
Dibenz(a,h)anthracene	1.20E-03	1/(µg/m3)	NA	NA	D	Cal EPA	NA
Indeno[1,2,3-cd]pyrene	1.10E-04	1/(µg/m3)	NA	NA	B2	Cal EPA	9/20/2002
Diesel Range Organics	NA	NA	NA	NA	NA	NA	NA
Gasoline Range Organics	NA	NA	NA	NA	NA	NA	NA
Arsenic	4.30E-03	1/(µg/m3)	NA	NA	A	IRIS	4/3/2011
Cobalt	9.00E-03	1/(µg/m3)	NA	NA	D	PPRTV	3/16/2001
Copper	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA

<u>Notes:</u>

EPA Group:
- A - Human carcinogen
- B1 - Probable human carcinogen - indicates that limited human data are available
- B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D - Not classifiable as a human carcinogen
- E - Evidence of noncarcinogenicity

<u>Sources:</u>

IRIS = Integrated Risk Information System
PPRTV = Provisional Peer Reviewed Toxicity Values
Cal EPA = California Environmental Protection Agency

NA = Not Applicable / Not Available

Weight of Evidence:
- Known/Likely (EPA classes A, B1, B2, C)
- Cannot be Determined (EPA class D)
- Not Likely (EPA class E)

TABLE 7.1.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Soil	Soil	Ingestion													
				Benzo[a]anthracene	0.110	mg/kg	7.7E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	5.6E-09	2.2E-08	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	8.9E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	6.5E-08	2.6E-08	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	1.2E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	8.6E-09	3.4E-08	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	1.0E-08	mg/kg-day	7.3E-02	1/(mg/kg-day)	7.4E-10	3.0E-08	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	9.9E-09	mg/kg-day	7.3E-03	1/(mg/kg-day)	7.2E-11	2.9E-08	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	2.8E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	2.0E-08	8.2E-09	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	3.7E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	2.7E-09	1.1E-08	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	1.4E-05	mg/kg-day	NA	--	--	4.2E-05	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	1.4E-04	mg/kg-day	NA	--	--	4.1E-04	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	5.6E-07	mg/kg-day	1.5E+00	1/(mg/kg-day)	8.4E-07	1.6E-06	mg/kg-day	3.0E-04	mg/kg-day	5.4E-03
				Cobalt	6.82	mg/kg	4.8E-07	mg/kg-day	NA	--	--	1.4E-06	mg/kg-day	3.0E-04	mg/kg-day	4.6E-03
				Copper	229	mg/kg	1.6E-05	mg/kg-day	NA	--	--	4.7E-05	mg/kg-day	4.0E-02	mg/kg-day	1.2E-03
				Thallium	0.139	mg/kg	9.7E-09	mg/kg-day	NA	--	--	2.8E-08	mg/kg-day	1.0E-05	mg/kg-day	2.8E-03
				Vanadium	44.4	mg/kg	3.1E-06	mg/kg-day	NA	--	--	9.0E-06	mg/kg-day	5.0E-03	mg/kg-day	1.8E-03
			Ingestion Total								9.4E-07					1.6E-02
			Dermal													
				Benzo[a]anthracene	0.110	mg/kg	4.0E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	2.9E-09	1.2E-08	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	4.6E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	3.4E-08	1.3E-08	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	6.1E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	4.5E-09	1.8E-08	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	5.3E-09	mg/kg-day	7.3E-02	1/(mg/kg-day)	3.9E-10	1.5E-08	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	5.1E-09	mg/kg-day	7.3E-03	1/(mg/kg-day)	3.8E-11	1.5E-08	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	1.5E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	1.1E-08	4.2E-09	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	1.9E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	1.4E-09	5.6E-09	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	5.8E-05	mg/kg-day	NA	--	--	1.7E-04	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	5.6E-04	mg/kg-day	NA	--	--	1.6E-03	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	6.7E-08	mg/kg-day	1.5E+00	1/(mg/kg-day)	1.0E-07	2.0E-07	mg/kg-day	3.0E-04	mg/kg-day	6.5E-04
				Cobalt	6.82	mg/kg	1.9E-08	mg/kg-day	NA	--	--	5.5E-08	mg/kg-day	3.0E-04	mg/kg-day	1.8E-04
				Copper	229	mg/kg	6.4E-07	mg/kg-day	NA	--	--	1.9E-06	mg/kg-day	4.0E-02	mg/kg-day	4.6E-05
				Thallium	0.139	mg/kg	3.9E-10	mg/kg-day	NA	--	--	1.1E-09	mg/kg-day	1.0E-05	mg/kg-day	1.1E-04
				Vanadium	44.4	mg/kg	1.2E-07	mg/kg-day	NA	--	--	3.6E-07	mg/kg-day	5.0E-03	mg/kg-day	7.2E-05
			Dermal Total								1.5E-07					1.1E-03
		Exposure Point Total									1.1E-06					1.7E-02
	Exposure Medium Total										1.1E-06					1.7E-02

TABLE 7.1.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Air	Fugative Dust	Inhalation													
				Benzo[a]anthracene	0.110	mg/kg	2.5E-11	mg/m3	1.1E-04	1/(µg/m3)	2.8E-12	7.3E-11	mg/m3	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	1.5E-11	mg/m3	1.1E-03	1/(µg/m3)	1.7E-11	4.4E-11	mg/m3	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	3.3E-11	mg/m3	1.1E-04	1/(µg/m3)	3.6E-12	9.6E-11	mg/m3	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	1.4E-11	mg/m3	1.1E-04	1/(µg/m3)	1.5E-12	4.0E-11	mg/m3	NA	--	--
				Chrysene	0.142	mg/kg	2.1E-10	mg/m3	1.1E-05	1/(µg/m3)	2.3E-12	6.2E-10	mg/m3	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	2.0E-12	mg/m3	1.2E-03	1/(µg/m3)	2.4E-12	5.9E-12	mg/m3	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	2.8E-12	mg/m3	1.1E-04	1/(µg/m3)	3.1E-13	8.2E-12	mg/m3	NA	--	--
				Diesel Range Organics	207	mg/kg	6.2E-10	mg/m3	NA	--	--	1.8E-09	mg/m3	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	6.0E-09	mg/m3	NA	--	--	1.8E-08	mg/m3	NA	--	--
				Arsenic	8.03	mg/kg	2.4E-11	mg/m3	4.3E-03	1/(µg/m3)	1.0E-10	7.0E-11	mg/m3	1.5E-05	mg/m3	4.7E-06
				Cobalt	6.82	mg/kg	2.0E-11	mg/m3	9.0E-03	1/(µg/m3)	1.8E-10	6.0E-11	mg/m3	6.0E-06	mg/m3	9.9E-06
				Copper	229	mg/kg	6.9E-10	mg/m3	NA	--	--	2.0E-09	mg/m3	NA	--	--
				Thallium	0.139	mg/kg	4.2E-13	mg/m3	NA	--	--	1.2E-12	mg/m3	NA	--	--
				Vanadium	44.4	mg/kg	1.3E-10	mg/m3	NA	--	--	3.9E-10	mg/m3	NA	--	--
			Inhalation Total								3.2E-10					1.5E-05
		Exposure Point Total									3.2E-10					1.5E-05
	Exposure Medium Total										3.2E-10					1.5E-05
Soil Total											1.1E-06					1.7E-02
										Total of Receptor Risks Across All Media	1.1E-06	Total of Receptor Hazards Across All Media				1.7E-02

TABLE 7.2.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Youth

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Soil	Soil	Ingestion													
				Benzo[a]anthracene	0.110	mg/kg	5.5E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	4.0E-09	3.5E-08	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	6.3E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	4.6E-08	4.0E-08	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	8.4E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	6.1E-09	5.4E-08	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	7.3E-09	mg/kg-day	7.3E-02	1/(mg/kg-day)	5.3E-10	4.6E-08	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	7.1E-09	mg/kg-day	7.3E-03	1/(mg/kg-day)	5.2E-11	4.5E-08	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	2.0E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	1.5E-08	1.3E-08	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	2.6E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	1.9E-09	1.7E-08	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	1.0E-05	mg/kg-day	NA	--	--	6.6E-05	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	1.0E-04	mg/kg-day	NA	--	--	6.4E-04	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	4.0E-07	mg/kg-day	1.5E+00	1/(mg/kg-day)	6.0E-07	2.5E-06	mg/kg-day	3.0E-04	mg/kg-day	8.5E-03
				Cobalt	6.82	mg/kg	3.4E-07	mg/kg-day	NA	--	--	2.2E-06	mg/kg-day	3.0E-04	mg/kg-day	7.2E-03
				Copper	229	mg/kg	1.1E-05	mg/kg-day	NA	--	--	7.2E-05	mg/kg-day	4.0E-02	mg/kg-day	1.8E-03
				Thallium	0.139	mg/kg	6.9E-09	mg/kg-day	NA	--	--	4.4E-08	mg/kg-day	1.0E-05	mg/kg-day	4.4E-03
				Vanadium	44.4	mg/kg	2.2E-06	mg/kg-day	NA	--	--	1.4E-05	mg/kg-day	5.0E-03	mg/kg-day	2.8E-03
			Ingestion Total								6.7E-07					2.5E-02
			Dermal													
				Benzo[a]anthracene	0.110	mg/kg	4.6E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	3.3E-09	2.9E-08	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	5.3E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	3.8E-08	3.3E-08	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	7.0E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	5.1E-09	4.5E-08	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	6.0E-09	mg/kg-day	7.3E-02	1/(mg/kg-day)	4.4E-10	3.8E-08	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	5.9E-09	mg/kg-day	7.3E-03	1/(mg/kg-day)	4.3E-11	3.7E-08	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	1.7E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	1.2E-08	1.1E-08	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	2.2E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	1.6E-09	1.4E-08	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	6.6E-05	mg/kg-day	NA	--	--	4.2E-04	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	6.4E-04	mg/kg-day	NA	--	--	4.1E-03	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	7.7E-08	mg/kg-day	1.5E+00	1/(mg/kg-day)	1.2E-07	4.9E-07	mg/kg-day	3.0E-04	mg/kg-day	1.6E-03
				Cobalt	6.82	mg/kg	2.2E-08	mg/kg-day	NA	--	--	1.4E-07	mg/kg-day	3.0E-04	mg/kg-day	4.6E-04
				Copper	229	mg/kg	7.3E-07	mg/kg-day	NA	--	--	4.6E-06	mg/kg-day	4.0E-02	mg/kg-day	1.2E-04
				Thallium	0.139	mg/kg	4.4E-10	mg/kg-day	NA	--	--	2.8E-09	mg/kg-day	1.0E-05	mg/kg-day	2.8E-04
				Vanadium	44.4	mg/kg	1.4E-07	mg/kg-day	NA	--	--	9.0E-07	mg/kg-day	5.0E-03	mg/kg-day	1.8E-04
			Dermal Total								1.8E-07					2.7E-03
		Exposure Point Total									8.5E-07					2.7E-02
	Exposure Medium Total										8.5E-07					2.7E-02

TABLE 7.2.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Youth

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Air	Fugative Dust	Inhalation													
				Benzo[a]anthracene	0.110	mg/kg	1.1E-11	mg/m3	1.1E-04	1/(µg/m3)	1.3E-12	7.3E-11	mg/m3	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	6.9E-12	mg/m3	1.1E-03	1/(µg/m3)	7.6E-12	4.4E-11	mg/m3	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	1.5E-11	mg/m3	1.1E-04	1/(µg/m3)	1.7E-12	9.6E-11	mg/m3	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	6.2E-12	mg/m3	1.1E-04	1/(µg/m3)	6.9E-13	4.0E-11	mg/m3	NA	--	--
				Chrysene	0.142	mg/kg	9.7E-11	mg/m3	1.1E-05	1/(µg/m3)	1.1E-12	6.2E-10	mg/m3	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	9.2E-13	mg/m3	1.2E-03	1/(µg/m3)	1.1E-12	5.9E-12	mg/m3	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	1.3E-12	mg/m3	1.1E-04	1/(µg/m3)	1.4E-13	8.2E-12	mg/m3	NA	--	--
				Diesel Range Organics	207	mg/kg	2.8E-10	mg/m3	NA	--	--	1.8E-09	mg/m3	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	2.8E-09	mg/m3	NA	--	--	1.8E-08	mg/m3	NA	--	--
				Arsenic	8.03	mg/kg	1.1E-11	mg/m3	4.3E-03	1/(µg/m3)	4.7E-11	7.0E-11	mg/m3	1.5E-05	mg/m3	4.7E-06
				Cobalt	6.82	mg/kg	9.4E-12	mg/m3	9.0E-03	1/(µg/m3)	8.4E-11	6.0E-11	mg/m3	6.0E-06	mg/m3	9.9E-06
				Copper	229	mg/kg	3.1E-10	mg/m3	NA	--	--	2.0E-09	mg/m3	NA	--	--
				Thallium	0.139	mg/kg	1.9E-13	mg/m3	NA	--	--	1.2E-12	mg/m3	NA	--	--
				Vanadium	44.4	mg/kg	6.1E-11	mg/m3	NA	--	--	3.9E-10	mg/m3	NA	--	--
			Inhalation Total								1.5E-10					1.5E-05
		Exposure Point Total									1.5E-10					1.5E-05
	Exposure Medium Total										1.5E-10					1.5E-05
Soil Total											8.5E-07					2.7E-02
										Total of Receptor Risks Across All Media	8.5E-07	Total of Receptor Hazards Across All Media				2.7E-02

TABLE 7.3.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: On-Site Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Soil	Soil	Ingestion													
				Benzo[a]anthracene	0.110	mg/kg	3.8E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	2.8E-08	1.1E-07	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	4.4E-08	mg/kg-day	7.3E+00	1/(mg/kg-day)	3.2E-07	1.2E-07	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	5.9E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	4.3E-08	1.7E-07	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	5.1E-08	mg/kg-day	7.3E-02	1/(mg/kg-day)	3.7E-09	1.4E-07	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	5.0E-08	mg/kg-day	7.3E-03	1/(mg/kg-day)	3.6E-10	1.4E-07	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	1.4E-08	mg/kg-day	7.3E+00	1/(mg/kg-day)	1.0E-07	3.9E-08	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	1.9E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	1.4E-08	5.2E-08	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	7.2E-05	mg/kg-day	NA	--	--	2.0E-04	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	7.0E-04	mg/kg-day	NA	--	--	2.0E-03	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	2.8E-06	mg/kg-day	1.5E+00	1/(mg/kg-day)	4.2E-06	7.9E-06	mg/kg-day	3.0E-04	mg/kg-day	2.6E-02
				Cobalt	6.82	mg/kg	2.4E-06	mg/kg-day	NA	--	--	6.7E-06	mg/kg-day	3.0E-04	mg/kg-day	2.2E-02
				Copper	229	mg/kg	8.0E-05	mg/kg-day	NA	--	--	2.2E-04	mg/kg-day	4.0E-02	mg/kg-day	5.6E-03
				Thallium	0.139	mg/kg	4.9E-08	mg/kg-day	NA	--	--	1.4E-07	mg/kg-day	1.0E-05	mg/kg-day	1.4E-02
				Vanadium	44.4	mg/kg	1.6E-05	mg/kg-day	NA	--	--	4.3E-05	mg/kg-day	5.0E-03	mg/kg-day	8.7E-03
			Ingestion Total								4.7E-06					7.6E-02
			Dermal													
				Benzo[a]anthracene	0.110	mg/kg	3.3E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	2.4E-08	9.2E-08	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	3.8E-08	mg/kg-day	7.3E+00	1/(mg/kg-day)	2.8E-07	1.1E-07	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	5.1E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	3.7E-08	1.4E-07	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	4.4E-08	mg/kg-day	7.3E-02	1/(mg/kg-day)	3.2E-09	1.2E-07	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	4.3E-08	mg/kg-day	7.3E-03	1/(mg/kg-day)	3.1E-10	1.2E-07	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	1.2E-08	mg/kg-day	7.3E+00	1/(mg/kg-day)	8.8E-08	3.4E-08	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	1.6E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	1.2E-08	4.5E-08	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	4.8E-04	mg/kg-day	NA	--	--	1.3E-03	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	4.6E-03	mg/kg-day	NA	--	--	1.3E-02	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	5.6E-07	mg/kg-day	1.5E+00	1/(mg/kg-day)	8.3E-07	1.6E-06	mg/kg-day	3.0E-04	mg/kg-day	5.2E-03
				Cobalt	6.82	mg/kg	1.6E-07	mg/kg-day	NA	--	--	4.4E-07	mg/kg-day	3.0E-04	mg/kg-day	1.5E-03
				Copper	229	mg/kg	5.3E-06	mg/kg-day	NA	--	--	1.5E-05	mg/kg-day	4.0E-02	mg/kg-day	3.7E-04
				Thallium	0.139	mg/kg	3.2E-09	mg/kg-day	NA	--	--	9.0E-09	mg/kg-day	1.0E-05	mg/kg-day	9.0E-04
				Vanadium	44.4	mg/kg	1.0E-06	mg/kg-day	NA	--	--	2.9E-06	mg/kg-day	5.0E-03	mg/kg-day	5.7E-04
			Dermal Total								1.3E-06					8.5E-03
		Exposure Point Total									6.0E-06					8.5E-02
	Exposure Medium Total										6.0E-06					8.5E-02

TABLE 7.3.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: On-Site Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF / Unit Risk Value	CSF / Unit Risk Units	Cancer Risk	Non-Cancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD / RfC Value	RfD / RfC Units	Quotient
Soil	Air	Fugative Dust	Inhalation													
				Benzo[a]anthracene	0.110	mg/kg	5.0E-10	mg/m3	1.1E-04	1/(µg/m3)	5.5E-11	1.4E-09	mg/m3	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	3.0E-10	mg/m3	1.1E-03	1/(µg/m3)	3.3E-10	8.4E-10	mg/m3	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	6.6E-10	mg/m3	1.1E-04	1/(µg/m3)	7.3E-11	1.9E-09	mg/m3	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	2.7E-10	mg/m3	1.1E-04	1/(µg/m3)	3.0E-11	7.6E-10	mg/m3	NA	--	--
				Chrysene	0.142	mg/kg	4.3E-09	mg/m3	1.1E-05	1/(µg/m3)	4.7E-11	1.2E-08	mg/m3	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	4.0E-11	mg/m3	1.2E-03	1/(µg/m3)	4.8E-11	1.1E-10	mg/m3	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	5.6E-11	mg/m3	1.1E-04	1/(µg/m3)	6.2E-12	1.6E-10	mg/m3	NA	--	--
				Diesel Range Organics	207	mg/kg	1.2E-08	mg/m3	NA	--	--	3.5E-08	mg/m3	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	1.2E-07	mg/m3	NA	--	--	3.4E-07	mg/m3	NA	--	--
				Arsenic	8.03	mg/kg	4.8E-10	mg/m3	4.3E-03	1/(µg/m3)	2.1E-09	1.3E-09	mg/m3	1.5E-05	mg/m3	9.0E-05
				Cobalt	6.82	mg/kg	4.1E-10	mg/m3	9.0E-03	1/(µg/m3)	3.7E-09	1.1E-09	mg/m3	6.0E-06	mg/m3	1.9E-04
				Copper	229	mg/kg	1.4E-08	mg/m3	NA	--	--	3.8E-08	mg/m3	NA	--	--
				Thallium	0.139	mg/kg	8.3E-12	mg/m3	NA	--	--	2.3E-11	mg/m3	NA	--	--
				Vanadium	44.4	mg/kg	2.7E-09	mg/m3	NA	--	--	7.5E-09	mg/m3	NA	--	--
			Inhalation Total								6.3E-09					2.8E-04
		Exposure Point Total									6.3E-09					2.8E-04
	Exposure Medium Total										6.3E-09					2.8E-04
Soil Total											6.0E-06					8.5E-02
										Total of Receptor Risks Across All Media	6.0E-06	Total of Receptor Hazards Across All Media				8.5E-02

TABLE 7.4.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Soil	Soil	Ingestion													
				Benzo[a]anthracene	0.110	mg/kg	8.6E-07	mg/kg-day	7.3E-01	1/(mg/kg-day)	6.3E-07	1.5E-07	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	0.0E+00	mg/kg-day	7.3E+00	1/(mg/kg-day)	0.0E+00	1.7E-07	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	0.0E+00	mg/kg-day	7.3E-01	1/(mg/kg-day)	0.0E+00	2.3E-07	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	0.0E+00	mg/kg-day	7.3E-02	1/(mg/kg-day)	0.0E+00	2.0E-07	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	0.0E+00	mg/kg-day	7.3E-03	1/(mg/kg-day)	0.0E+00	1.9E-07	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	0.0E+00	mg/kg-day	7.3E+00	1/(mg/kg-day)	0.0E+00	5.5E-08	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	0.0E+00	mg/kg-day	7.3E-01	1/(mg/kg-day)	0.0E+00	7.3E-08	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	9.7E-05	mg/kg-day	NA	--	--	2.8E-04	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	9.4E-04	mg/kg-day	NA	--	--	2.8E-03	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	3.8E-06	mg/kg-day	1.5E+00	1/(mg/kg-day)	5.7E-06	1.1E-05	mg/kg-day	3.0E-04	mg/kg-day	3.7E-02
				Cobalt	6.82	mg/kg	3.2E-06	mg/kg-day	NA	--	--	9.3E-06	mg/kg-day	3.0E-04	mg/kg-day	3.1E-02
				Copper	229	mg/kg	1.1E-04	mg/kg-day	NA	--	--	3.1E-04	mg/kg-day	4.0E-02	mg/kg-day	7.8E-03
				Thallium	0.139	mg/kg	6.5E-08	mg/kg-day	NA	--	--	1.9E-07	mg/kg-day	1.0E-05	mg/kg-day	1.9E-02
				Vanadium	44.4	mg/kg	2.1E-05	mg/kg-day	NA	--	--	6.1E-05	mg/kg-day	5.0E-03	mg/kg-day	1.2E-02
			Ingestion Total								6.3E-06					1.1E-01
			Dermal													
				Benzo[a]anthracene	0.110	mg/kg	3.3E-07	mg/kg-day	7.3E-01	1/(mg/kg-day)	2.4E-07	7.8E-08	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	0.0E+00	mg/kg-day	7.3E+00	1/(mg/kg-day)	0.0E+00	9.0E-08	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	0.0E+00	mg/kg-day	7.3E-01	1/(mg/kg-day)	0.0E+00	1.2E-07	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	0.0E+00	mg/kg-day	7.3E-02	1/(mg/kg-day)	0.0E+00	1.0E-07	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	0.0E+00	mg/kg-day	7.3E-03	1/(mg/kg-day)	0.0E+00	1.0E-07	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	0.0E+00	mg/kg-day	7.3E+00	1/(mg/kg-day)	0.0E+00	2.9E-08	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	0.0E+00	mg/kg-day	7.3E-01	1/(mg/kg-day)	0.0E+00	3.8E-08	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	3.9E-04	mg/kg-day	NA	--	--	1.1E-03	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	3.8E-03	mg/kg-day	NA	--	--	1.1E-02	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	4.5E-07	mg/kg-day	1.5E+00	1/(mg/kg-day)	6.8E-07	1.3E-06	mg/kg-day	3.0E-04	mg/kg-day	4.4E-03
				Cobalt	6.82	mg/kg	1.3E-07	mg/kg-day	NA	--	--	3.7E-07	mg/kg-day	3.0E-04	mg/kg-day	1.2E-03
				Copper	229	mg/kg	4.3E-06	mg/kg-day	NA	--	--	1.3E-05	mg/kg-day	4.0E-02	mg/kg-day	3.1E-04
				Thallium	0.139	mg/kg	2.6E-09	mg/kg-day	NA	--	--	7.6E-09	mg/kg-day	1.0E-05	mg/kg-day	7.6E-04
				Vanadium	44.4	mg/kg	8.3E-07	mg/kg-day	NA	--	--	2.4E-06	mg/kg-day	5.0E-03	mg/kg-day	4.9E-04
			Dermal Total								9.2E-07					7.2E-03
		Exposure Point Total									7.2E-06					1.1E-01
	Exposure Medium Total										7.2E-06					1.1E-01

TABLE 7.4.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Air	Fugative Dust	Inhalation													
				Benzo[a]anthracene	0.110	mg/kg	1.6E-09	mg/m3	1.1E-04	1/(μg/m3)	1.8E-10	5.9E-09	mg/m3	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	0.0E+00	mg/m3	1.1E-03	1/(μg/m3)	0.0E+00	3.5E-09	mg/m3	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	0.0E+00	mg/m3	1.1E-04	1/(μg/m3)	0.0E+00	7.8E-09	mg/m3	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	0.0E+00	mg/m3	1.1E-04	1/(μg/m3)	0.0E+00	3.2E-09	mg/m3	NA	--	--
				Chrysene	0.142	mg/kg	0.0E+00	mg/m3	1.1E-05	1/(μg/m3)	0.0E+00	5.0E-08	mg/m3	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	0.0E+00	mg/m3	1.2E-03	1/(μg/m3)	0.0E+00	4.7E-10	mg/m3	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	0.0E+00	mg/m3	1.1E-04	1/(μg/m3)	0.0E+00	6.6E-10	mg/m3	NA	--	--
				Diesel Range Organics	207	mg/kg	5.0E-08	mg/m3	NA	--	--	1.5E-07	mg/m3	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	4.9E-07	mg/m3	NA	--	--	1.4E-06	mg/m3	NA	--	--
				Arsenic	8.03	mg/kg	1.9E-09	mg/m3	4.3E-03	1/(μg/m3)	8.3E-09	5.7E-09	mg/m3	1.5E-05	mg/m3	3.8E-04
				Cobalt	6.82	mg/kg	1.6E-09	mg/m3	9.0E-03	1/(μg/m3)	1.5E-08	4.8E-09	mg/m3	6.0E-06	mg/m3	8.0E-04
				Copper	229	mg/kg	5.5E-08	mg/m3	NA	--	--	1.6E-07	mg/m3	NA	--	--
				Thallium	0.139	mg/kg	3.4E-11	mg/m3	NA	--	--	9.8E-11	mg/m3	NA	--	--
				Vanadium	44.4	mg/kg	1.1E-08	mg/m3	NA	--	--	3.1E-08	mg/m3	NA	--	--
			Inhalation Total								2.3E-08					1.2E-03
		Exposure Point Total									2.3E-08					1.2E-03
	Exposure Medium Total										2.3E-08					1.2E-03
Soil Total											7.2E-06					1.2E-01
										Total of Receptor Risks Across All Media	7.2E-06	Total of Receptor Hazards Across All Media				1.2E-01

TABLE 7.5.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Young Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Soil	Soil	Ingestion													
				Benzo[a]anthracene	0.110	mg/kg	7.6E-07	mg/kg-day	7.3E-01	1/(mg/kg-day)	5.5E-07	1.4E-06	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	0.0E+00	mg/kg-day	7.3E+00	1/(mg/kg-day)	0.0E+00	1.6E-06	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	0.0E+00	mg/kg-day	7.3E-01	1/(mg/kg-day)	0.0E+00	2.2E-06	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	0.0E+00	mg/kg-day	7.3E-02	1/(mg/kg-day)	0.0E+00	1.9E-06	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	0.0E+00	mg/kg-day	7.3E-03	1/(mg/kg-day)	0.0E+00	1.8E-06	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	0.0E+00	mg/kg-day	7.3E+00	1/(mg/kg-day)	0.0E+00	5.1E-07	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	0.0E+00	mg/kg-day	7.3E-01	1/(mg/kg-day)	0.0E+00	6.8E-07	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	2.3E-04	mg/kg-day	NA	--	--	2.6E-03	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	2.2E-03	mg/kg-day	NA	--	--	2.6E-02	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	8.8E-06	mg/kg-day	1.5E+00	1/(mg/kg-day)	1.3E-05	1.0E-04	mg/kg-day	3.0E-04	mg/kg-day	3.4E-01
				Cobalt	6.82	mg/kg	7.5E-06	mg/kg-day	NA	--	--	8.7E-05	mg/kg-day	3.0E-04	mg/kg-day	2.9E-01
				Copper	229	mg/kg	2.5E-04	mg/kg-day	NA	--	--	2.9E-03	mg/kg-day	4.0E-02	mg/kg-day	7.3E-02
				Thallium	0.139	mg/kg	1.5E-07	mg/kg-day	NA	--	--	1.8E-06	mg/kg-day	1.0E-05	mg/kg-day	1.8E-01
				Vanadium	44.4	mg/kg	4.9E-05	mg/kg-day	NA	--	--	5.7E-04	mg/kg-day	5.0E-03	mg/kg-day	1.1E-01
			Ingestion Total								1.4E-05					1.0E+00
			Dermal													
				Benzo[a]anthracene	0.110	mg/kg	2.8E-07	mg/kg-day	7.3E-01	1/(mg/kg-day)	2.0E-07	5.1E-07	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	0.0E+00	mg/kg-day	7.3E+00	1/(mg/kg-day)	0.0E+00	5.9E-07	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	0.0E+00	mg/kg-day	7.3E-01	1/(mg/kg-day)	0.0E+00	7.9E-07	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	0.0E+00	mg/kg-day	7.3E-02	1/(mg/kg-day)	0.0E+00	6.8E-07	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	0.0E+00	mg/kg-day	7.3E-03	1/(mg/kg-day)	0.0E+00	6.6E-07	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	0.0E+00	mg/kg-day	7.3E+00	1/(mg/kg-day)	0.0E+00	1.9E-07	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	0.0E+00	mg/kg-day	7.3E-01	1/(mg/kg-day)	0.0E+00	2.5E-07	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	6.4E-04	mg/kg-day	NA	--	--	7.4E-03	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	6.2E-03	mg/kg-day	NA	--	--	7.2E-02	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	7.4E-07	mg/kg-day	1.5E+00	1/(mg/kg-day)	1.1E-06	8.6E-06	mg/kg-day	3.0E-04	mg/kg-day	2.9E-02
				Cobalt	6.82	mg/kg	2.1E-07	mg/kg-day	NA	--	--	2.4E-06	mg/kg-day	3.0E-04	mg/kg-day	8.1E-03
				Copper	229	mg/kg	7.0E-06	mg/kg-day	NA	--	--	8.2E-05	mg/kg-day	4.0E-02	mg/kg-day	2.0E-03
				Thallium	0.139	mg/kg	4.3E-09	mg/kg-day	NA	--	--	5.0E-08	mg/kg-day	1.0E-05	mg/kg-day	5.0E-03
				Vanadium	44.4	mg/kg	1.4E-06	mg/kg-day	NA	--	--	1.6E-05	mg/kg-day	5.0E-03	mg/kg-day	3.2E-03
			Dermal Total								1.3E-06					4.7E-02
		Exposure Point Total									1.5E-05					**1.0E+00**
	Exposure Medium Total										1.5E-05					**1.0E+00**

TABLE 7.5.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Young Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Air	Fugative Dust	Inhalation													
				Benzo[a]anthracene	0.110	mg/kg	7.4E-10	mg/m3	1.1E-04	1/(µg/m3)	8.1E-11	5.9E-09	mg/m3	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	0.0E+00	mg/m3	1.1E-03	1/(µg/m3)	0.0E+00	3.5E-09	mg/m3	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	0.0E+00	mg/m3	1.1E-04	1/(µg/m3)	0.0E+00	7.8E-09	mg/m3	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	0.0E+00	mg/m3	1.1E-04	1/(µg/m3)	0.0E+00	3.2E-09	mg/m3	NA	--	--
				Chrysene	0.142	mg/kg	0.0E+00	mg/m3	1.1E-05	1/(µg/m3)	0.0E+00	5.0E-08	mg/m3	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	0.0E+00	mg/m3	1.2E-03	1/(µg/m3)	0.0E+00	4.7E-10	mg/m3	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	0.0E+00	mg/m3	1.1E-04	1/(µg/m3)	0.0E+00	6.6E-10	mg/m3	NA	--	--
				Diesel Range Organics	207	mg/kg	1.3E-08	mg/m3	NA	--	--	1.5E-07	mg/m3	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	1.2E-07	mg/m3	NA	--	--	1.4E-06	mg/m3	NA	--	--
				Arsenic	8.03	mg/kg	4.9E-10	mg/m3	4.3E-03	1/(µg/m3)	2.1E-09	5.7E-09	mg/m3	1.5E-05	mg/m3	3.8E-04
				Cobalt	6.82	mg/kg	4.1E-10	mg/m3	9.0E-03	1/(µg/m3)	3.7E-09	4.8E-09	mg/m3	6.0E-06	mg/m3	8.0E-04
				Copper	229	mg/kg	1.4E-08	mg/m3	NA	--	--	1.6E-07	mg/m3	NA	--	--
				Thallium	0.139	mg/kg	8.4E-12	mg/m3	NA	--	--	9.8E-11	mg/m3	NA	--	--
				Vanadium	44.4	mg/kg	2.7E-09	mg/m3	NA	--	--	3.1E-08	mg/m3	NA	--	--
			Inhalation Total								5.9E-09					1.2E-03
		Exposure Point Total									5.9E-09					1.2E-03
	Exposure Medium Total										5.9E-09					1.2E-03
Soil Total											1.5E-05					**1.0E+00**
										Total of Receptor Risks Across All Media	1.5E-05	Total of Receptor Hazards Across All Media				**1.0E+00**

TABLE 7.6.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Industrial / Commercial Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Soil	Soil	Ingestion													
				Benzo[a]anthracene	0.110	mg/kg	3.8E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	2.8E-08	1.1E-07	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	4.4E-08	mg/kg-day	7.3E+00	1/(mg/kg-day)	3.2E-07	1.2E-07	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	5.9E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	4.3E-08	1.7E-07	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	5.1E-08	mg/kg-day	7.3E-02	1/(mg/kg-day)	3.7E-09	1.4E-07	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	5.0E-08	mg/kg-day	7.3E-03	1/(mg/kg-day)	3.6E-10	1.4E-07	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	1.4E-08	mg/kg-day	7.3E+00	1/(mg/kg-day)	1.0E-07	3.9E-08	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	1.9E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	1.4E-08	5.2E-08	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	7.2E-05	mg/kg-day	NA	--	--	2.0E-04	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	7.0E-04	mg/kg-day	NA	--	--	2.0E-03	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	2.8E-06	mg/kg-day	1.5E+00	1/(mg/kg-day)	4.2E-06	7.9E-06	mg/kg-day	3.0E-04	mg/kg-day	2.6E-02
				Cobalt	6.82	mg/kg	2.4E-06	mg/kg-day	NA	--	--	6.7E-06	mg/kg-day	3.0E-04	mg/kg-day	2.2E-02
				Copper	229	mg/kg	8.0E-05	mg/kg-day	NA	--	--	2.2E-04	mg/kg-day	4.0E-02	mg/kg-day	5.6E-03
				Thallium	0.139	mg/kg	4.9E-08	mg/kg-day	NA	--	--	1.4E-07	mg/kg-day	1.0E-05	mg/kg-day	1.4E-02
				Vanadium	44.4	mg/kg	1.6E-05	mg/kg-day	NA	--	--	4.3E-05	mg/kg-day	5.0E-03	mg/kg-day	8.7E-03
			Ingestion Total								4.7E-06					7.6E-02
			Dermal													
				Benzo[a]anthracene	0.110	mg/kg	3.3E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	2.4E-08	9.2E-08	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	3.8E-08	mg/kg-day	7.3E+00	1/(mg/kg-day)	2.8E-07	1.1E-07	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	5.1E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	3.7E-08	1.4E-07	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	4.4E-08	mg/kg-day	7.3E-02	1/(mg/kg-day)	3.2E-09	1.2E-07	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	4.3E-08	mg/kg-day	7.3E-03	1/(mg/kg-day)	3.1E-10	1.2E-07	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	1.2E-08	mg/kg-day	7.3E+00	1/(mg/kg-day)	8.8E-08	3.4E-08	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	1.6E-08	mg/kg-day	7.3E-01	1/(mg/kg-day)	1.2E-08	4.5E-08	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	4.8E-04	mg/kg-day	NA	--	--	1.3E-03	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	4.6E-03	mg/kg-day	NA	--	--	1.3E-02	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	5.6E-07	mg/kg-day	1.5E+00	1/(mg/kg-day)	8.3E-07	1.6E-06	mg/kg-day	3.0E-04	mg/kg-day	5.2E-03
				Cobalt	6.82	mg/kg	1.6E-07	mg/kg-day	NA	--	--	4.4E-07	mg/kg-day	3.0E-04	mg/kg-day	1.5E-03
				Copper	229	mg/kg	5.3E-06	mg/kg-day	NA	--	--	1.5E-05	mg/kg-day	4.0E-02	mg/kg-day	3.7E-04
				Thallium	0.139	mg/kg	3.2E-09	mg/kg-day	NA	--	--	9.0E-09	mg/kg-day	1.0E-05	mg/kg-day	9.0E-04
				Vanadium	44.4	mg/kg	1.0E-06	mg/kg-day	NA	--	--	2.9E-06	mg/kg-day	5.0E-03	mg/kg-day	5.7E-04
			Dermal Total								1.3E-06					8.5E-03
		Exposure Point Total									6.0E-06					8.5E-02
	Exposure Medium Total										6.0E-06					8.5E-02

TABLE 7.6.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Industrial / Commercial Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Air	Fugative Dust	Inhalation													
				Benzo[a]anthracene	0.110	mg/kg	5.0E-10	mg/m3	1.1E-04	1/(µg/m3)	5.5E-11	1.4E-09	mg/m3	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	3.0E-10	mg/m3	1.1E-03	1/(µg/m3)	3.3E-10	8.4E-10	mg/m3	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	6.6E-10	mg/m3	1.1E-04	1/(µg/m3)	7.3E-11	1.9E-09	mg/m3	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	2.7E-10	mg/m3	1.1E-04	1/(µg/m3)	3.0E-11	7.6E-10	mg/m3	NA	--	--
				Chrysene	0.142	mg/kg	4.3E-09	mg/m3	1.1E-05	1/(µg/m3)	4.7E-11	1.2E-08	mg/m3	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	4.0E-11	mg/m3	1.2E-03	1/(µg/m3)	4.8E-11	1.1E-10	mg/m3	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	5.6E-11	mg/m3	1.1E-04	1/(µg/m3)	6.2E-12	1.6E-10	mg/m3	NA	--	--
				Diesel Range Organics	207	mg/kg	1.2E-08	mg/m3	NA	--	--	3.5E-08	mg/m3	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	1.2E-07	mg/m3	NA	--	--	3.4E-07	mg/m3	NA	--	--
				Arsenic	8.03	mg/kg	4.8E-10	mg/m3	4.3E-03	1/(µg/m3)	2.1E-09	1.3E-09	mg/m3	1.5E-05	mg/m3	9.0E-05
				Cobalt	6.82	mg/kg	4.1E-10	mg/m3	9.0E-03	1/(µg/m3)	3.7E-09	1.1E-09	mg/m3	6.0E-06	mg/m3	1.9E-04
				Copper	229	mg/kg	1.4E-08	mg/m3	NA	--	--	3.8E-08	mg/m3	NA	--	--
				Thallium	0.139	mg/kg	8.3E-12	mg/m3	NA	--	--	2.3E-11	mg/m3	NA	--	--
				Vanadium	44.4	mg/kg	2.7E-09	mg/m3	NA	--	--	7.5E-09	mg/m3	NA	--	--
			Inhalation Total								6.3E-09					2.8E-04
		Exposure Point Total									6.3E-09					2.8E-04
	Exposure Medium Total										6.3E-09					2.8E-04
Soil Total											6.0E-06					8.5E-02
Total of Receptor Risks Across All Media											6.0E-06	Total of Receptor Hazards Across All Media				8.5E-02

TABLE 7.7.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Soil	Soil	Ingestion													
				Benzo[a]anthracene	0.110	mg/kg	5.1E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	3.7E-09	3.6E-07	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	5.9E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	4.3E-08	4.1E-07	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	7.8E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	5.7E-09	5.5E-07	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	6.7E-09	mg/kg-day	7.3E-02	1/(mg/kg-day)	4.9E-10	4.7E-07	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	6.6E-09	mg/kg-day	7.3E-03	1/(mg/kg-day)	4.8E-11	4.6E-07	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	1.9E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	1.4E-08	1.3E-07	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	2.5E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	1.8E-09	1.7E-07	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	9.5E-06	mg/kg-day	NA	--	--	6.7E-04	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	9.3E-05	mg/kg-day	NA	--	--	6.5E-03	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	3.7E-07	mg/kg-day	1.5E+00	1/(mg/kg-day)	5.6E-07	2.6E-05	mg/kg-day	3.0E-04	mg/kg-day	8.6E-02
				Cobalt	6.82	mg/kg	3.1E-07	mg/kg-day	NA	--	--	2.2E-05	mg/kg-day	3.0E-04	mg/kg-day	7.3E-02
				Copper	229	mg/kg	1.1E-05	mg/kg-day	NA	--	--	7.4E-04	mg/kg-day	4.0E-02	mg/kg-day	1.8E-02
				Thallium	0.139	mg/kg	6.4E-09	mg/kg-day	NA	--	--	4.5E-07	mg/kg-day	1.0E-05	mg/kg-day	4.5E-02
				Vanadium	44.4	mg/kg	2.0E-06	mg/kg-day	NA	--	--	1.4E-04	mg/kg-day	5.0E-03	mg/kg-day	2.9E-02
			Ingestion Total								6.2E-07					2.5E-01
			Dermal													
				Benzo[a]anthracene	0.110	mg/kg	2.0E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	1.4E-09	1.4E-07	mg/kg-day	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	2.3E-09	mg/kg-day	7.3E+00	1/(mg/kg-day)	1.7E-08	1.6E-07	mg/kg-day	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	3.0E-09	mg/kg-day	7.3E-01	1/(mg/kg-day)	2.2E-09	2.1E-07	mg/kg-day	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	2.6E-09	mg/kg-day	7.3E-02	1/(mg/kg-day)	1.9E-10	1.8E-07	mg/kg-day	NA	--	--
				Chrysene	0.142	mg/kg	2.6E-09	mg/kg-day	7.3E-03	1/(mg/kg-day)	1.9E-11	1.8E-07	mg/kg-day	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	7.2E-10	mg/kg-day	7.3E+00	1/(mg/kg-day)	5.3E-09	5.1E-08	mg/kg-day	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	9.6E-10	mg/kg-day	7.3E-01	1/(mg/kg-day)	7.0E-10	6.7E-08	mg/kg-day	NA	--	--
				Diesel Range Organics	207	mg/kg	2.9E-05	mg/kg-day	NA	--	--	2.0E-03	mg/kg-day	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	2.8E-04	mg/kg-day	NA	--	--	1.9E-02	mg/kg-day	NA	--	--
				Arsenic	8.03	mg/kg	3.3E-08	mg/kg-day	1.5E+00	1/(mg/kg-day)	5.0E-08	2.3E-06	mg/kg-day	3.0E-04	mg/kg-day	7.8E-03
				Cobalt	6.82	mg/kg	9.4E-09	mg/kg-day	NA	--	--	6.6E-07	mg/kg-day	3.0E-04	mg/kg-day	2.2E-03
				Copper	229	mg/kg	3.2E-07	mg/kg-day	NA	--	--	2.2E-05	mg/kg-day	4.0E-02	mg/kg-day	5.5E-04
				Thallium	0.139	mg/kg	1.9E-10	mg/kg-day	NA	--	--	1.3E-08	mg/kg-day	1.0E-05	mg/kg-day	1.3E-03
				Vanadium	44.4	mg/kg	6.1E-08	mg/kg-day	NA	--	--	4.3E-06	mg/kg-day	5.0E-03	mg/kg-day	8.6E-04
			Dermal Total								7.7E-08					1.3E-02
		Exposure Point Total									7.0E-07					2.6E-01
	Exposure Medium Total										7.0E-07					2.6E-01

TABLE 7.7.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Air	Fugative Dust	Inhalation													
				Benzo[a]anthracene	0.110	mg/kg	2.9E-10	mg/m3	1.1E-04	1/(µg/m3)	3.2E-11	2.1E-08	mg/m3	NA	--	--
				Benzo[a]pyrene	0.127	mg/kg	3.3E-10	mg/m3	1.1E-03	1/(µg/m3)	3.6E-10	2.3E-08	mg/m3	NA	--	--
				Benzo[b]fluoranthene	0.169	mg/kg	4.5E-10	mg/m3	1.1E-04	1/(µg/m3)	4.9E-11	3.1E-08	mg/m3	NA	--	--
				Benzo[k]fluoranthene	0.146	mg/kg	3.7E-10	mg/m3	1.1E-04	1/(µg/m3)	4.1E-11	2.6E-08	mg/m3	NA	--	--
				Chrysene	0.142	mg/kg	5.2E-10	mg/m3	1.1E-05	1/(µg/m3)	5.7E-12	3.7E-08	mg/m3	NA	--	--
				Dibenz(a,h)anthracene	0.0402	mg/kg	1.0E-10	mg/m3	1.2E-03	1/(µg/m3)	1.2E-10	7.1E-09	mg/m3	NA	--	--
				Indeno[1,2,3-cd]pyrene	0.0532	mg/kg	1.3E-10	mg/m3	1.1E-04	1/(µg/m3)	1.5E-11	9.4E-09	mg/m3	NA	--	--
				Diesel Range Organics	207	mg/kg	5.1E-07	mg/m3	NA	--	--	3.6E-05	mg/m3	NA	--	--
				Gasoline Range Organics	2,011	mg/kg	5.0E-06	mg/m3	NA	--	--	3.5E-04	mg/m3	NA	--	--
				Arsenic	8.03	mg/kg	2.0E-08	mg/m3	4.3E-03	1/(µg/m3)	8.6E-08	1.4E-06	mg/m3	1.5E-05	mg/m3	9.3E-02
				Cobalt	6.82	mg/kg	1.7E-08	mg/m3	9.0E-03	1/(µg/m3)	1.5E-07	1.2E-06	mg/m3	6.0E-06	mg/m3	2.0E-01
				Copper	229	mg/kg	5.7E-07	mg/m3	NA	--	--	4.0E-05	mg/m3	NA	--	--
				Thallium	0.139	mg/kg	3.5E-10	mg/m3	NA	--	--	2.4E-08	mg/m3	NA	--	--
				Vanadium	44.4	mg/kg	1.1E-07	mg/m3	NA	--	--	7.7E-06	mg/m3	NA	--	--
			Inhalation Total								2.4E-07					2.9E-01
		Exposure Point Total									2.4E-07					2.9E-01
	Exposure Medium Total										2.4E-07					2.9E-01
Soil Total											9.4E-07					5.6E-01
Total of Receptor Risks Across All Media											9.4E-07	Total of Receptor Hazards Across All Media				5.6E-01

TABLE 8.1.RME
CALCULATION OF RADIATION CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe:
Receptor Population:
Receptor Age:

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF / Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD / RfC		Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
			Total													
NOT APPLICABLE																
			Total													
		Exposure Point Total														
	Exposure Medium Total															
			Total													
		Exposure Point Total														
	Exposure Medium Total															
Total																
										Total of Receptor Risks Across All Media					Total of Receptor Hazards Across All Media	

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	5.6E-09	--	2.9E-09	--	8.5E-09	NA	--	--	--	--
			Benzo[a]pyrene	6.5E-08	--	3.4E-08	--	9.8E-08	NA	--	--	--	--
			Benzo[b]fluoranthene	8.6E-09	--	4.5E-09	--	1.3E-08	NA	--	--	--	--
			Benzo[k]fluoranthene	7.4E-10	--	3.9E-10	--	1.1E-09	NA	--	--	--	--
			Chrysene	7.2E-11	--	3.8E-11	--	1.1E-10	NA	--	--	--	--
			Dibenz(a,h)anthracene	2.0E-08	--	1.1E-08	--	3.1E-08	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	2.7E-09	--	1.4E-09	--	4.1E-09	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	8.4E-07	--	1.0E-07	--	9.4E-07	Skin / CVS	<0.01	--	<0.01	<0.01
			Cobalt	--	--	--	--	--	CVS	<0.01	--	<0.01	<0.01
			Copper	--	--	--	--	--	GIS	<0.01	--	<0.01	<0.01
			Thallium	--	--	--	--	--	Liver / CVS / Skin	<0.01	--	<0.01	<0.01
			Vanadium	--	--	--	--	--	GIS / Kidney	<0.01	--	<0.01	<0.01
			Chemical Total	9.4E-07	--	1.5E-07	--	1.1E-06		0.02	--	<0.01	0.02
		Exposure Point Total						1.1E-06					0.02
	Exposure Medium Total							1.1E-06					0.02
	Air	Fugative Dust											
			Benzo[a]anthracene	--	2.8E-12	--	--	2.8E-12	NA	--	--	--	--
			Benzo[a]pyrene	--	1.7E-11	--	--	1.7E-11	NA	--	--	--	--
			Benzo[b]fluoranthene	--	3.6E-12	--	--	3.6E-12	NA	--	--	--	--
			Benzo[k]fluoranthene	--	1.5E-12	--	--	1.5E-12	NA	--	--	--	--
			Chrysene	--	2.3E-12	--	--	2.3E-12	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	2.4E-12	--	--	2.4E-12	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	3.1E-13	--	--	3.1E-13	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	1.0E-10	--	--	1.0E-10	NA	--	<0.01	--	<0.01
			Cobalt	--	1.8E-10	--	--	1.8E-10	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	3.2E-10	--	--	3.2E-10		--	<0.01	--	<0.01
		Exposure Point Total						3.2E-10					<0.01
	Exposure Medium Total							3.2E-10					<0.01
Soil Total								**1.10E-06**					**0.02**

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Adult Trespassers Total								**1.10E-06**					**0.02**

Total Risk Across Soil	1.1E-06	Total Hazard Index Across Soil	0.02
Total Risk Across All Media and All Exposure Routes	1.1E-06	Total Hazard Index Across All Media and All Exposure Routes	0.02

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		<0.01	<0.01
Cardiovascular System HI =		0.01	0.01
Skin HI =		<0.01	<0.01
Kidney HI =		<0.01	<0.01
Liver HI =		<0.01	<0.01
Respiratory System HI =	<0.01		<0.01

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	4.0E-09	--	3.3E-09	--	7.3E-09	NA	--	--	--	--
			Benzo[a]pyrene	4.6E-08	--	3.8E-08	--	8.4E-08	NA	--	--	--	--
			Benzo[b]fluoranthene	6.1E-09	--	5.1E-09	--	1.1E-08	NA	--	--	--	--
			Benzo[k]fluoranthene	5.3E-10	--	4.4E-10	--	9.7E-10	NA	--	--	--	--
			Chrysene	5.2E-11	--	4.3E-11	--	9.4E-11	NA	--	--	--	--
			Dibenz(a,h)anthracene	1.5E-08	--	1.2E-08	--	2.7E-08	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	1.9E-09	--	1.6E-09	--	3.5E-09	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	6.0E-07	--	1.2E-07	--	7.1E-07	Skin / CVS	<0.01	--	<0.01	0.01
			Cobalt	--	--	--	--	--	CVS	<0.01	--	<0.01	<0.01
			Copper	--	--	--	--	--	GIS	<0.01	--	<0.01	<0.01
			Thallium	--	--	--	--	--	Liver / CVS / Skin	<0.01	--	<0.01	<0.01
			Vanadium	--	--	--	--	--	GIS / Kidney	<0.01	--	<0.01	<0.01
			Chemical Total	6.7E-07	--	1.8E-07	--	8.5E-07		0.02	--	<0.01	0.03
		Exposure Point Total						8.5E-07					0.03
	Exposure Medium Total							8.5E-07					0.03
	Air	Fugative Dust											
			Benzo[a]anthracene	--	1.3E-12	--	--	1.3E-12	NA	--	--	--	--
			Benzo[a]pyrene	--	7.6E-12	--	--	7.6E-12	NA	--	--	--	--
			Benzo[b]fluoranthene	--	1.7E-12	--	--	1.7E-12	NA	--	--	--	--
			Benzo[k]fluoranthene	--	6.9E-13	--	--	6.9E-13	NA	--	--	--	--
			Chrysene	--	1.1E-12	--	--	1.1E-12	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	1.1E-12	--	--	1.1E-12	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	1.4E-13	--	--	1.4E-13	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	4.7E-11	--	--	4.7E-11	NA	--	<0.01	--	<0.01
			Cobalt	--	8.4E-11	--	--	8.4E-11	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	1.5E-10	--	--	1.5E-10		--	<0.01	--	<0.01
		Exposure Point Total						1.5E-10					<0.01
	Exposure Medium Total							1.5E-10					<0.01
Soil Total								**8.49E-07**					**0.03**

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: Trespassers
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Youth Trespassers Total								**8.49E-07**					**0.03**

Total Risk Across Soil	8.5E-07	Total Hazard Index Across Soil	0.03
Total Risk Across All Media and All Exposure Routes	8.5E-07	ɔss All Media and All Exposure Routes	0.03

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		<0.01	<0.01
Cardiovascular System HI =		0.02	0.02
Skin HI =		0.01	0.01
Kidney HI =		<0.01	<0.01
Liver HI =		<0.01	<0.01
Respiratory System HI =	<0.01		<0.01

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: On-Site Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	2.8E-08	--	2.4E-08	--	5.2E-08	NA	--	--	--	--
			Benzo[a]pyrene	3.2E-07	--	2.8E-07	--	6.0E-07	NA	--	--	--	--
			Benzo[b]fluoranthene	4.3E-08	--	3.7E-08	--	8.0E-08	NA	--	--	--	--
			Benzo[k]fluoranthene	3.7E-09	--	3.2E-09	--	6.9E-09	NA	--	--	--	--
			Chrysene	3.6E-10	--	3.1E-10	--	6.7E-10	NA	--	--	--	--
			Dibenz(a,h)anthracene	1.0E-07	--	8.8E-08	--	1.9E-07	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	1.4E-08	--	1.2E-08	--	2.5E-08	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	4.2E-06	--	8.3E-07	--	5.0E-06	Skin / CVS	0.03	--	<0.01	0.03
			Cobalt	--	--	--	--	--	CVS	0.02	--	<0.01	0.02
			Copper	--	--	--	--	--	GIS	<0.01	--	<0.01	<0.01
			Thallium	--	--	--	--	--	Liver / CVS / Skin	0.01	--	<0.01	0.01
			Vanadium	--	--	--	--	--	GIS / Kidney	<0.01	--	<0.01	<0.01
			Chemical Total	4.7E-06	--	1.3E-06	--	6.0E-06		0.08	--	<0.01	0.08
		Exposure Point Total						6.0E-06					0.08
	Exposure Medium Total							6.0E-06					0.08
	Air	Fugative Dust											
			Benzo[a]anthracene	--	5.5E-11	--	--	5.5E-11	NA	--	--	--	--
			Benzo[a]pyrene	--	3.3E-10	--	--	3.3E-10	NA	--	--	--	--
			Benzo[b]fluoranthene	--	7.3E-11	--	--	7.3E-11	NA	--	--	--	--
			Benzo[k]fluoranthene	--	3.0E-11	--	--	3.0E-11	NA	--	--	--	--
			Chrysene	--	4.7E-11	--	--	4.7E-11	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	4.8E-11	--	--	4.8E-11	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	6.2E-12	--	--	6.2E-12	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	2.1E-09	--	--	2.1E-09	NA	--	<0.01	--	<0.01
			Cobalt	--	3.7E-09	--	--	3.7E-09	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	6.3E-09	--	--	6.3E-09		--	<0.01	--	<0.01
		Exposure Point Total						6.3E-09					<0.01
	Exposure Medium Total							6.3E-09					<0.01
Soil Total								**6.01E-06**					**0.09**

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Current, Future
Receptor Population: On-Site Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
On-Site Workers Total								**6.01E-06**					**0.09**

Total Risk Across Soil	6.0E-06
Total Risk Across All Media and All Exposure Routes	6.0E-06

Total Hazard Index Across Soil	0.09
ɔss All Media and All Exposure Routes	0.09

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		0.02	0.02
Cardiovascular System HI =		0.07	0.07
Skin HI =		0.05	0.05
Kidney HI =		<0.01	<0.01
Liver HI =		0.01	0.01
Respiratory System HI =	<0.01		<0.01

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	6.3E-07	--	2.4E-07	--	8.7E-07	NA	--	--	--	--
			Benzo[a]pyrene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Benzo[b]fluoranthene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Benzo[k]fluoranthene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Chrysene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Dibenz(a,h)anthracene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	5.7E-06	--	6.8E-07	--	6.3E-06	Skin / CVS	0.04	--	<0.01	0.04
			Cobalt	--	--	--	--	--	CVS	0.03	--	<0.01	0.03
			Copper	--	--	--	--	--	GIS	<0.01	--	<0.01	<0.01
			Thallium	--	--	--	--	--	Liver / CVS / Skin	0.02	--	<0.01	0.02
			Vanadium	--	--	--	--	--	GIS / Kidney	0.01	--	<0.01	0.01
			Chemical Total	6.3E-06	--	9.2E-07	--	7.2E-06		0.11	--	<0.01	0.11
		Exposure Point Total						7.2E-06					0.11
	Exposure Medium Total							7.2E-06					0.11
	Air	Fugative Dust											
			Benzo[a]anthracene	--	1.8E-10	--	--	1.8E-10	NA	--	--	--	--
			Benzo[a]pyrene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Benzo[b]fluoranthene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Benzo[k]fluoranthene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Chrysene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	8.3E-09	--	--	8.3E-09	NA	--	<0.01	--	<0.01
			Cobalt	--	1.5E-08	--	--	1.5E-08	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	2.3E-08	--	--	2.3E-08		--	<0.01	--	<0.01
		Exposure Point Total						2.3E-08					<0.01
	Exposure Medium Total							2.3E-08					<0.01
Soil Total								**7.22E-06**					**0.12**

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Adult Residents Total								**7.22E-06**					**0.12**

Total Risk Across Soil	7.2E-06
Total Risk Across All Media and All Exposure Routes	7.2E-06

Total Hazard Index Across Soil	0.12
oss All Media and All Exposure Routes	0.12

Notes:
<u>Target Organ Abbreviations:</u>
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		0.02	0.02
Cardiovascular System HI =		0.09	0.09
Skin HI =		0.06	0.06
Kidney HI =		0.01	0.01
Liver HI =		0.02	0.02
Respiratory System HI =	<0.01		<0.01

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Young Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	5.5E-07	--	2.0E-07	--	7.5E-07	NA	--	--	--	--
			Benzo[a]pyrene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Benzo[b]fluoranthene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Benzo[k]fluoranthene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Chrysene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Dibenz(a,h)anthracene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	0.0E+00	--	0.0E+00	--	0.0E+00	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	1.3E-05	--	1.1E-06	--	1.4E-05	Skin / CVS	0.34	--	0.03	0.37
			Cobalt	--	--	--	--	--	CVS	0.29	--	<0.01	0.30
			Copper	--	--	--	--	--	GIS	0.07	--	<0.01	0.08
			Thallium	--	--	--	--	--	Liver / CVS / Skin	0.18	--	<0.01	0.18
			Vanadium	--	--	--	--	--	GIS / Kidney	0.11	--	<0.01	0.12
			Chemical Total	1.4E-05	--	1.3E-06	--	1.5E-05		1.00	--	0.05	**1.04**
		Exposure Point Total						1.5E-05					**1.04**
	Exposure Medium Total							1.5E-05					**1.04**
	Air	Fugative Dust											
			Benzo[a]anthracene	--	8.1E-11	--	--	8.1E-11	NA	--	--	--	--
			Benzo[a]pyrene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Benzo[b]fluoranthene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Benzo[k]fluoranthene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Chrysene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	0.0E+00	--	--	0.0E+00	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	2.1E-09	--	--	2.1E-09	NA	--	<0.01	--	<0.01
			Cobalt	--	3.7E-09	--	--	3.7E-09	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	5.9E-09	--	--	5.9E-09		--	<0.01	--	<0.01
		Exposure Point Total						5.9E-09					<0.01
	Exposure Medium Total							5.9E-09					<0.01
Soil Total								**1.51E-05**					**1.05**

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Young Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Young Child Residents Total								**1.51E-05**					**1.05**

Total Risk Across Soil	1.5E-05	Total Hazard Index Across Soil	**1.0**
Total Risk Across All Media and All Exposure Routes	1.5E-05	ɔss All Media and All Exposure Routes	**1.0**

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		0.19	0.19
Cardiovascular System HI =		0.85	0.85
Skin HI =		0.55	0.55
Kidney HI =		0.12	0.12
Liver HI =		0.18	0.18
Respiratory System HI =	<0.01		<0.01

TABLE 9.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Industrial / Commercial Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	2.8E-08	--	2.4E-08	--	5.2E-08	NA	--	--	--	--
			Benzo[a]pyrene	3.2E-07	--	2.8E-07	--	6.0E-07	NA	--	--	--	--
			Benzo[b]fluoranthene	4.3E-08	--	3.7E-08	--	8.0E-08	NA	--	--	--	--
			Benzo[k]fluoranthene	3.7E-09	--	3.2E-09	--	6.9E-09	NA	--	--	--	--
			Chrysene	3.6E-10	--	3.1E-10	--	6.7E-10	NA	--	--	--	--
			Dibenz(a,h)anthracene	1.0E-07	--	8.8E-08	--	1.9E-07	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	1.4E-08	--	1.2E-08	--	2.5E-08	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	4.2E-06	--	8.3E-07	--	5.0E-06	Skin / CVS	0.03	--	<0.01	0.03
			Cobalt	--	--	--	--	--	CVS	0.02	--	<0.01	0.02
			Copper	--	--	--	--	--	GIS	<0.01	--	<0.01	<0.01
			Thallium	--	--	--	--	--	Liver / CVS / Skin	0.01	--	<0.01	0.01
			Vanadium	--	--	--	--	--	GIS / Kidney	<0.01	--	<0.01	<0.01
			Chemical Total	4.7E-06	--	1.3E-06	--	6.0E-06		0.08	--	<0.01	0.08
		Exposure Point Total						6.0E-06					0.08
	Exposure Medium Total							6.0E-06					0.08
	Air	Fugative Dust											
			Benzo[a]anthracene	--	5.5E-11	--	--	5.5E-11	NA	--	--	--	--
			Benzo[a]pyrene	--	3.3E-10	--	--	3.3E-10	NA	--	--	--	--
			Benzo[b]fluoranthene	--	7.3E-11	--	--	7.3E-11	NA	--	--	--	--
			Benzo[k]fluoranthene	--	3.0E-11	--	--	3.0E-11	NA	--	--	--	--
			Chrysene	--	4.7E-11	--	--	4.7E-11	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	4.8E-11	--	--	4.8E-11	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	6.2E-12	--	--	6.2E-12	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	2.1E-09	--	--	2.1E-09	NA	--	<0.01	--	<0.01
			Cobalt	--	3.7E-09	--	--	3.7E-09	RsS	--	<0.01	--	<0.01
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	6.3E-09	--	--	6.3E-09		--	<0.01	--	<0.01
		Exposure Point Total						6.3E-09					<0.01
	Exposure Medium Total							6.3E-09					<0.01
Soil Total								**6.01E-06**					**0.09**

TABLE 9.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Industrial / Commercial Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Industrial / Commercial Workers Total								**6.01E-06**					**0.09**

Total Risk Across Soil	6.0E-06
Total Risk Across All Media and All Exposure Routes	6.0E-06

Total Hazard Index Across Soil	0.09
oss All Media and All Exposure Routes	0.09

Notes:
<u>Target Organ Abbreviations:</u>
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		0.02	0.02
Cardiovascular System HI =		0.07	0.07
Skin HI =		0.05	0.05
Kidney HI =		<0.01	<0.01
Liver HI =		0.01	0.01
Respiratory System HI =	<0.01		<0.01

TABLE 9.7.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Soil											
			Benzo[a]anthracene	3.7E-09	--	1.4E-09	--	5.1E-09	NA	--	--	--	--
			Benzo[a]pyrene	4.3E-08	--	1.7E-08	--	5.9E-08	NA	--	--	--	--
			Benzo[b]fluoranthene	5.7E-09	--	2.2E-09	--	7.9E-09	NA	--	--	--	--
			Benzo[k]fluoranthene	4.9E-10	--	1.9E-10	--	6.8E-10	NA	--	--	--	--
			Chrysene	4.8E-11	--	1.9E-11	--	6.6E-11	NA	--	--	--	--
			Dibenz(a,h)anthracene	1.4E-08	--	5.3E-09	--	1.9E-08	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	1.8E-09	--	7.0E-10	--	2.5E-09	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	5.6E-07	--	5.0E-08	--	6.1E-07	Skin / CVS	0.09	--	<0.01	0.09
			Cobalt	--	--	--	--	--	CVS	0.07	--	<0.01	0.08
			Copper	--	--	--	--	--	GIS	0.02	--	<0.01	0.02
			Thallium	--	--	--	--	--	Liver / CVS / Skin	0.04	--	<0.01	0.05
			Vanadium	--	--	--	--	--	GIS / Kidney	0.03	--	<0.01	0.03
			Chemical Total	6.2E-07	--	7.7E-08	--	7.0E-07		0.25	--	0.01	0.26
		Exposure Point Total						7.0E-07					0.26
	Exposure Medium Total							7.0E-07					0.26
	Air	Fugative Dust											
			Benzo[a]anthracene	--	3.2E-11	--	--	3.2E-11	NA	--	--	--	--
			Benzo[a]pyrene	--	3.6E-10	--	--	3.6E-10	NA	--	--	--	--
			Benzo[b]fluoranthene	--	4.9E-11	--	--	4.9E-11	NA	--	--	--	--
			Benzo[k]fluoranthene	--	4.1E-11	--	--	4.1E-11	NA	--	--	--	--
			Chrysene	--	5.7E-12	--	--	5.7E-12	NA	--	--	--	--
			Dibenz(a,h)anthracene	--	1.2E-10	--	--	1.2E-10	NA	--	--	--	--
			Indeno[1,2,3-cd]pyrene	--	1.5E-11	--	--	1.5E-11	NA	--	--	--	--
			Diesel Range Organics	--	--	--	--	--	NA	--	--	--	--
			Gasoline Range Organics	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	8.6E-08	--	--	8.6E-08	NA	--	0.09	--	0.09
			Cobalt	--	1.5E-07	--	--	1.5E-07	RsS	--	0.20	--	0.20
			Copper	--	--	--	--	--	NA	--	--	--	--
			Thallium	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	2.4E-07	--	--	2.4E-07		--	0.29	--	0.29
		Exposure Point Total						2.4E-07					0.29
	Exposure Medium Total							2.4E-07					0.29
Soil Total								**9.39E-07**					**0.56**

TABLE 9.7.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FUELING PIERS AREA, SWMU 74 – FUEL PIPELINES AND HYDRANT PITS
PHASE II INVESTIGATION AND CMS REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Construction Workers Total								**9.39E-07**					**0.56**

Total Risk Across Soil	9.4E-07
Total Risk Across All Media and All Exposure Routes	9.4E-07
Total Hazard Index Across Soil	0.56
oss All Media and All Exposure Routes	0.56

Notes:
Target Organ Abbreviations:
CVS = Cardiovascular System
GIS = Gastrointestinal System
RsS = Respiratory System

	Inhalation	Oral/Dermal	Total
Gastrointestinal System HI =		0.05	0.05
Cardiovascular System HI =		0.22	0.22
Skin HI =		0.14	0.14
Kidney HI =		0.03	0.03
Liver HI =		0.05	0.05
Respiratory System HI =	0.20		0.20