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NAS WHITING FIELD  
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REMEDIAL INVESTIGATION REPORT SITE 2 NORTHWEST OPEN DISPOSAL AREA NAS  
WHITING FIELD FL  
12/1/1998  
HARDING LAWSON ASSOCIATES



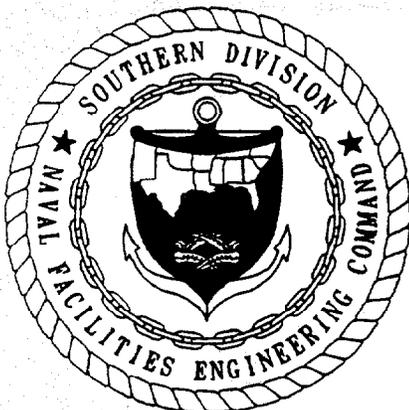
**REMEDIAL INVESTIGATION REPORT**

**SITE 2, NORTHWEST OPEN DISPOSAL AREA**

**NAVAL AIR STATION WHITING FIELD  
MILTON, FLORIDA**

**UNIT IDENTIFICATION CODE: N605508  
CONTRACT NO.: N62467-89-D-0317/116**

**DECEMBER 1998**



**SOUTHERN DIVISION  
NAVAL FACILITIES ENGINEERING COMMAND  
NORTH CHARLESTON, SOUTH CAROLINA  
29418**

1D 00240

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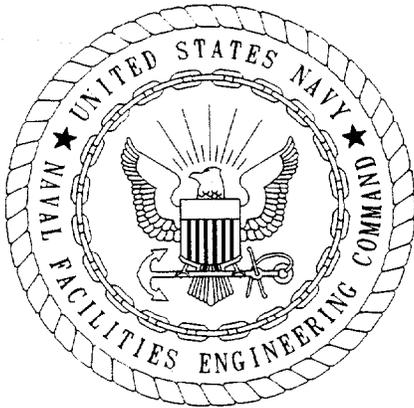
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**December 1998**



CERTIFICATION OF TECHNICAL  
DATA CONFORMITY (MAY 1987)

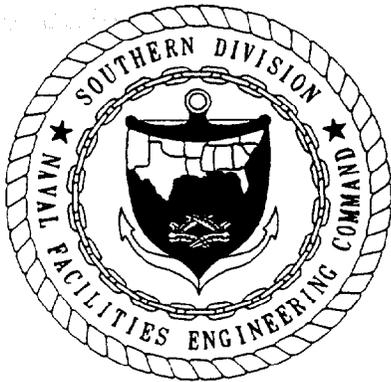
The Contractor, Harding Lawson Associates, hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0317/116 are complete and accurate and comply with all requirements of this contract.

DATE: December 21, 1998

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(DFAR 252.227-7036)



## FOREWORD

To meet its mission objectives, the U.S. Navy performs a variety of operations, some requiring the use, handling, storage, or disposal of hazardous materials. Through accidental spills and leaks and conventional methods of past disposal, hazardous materials may have entered the environment in ways unacceptable by today's standards. With growing knowledge of the long-term effects of hazardous materials on the environment, the Department of Defense initiated various programs to investigate and remediate conditions related to suspected past releases of hazardous materials at their facilities.

One of these programs is the Installation Restoration (IR) program. This program complies with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA), the Resource Conservation and Recovery Act and the Hazardous and Solid Waste Amendments of 1984. These acts establish the means to assess and clean up hazardous waste sites for both private-sector and Federal facilities. The CERCLA and SARA acts form the basis for what is commonly known as the Superfund program.

Originally, the Navy's part of this program was called the Naval Assessment and Control of Installation Pollutants (NACIP) program. Early reports reflect the NACIP process and terminology. The Navy eventually adopted the program structure and terminology of the standard IR program.

The IR program is conducted in several stages as follows:

- preliminary assessment (PA)
- site inspection (SI) (formerly the PA and SI steps were called the initial assessment study under the NACIP program),
- remedial investigation and feasibility study and
- remedial design and remedial action.

The Southern Division, Naval Facilities Engineering Command manages and the U.S. Environmental Protection Agency and the Florida Department of Environmental Protection (formerly Florida Department of Environmental Regulation) oversee the Navy environmental program at Naval Air Station (NAS) Whiting Field. All aspects of the program are conducted in compliance with State and Federal regulations, as ensured by the participation of these regulatory agencies.

Questions regarding the CERCLA program at NAS Whiting Field should be addressed to Ms. Linda Martin, Code 1859, at (843) 820-5574.

## EXECUTIVE SUMMARY

A remedial investigation (RI) and feasibility study is being conducted at Naval Air Station (NAS) Whiting Field in Milton, Florida, by Southern Division, Naval Facilities Engineering Command as part of the Department of Defense Installation Restoration (IR) program. The IR program was designed to identify and abate or control contaminant migration resulting from past operations at naval installations.

A phased approach was implemented to conduct the RI. Phase I was completed in May 1992. The subsequent phases of the RI were designated as Phase IIA and Phase IIB. Fieldwork for Phase IIA was completed in March 1994. RI Phase IIB was completed in November 1996.

This RI report contains the results of assessment activities used to characterize site-specific chemicals detected in environmental media (soil and groundwater) at Site 2, Northwest Open Disposal Area at NAS Whiting Field. Data obtained from these activities were used to evaluate the nature and extent of contamination at the site and support feasibility studies (if required) and baseline risk assessments. Human health and ecological baseline risk assessments are included with the RI report.

The fieldwork conducted during the RI included the following tasks:

- surface soil sampling,
- subsurface soil sampling,
- monitoring well installation,
- groundwater sampling, and
- hydrogeologic investigations.

Soil and groundwater samples were analyzed for target compound list organic analytes, and target analyte list inorganic analytes.

The following conclusions are based on results of the RI investigation activities at Site 2, Northwest Open Disposal Area, NAS Whiting Field.

- One volatile organic compound (VOC) (chloroform) and one semivolatile organic compound (SVOC) (bis(2-ethylhexyl)phthalate) were detected in surface soil samples collected at the site. Four pesticide compounds (dieldrin, 4,4'-dichlorodiphenyltrichloroethane [DDT], alpha-chlordane, and gamma-chlordane) were also detected in surface soil samples collected at the site. Nineteen inorganic analytes were detected in the surface soil samples. Nine of the inorganic analytes exceeded the site-specific background screening values. None of the analytes detected in surface soil samples exceeded the industrial-use values of the USEPA Region III RBCs or Chapter 62-785, Florida Administrative Code (FAC), soil cleanup target levels (SCTLs). Four analytes (aluminum, arsenic, iron, and manganese) detected in surface soil samples exceeded the residential values for either the USEPA Region III RBCs or the Chapter 62-785, FAC, SCTLs.

- No VOCs were detected in subsurface soil samples collected during the site assessment. Two SVOCs (2-methylnaphthalene and phenanthrene) and three pesticide compounds (dieldrin, alpha-chlordane, and gamma-chlordane) were detected in subsurface soil samples. One polychlorinated biphenyl (PCB) compound (Aroclor-1260) was detected in two subsurface soil samples. Seventeen inorganic analytes were detected in the subsurface soil samples. Four inorganic analytes (calcium, manganese, potassium, and sodium) exceeded the background screening values. The analytes and compounds detected in subsurface soil samples did not exceed industrial-use or leachability values of the Chapter 62-785, FAC, SCTLs, or USEPA Region III RBCs for industrial sites.
- The groundwater flow direction is to the south and likely discharges at Clear Creek, located approximately 4,000 feet southwest of the site.
- The pH values of groundwater samples collected from monitoring wells were below the lower range for Federal and State Secondary maximum contaminant levels (MCLs); however, these values were within the range observed in facility-specific background groundwater samples collected at NAS Whiting Field (ABB Environmental Services, Inc., 1998).
- Groundwater samples collected from onsite monitoring wells contained one VOC (carbon disulfide) and one SVOC (bis(2-ethylhexyl)phthalate) at concentrations less than FDEP guidance concentrations. No pesticide or PCB compounds were detected in groundwater samples.
- Two inorganic analytes, aluminum and iron, were detected at concentrations exceeding Federal MCLs and Chapter 62-785, FAC, Groundwater Cleanup Target Levels in the monitoring well groundwater samples collected by low-flow methods.
- The Human Health Risk Assessment determined carcinogenic risks associated with groundwater did not exceed the FDEP target level ( $1 \times 10^{-6}$ ) for a current or hypothetical future resident at the site.
- The total excess lifetime cancer risk associated with surface soil for a potential future resident ( $2 \times 10^{-5}$ ), current and future trespassers ( $2 \times 10^{-6}$ ), and occupational worker ( $3 \times 10^{-6}$ ) exceeded Florida's target risk ( $1 \times 10^{-6}$ ) due to arsenic. However, it is likely the natural background concentrations of arsenic contributes to exceeding the FDEP target level. It could not be determined whether or not arsenic concentrations were related to the disposal of waste at Site 2.
- The Ecological Risk Assessment determined exposures to Site 2 surface soil are unlikely to result in adverse effects to wildlife receptors because all maximum exposure point concentrations were well below toxicity values.
- The maximum exposure point concentration for vanadium exceeded its phytotoxicity benchmark; however except for one sample, vanadium

concentrations detected in surface soil were within the range found in background surface soil collected from NAS Whiting Field. Additionally, stressed vegetation was not apparent in plants at the site; therefore, risks to terrestrial plants are not predicted.

- Chloroform and arsenic are chemicals of potential concern (CPCs) identified in the risk assessments that are soluble and may be transported in groundwater. Leaching of chemicals to groundwater is the most likely mechanism of transport from Site 2; however, none of the compounds detected in subsurface soil samples exceeded the Chapter 62-785, FAC, leachability SCTLs.
- Based on a 21-year site history and an evaluation of hydrogeologic data, a potential migration distance for CPCs is estimated to be approximately 930 feet; however, there is no evidence that any chemical is migrating from the site.

Based on the interpretation of findings from the remedial investigation activities, a focused feasibility study is proposed for soil at Site 2, Northwest Open Disposal Area. A comprehensive basewide groundwater investigation that will characterize the Site 2 groundwater is currently being conducted at NAS Whiting Field. The results of the NAS Whiting Field basewide groundwater investigation will be reported in the Site 40 Remedial Investigation Report.

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## GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
ARAR	applicable or relevant and appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	bioaccumulation factor
BAT	Bengt-Arne-Torstensson
BEHP	bis(2-ethylhexyl)phthalate
bls	below land surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm/sec	centimeters per second
CPC	chemical of potential concern
CRC	Chemical Rubber Company
CRDL	contract-required detection limit
°C	degrees Celsius
°F	degrees Fahrenheit
%D	percent Difference
DDT	dichlorodiphenyltrichloroethane
DQO	data quality objective
ECPC	ecological contaminant of potential concern
Eh	Redox Potential
ELCR	excess lifetime cancer risk
EPC	exposure point concentration
ERA	Ecological Risk Assessment
FAC	Florida Administrative Code
FDEP	Federal Department of Environmental Protection (as of 7/93)
FS	feasibility study
ft/day	feet per day
ft/ft	feet per foot
ft/yr	feet per year
GIR	General Information Report
HASP	Health and Safety Plan
HHCP	human health chemical of potential concern
HHRA	Human Health Risk Assessment
HI	hazard index
HLA	Harding Lawson Associates
HQ	hazard quotient
HRS	Hazard Ranking System
IAS	Initial Assessment Study
ICV	initial calibration verification
IDL	instrument detection limit
IR	Installation Restoration

## GLOSSARY (Continued)

LD <sub>50</sub>	lethal dose to 50 percent of test population
LDC	Laboratory Data Consultants, Inc.
LOAEL	lowest observed adverse effects level
MCL	maximum contaminant level
μg/kg	micrograms per kilogram
μg/l	microgram per liter
μmhos/cm	micromhos per centimeter
mg/kg	milligrams per kilogram
MS/MSD	matrix spike and matrix spike duplicate
NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NFA	no further action
NOAA	National Oceanographic and Atmospheric Administration
NOAEL	no observable adverse effect level
NPL	National Priority List
NTU	nephelometric turbidity unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PCPT	piezocone penetrometer test
PDE	potential dietary exposure
PVC	polyvinyl chloride
QA/QC	quality assurance and quality control
QAPP	Quality Assurance Program Plan
RBC	risk-based concentration
RGO	remedial goal option
RI/FS	remedial investigation and feasibility study
RME	reasonable maximum exposure
RPD	relative percent difference
RRF	relative response factor
%RSD	percent Relative Standard Deviation
SARA	Superfund Amendments and Reauthorization Act
SCTL	soil cleanup target level
SDG	sample delivery group
SFF	site foraging frequency
SI	Site Inspection
SOUTHNAV- FACENCOM	Southern Division, Naval Facilities Engineering Command
SQL	sample quantitation limit
SU	standard unit
SVOC	semivolatile organic compound

GLOSSARY (Continued)

TAL	target analyte list
TCL	target compound list
TRV	toxicity reference value
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

## 1.0 INTRODUCTION

Harding Lawson Associates (HLA) (formerly ABB Environmental Services, Inc. [ABB-ES]), under contract to the Department of Navy, Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) is submitting the Remedial Investigation (RI) Report for Site 2, Northwest Open Disposal Area at Naval Air Station (NAS) Whiting Field located in Milton, Florida. The RI Report for Site 2, is one in a series of site-specific reports being completed in conjunction with the NAS Whiting Field General Information Report (GIR) (HLA, 1998) to summarize the previous investigations and to present the results of the RI.

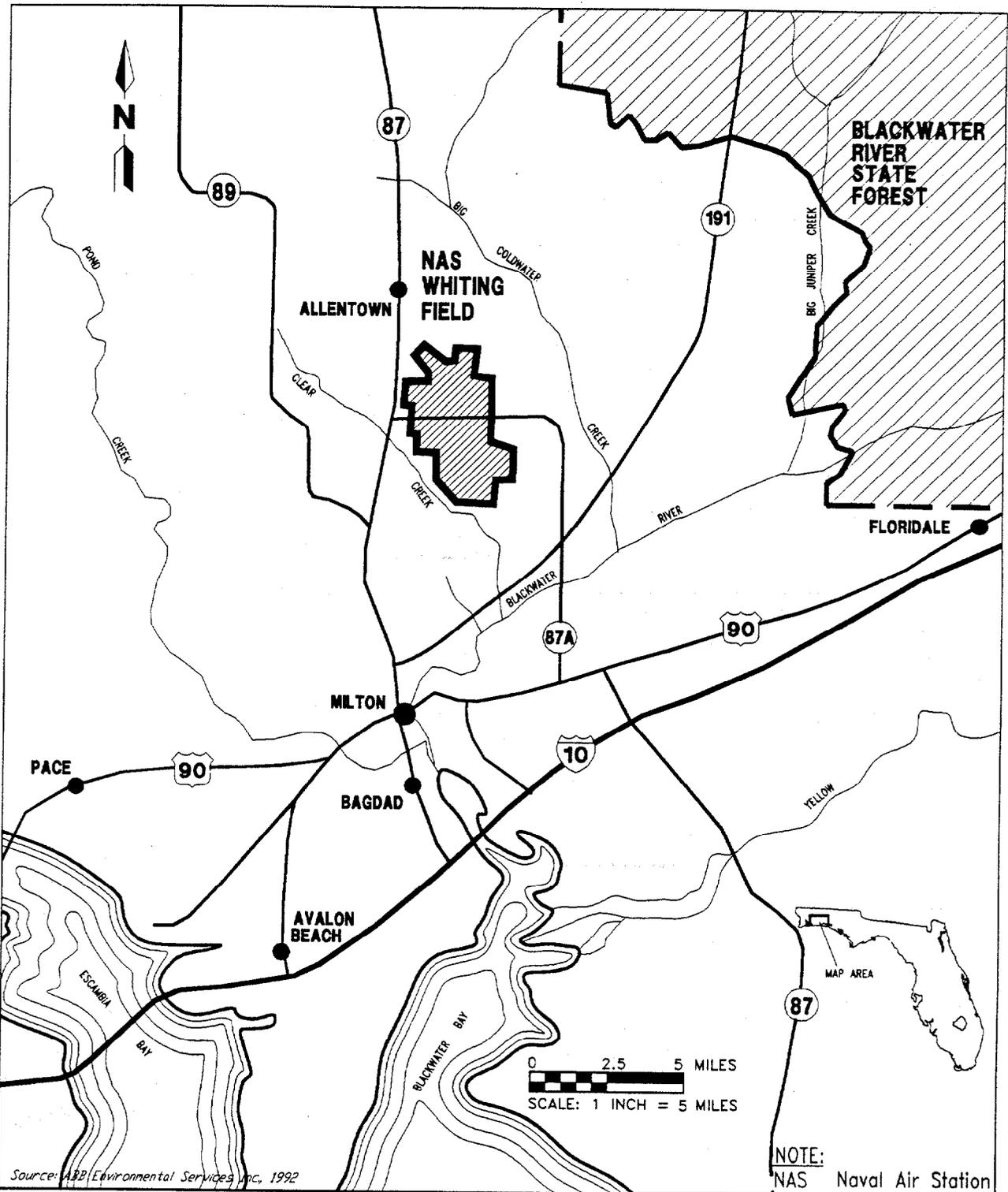
The Remedial Investigation and Feasibility Study (RI/FS) is being conducted on behalf of the Navy at NAS Whiting Field under contract No. N62467-89-D-0317. The RI was conducted in three phases. The Phase I RI field program was completed in May 1992. The Phase IIA RI field program was conducted between May 1992 and March 1994. The Phase IIB RI field program was completed in November 1996.

Installation Location and Description. NAS Whiting Field is located in Santa Rosa County, in Florida's northwest coastal area, approximately 5.5 miles north of Milton and 25 miles northeast of Pensacola (Figure 1-1). NAS Whiting Field presently consists of two air fields separated by an industrial area. The entire installation is approximately 3,842 acres. Figure 1-2 presents the installation layout and locations of RI/FS sites at NAS Whiting Field. A complete description of historic operations at the facility is presented in Section 1.3 and Appendix A of the NAS Whiting Field GIR (HLA, 1998).

1.1 PURPOSE OF THE REMEDIAL INVESTIGATION AND FEASIBILITY STUDY. The purpose of the NAS Whiting Field RI is to identify and characterize the nature and extent of chemicals in environmental media and potential risks to human and ecological receptors that might be posed by toxic or hazardous chemicals present on site. The chemicals were potentially released to the environment during past waste disposal practices or spills. The data collected during the RI field program will also be used in a feasibility study (FS) (if necessary) to screen, evaluate, and select remedial alternatives to provide permanent, feasible solutions to environmental impacts that may be a result of past waste disposal practices or spills.

1.2 SITE DESCRIPTION. Site 2, an old borrow pit, is a 12-acre parcel located along the northwestern facility boundary near the North Air Field (Figure 1-2). Currently, the site is a surface depression, and bottom elevation is approximately 20 feet below the surrounding land surface, at its lowest point. All surface drainage at the site is internal because of the steep side slopes of the borrow pit. Surface drainage within the borrow pit is down the partially vegetated side slopes to low areas near the middle of the pit where infiltration into the soil occurs.

Access to the site is by a gate, located in the southwest corner of the site, from perimeter road. The site contains wood debris, pallets, asphalt rubble piles, sheet metal, tires, furniture, and crushed paint cans. Buried wastes are not exposed at the land surface in erosional areas, nor are there indications (e.g., stained soil or stressed vegetation) of other past waste disposal prac-



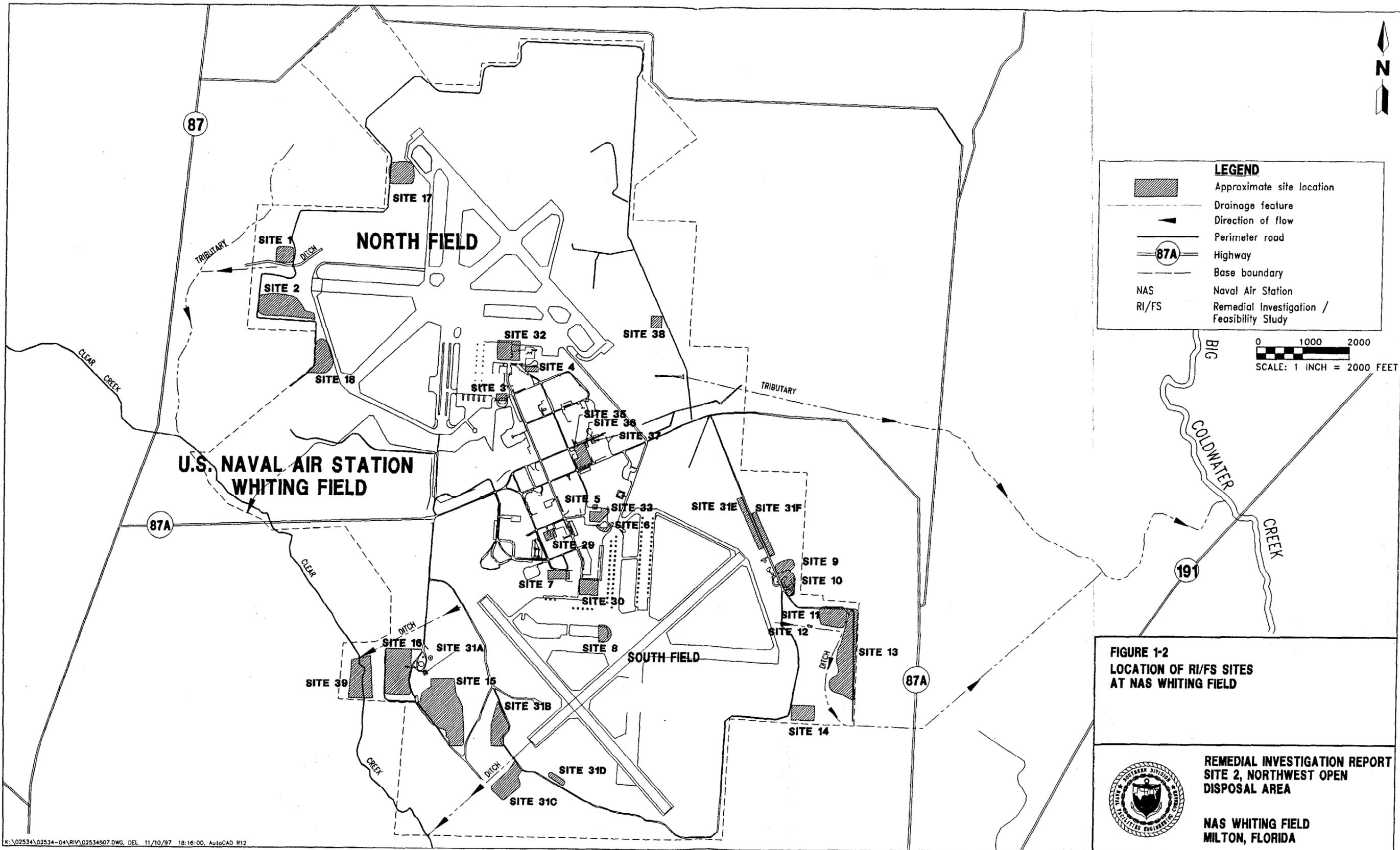
**FIGURE 1-1  
FACILITY LOCATION MAP**



**REMEDIAL INVESTIGATION REPORT  
SITE 2, NORTHWEST OPEN  
DISPOSAL AREA**

**NAS WHITING FIELD  
MILTON, FLORIDA**

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tices. The perimeter area of the site is currently forested with pine trees, approximately 25 to 40 feet in height.

According to the U.S. Department of Agriculture (USDA), the soil at Site 2 is classified as Troup Loamy Sand and Lakeland Sand (USDA, 1980). Because the soil at the site is predominantly silty sand, the onsite rainfall infiltrates directly into the soil.

**1.3 REGULATORY SETTING.** The Navy Installation Restoration (IR) program was designed to identify and abate or control contaminant migration resulting from past operations at naval installations. The IR program is the Navy response authority under Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and Executive Order 12580. SOUTHNAVFACENCOM is the agency responsible for the Navy IR program in the southeastern United States. Therefore, SOUTHNAVFACENCOM has the responsibility to process NAS Whiting Field through preliminary assessment, site inspection (SI), RI/FS, and remedial response selection in compliance with the guidelines of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] 300) (USEPA, 1990).

Section 105(a)(8)(A) of SARA requires the U.S. Environmental Protection Agency (USEPA) to develop criteria to set priorities for remedial action for chemicals detected in environmental media based on relative risk to human health and the environment. To meet this requirement, USEPA has established the Hazard Ranking System (HRS) as Appendix A to the NCP. First promulgated in 1982, the HRS was amended in December 1990, effective March 14, 1991 (55 Federal Register No. 241:51532-51667), to comply with requirements of Section 105(c)(1) of SARA to increase the accuracy of the assessment of relative risk. The HRS (March 1991) has been substantially revised and is designed to prioritize sites after the SI phase of the CERCLA process.

The HRS score for NAS Whiting Field was generated in 1993. The score was sufficient to place NAS Whiting Field on the National Priority List (NPL).

In January 1994, the USEPA placed NAS Whiting Field on a proposed list of sites to be included on the NPL (40 CFR 300, Federal Register, 18 January 1994), and on May 31, 1994, NAS Whiting Field was placed on the NPL effective June 30, 1994 (40 CFR 300, Federal Register, May 31, 1994). As a result, the RI/FS for NAS Whiting Field must follow the requirements of the NCP, as amended by SARA, and regulatory guidance for conducting RI/FS programs under CERCLA.

**1.4 REPORT ORGANIZATION.** The RI Report is organized into ten chapters (Chapters 1.0 to 10.0). Chapter 1.0 presents the purpose, site description, and regulatory setting for the RI at NAS Whiting Field. Chapter 2.0 summarizes previous investigations. Chapter 3.0 presents the investigative methodology for conducting the assessment. Chapter 4.0 presents the site-specific data quality assessment. Chapter 5.0 discusses the investigative results of the assessment. Chapter 6.0 presents the Human Health Risk Assessment, and Chapter 7.0 presents the Ecological Risk Assessment. Chapter 8.0 discusses the fate and transport of chemicals determined to be human and/or ecological chemicals of potential concern (COCs). Chapter 9.0 provides a summary of the conclusions and recommendations. Chapter 10.0 presents professional review certification.

## 2.0 PREVIOUS INVESTIGATIONS

This chapter summarizes the previous investigations at Site 2, Northwest Open Disposal Area at NAS Whiting Field.

2.1 INITIAL ASSESSMENT STUDY. Background information was gathered for the Initial Assessment Study (IAS) (Envirodyne Engineers, Inc., 1985) by conducting a record search, performing an onsite survey, and conducting interviews with long-time employees and retired personnel familiar with the site.

The IAS determined that between 1976 and 1984, the site was used as an open disposal area primarily for construction and demolition debris. Wastes disposed of at the site include asphalt, wood, tires, furniture, and similar materials that were not suitable for landfill disposal. Crushed paint cans and scrap metal parts have been scattered throughout the site (Envirodyne Engineers, Inc., 1985).

Site 2 was not recommended for additional investigation during the IAS due to the nonhazardous nature of the wastes reportedly disposed of there and subsequently was not investigated during the verification study (Envirodyne Engineers, Inc., 1985).

2.2 REMEDIAL INVESTIGATIONS. The RI Phase I investigation at Site 2 consisted of collecting a groundwater sample using a piezocone penetrometer test (PCPT) and Bengt-Arne-Torstensson (BAT) sampler. Site 2 was proposed by the Navy for no further action (NFA) at the end of the RI Phase I sampling and analyses program (ABB-ES, 1992c).

In 1992, the regulatory agencies Florida Department of Environmental Protection (FDEP) and USEPA requested additional sampling and analyses be conducted at Sites 2 during RI Phase IIA investigation before an NFA decision could be considered. On November 13, 1992, a Remedial Project Managers meeting was held with representatives from the USEPA, Navy, FDEP, National Oceanic and Atmospheric Administration, and HLA. The USEPA recommended one hydraulically downgradient monitoring well and one soil boring be drilled within the borrow pit and samples be collected for target compound list (TCL) organic and target analyte list (TAL) inorganic analysis. A consensus was reached that if these explorations were conducted and no contamination was detected, an NFA decision document could be prepared.

Site 2 was subsequently studied during Phases IIA and IIB of the RI. The field investigative methodology for the RI is presented in Section 3.0 of this report.

### 3.0 FIELD INVESTIGATIVE METHODS

Field investigative techniques used during the RI to collect the data are described in the RI/FS workplan, Volume II (E.C. Jordan, 1990), which provides descriptions of sampling methods, field personnel responsibilities, sample management, chain of custody, project documentation, change in field methods, protocols on corrective actions, decontamination procedures, waste management handling, and other general project standards and procedures in Section 3.1, General Site Operations.

Field and laboratory quality assurance and quality control (QA/QC) requirements for the RI activities comply with the RI/FS Quality Assurance Project Plan (QAPP) located in Appendix A of the RI/FS workplan, Volume II (E.C. Jordan, 1990). Health and safety requirements were in accordance with the general Health and Safety Plan located in Volume III, RI/FS Planning Document, NAS Whiting Field, Milton, Florida (E.C. Jordan, 1990).

Field investigative methods not covered in the documents identified above are described in Technical Memorandum No. 7, RI Phase IIB workplan (ABB-ES, 1995d) and in the NAS Whiting Field GIR (HLA, 1998).

These field and laboratory investigation techniques are in general conformance with USEPA standard operating procedure (USEPA, 1991a and 1996a) and were followed during the RI sampling and analysis program.

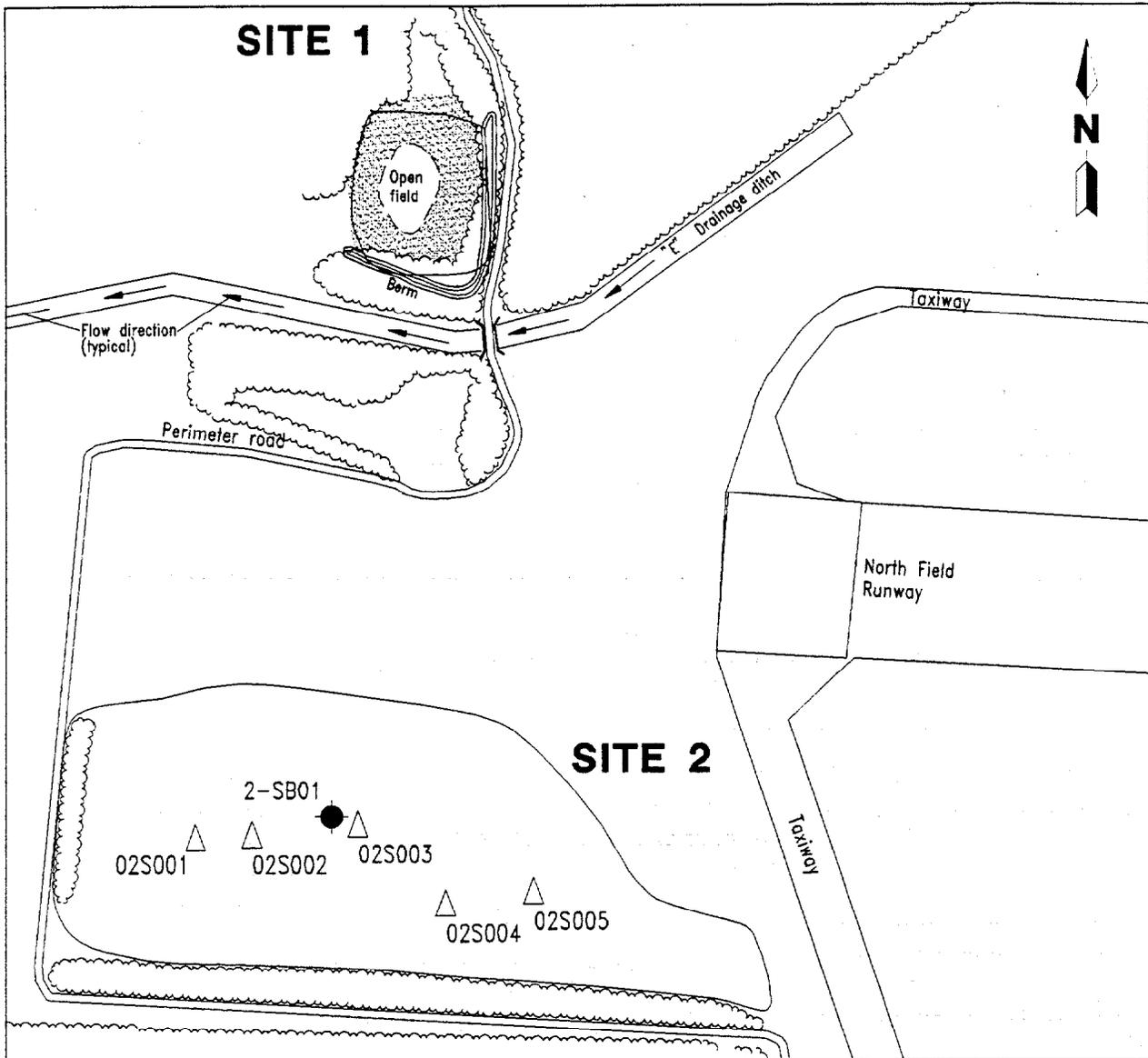
The RI Phase I investigation (ABB-ES, 1992c) at Site 2 consisted of collecting a groundwater sample using a PCPT and BAT sampler. The Phase IIA investigation included collection of one surface soil sample and six subsurface soil samples from a soil boring, installation of one monitoring well, and collection of a groundwater sample. The Phase IIB investigation included collection of five surface soil samples, installation of two monitoring wells, and collection of three groundwater samples. The samples were analyzed for TCL volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs) and TAL inorganic analytes.

The following provides a brief description of the number and types of environmental samples and the analytical methodology for the RI for Site 2, Northwest Open Disposal Area.

3.1 SURFACE SOIL ASSESSMENT. The surface soil assessment included the collection of one surface soil sample during Phase IIA and five surface soil samples during Phase IIB of the RI.

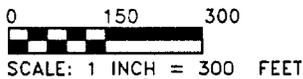
The Phase IIA soil sample, designated 2-SB01(0-2), was collected from the interval between land surface to a depth of 2 feet below land surface (bls) in July 1993 at the location of soil boring 2-SB01 (see Figure 3-1).

The five Phase IIB surface soil samples were collected in December 1995 at locations (designated 02S001 through 02S005, respectively) shown on Figure 3-1. In addition to providing unbiased sampling locations, these samples also support the ecological (potential exposure to terrestrial wildlife) and human health risk



**LEGEND**

- 2-SB01 ● Phase IIA soil boring location and designation
- 02S001 △ Phase IIB surface soil sampling location and designation
- [Stippled Area] Area of planted pine trees
- [Wavy Line] Older tree line
- [Dashed Line] Approximate site boundary
- RI Remedial Investigation
- NAS Naval Air Station



**FIGURE 3-1**  
**SITE 2, LOCATION OF**  
**SOIL BORING AND**  
**SURFACE SOIL SAMPLES**



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assessments (exposure of transient persons to site soil). Locations were determined using the systematic sampling method where a point is chosen at random along a transect, and then samples are collected at equidistant intervals (Gilbert, 1987; USEPA, 1989a).

The Phase IIB surface soil samples were collected from the land surface to a maximum depth of 12 inches bls using a decontaminated stainless-steel auger. Soil samples were described using the Unified Soil Classification System and recorded in a bound field logbook by HLA personnel.

The surface soil samples were analyzed for Contract Laboratory Program (CLP) (Naval Energy and Environmental Support Activity [NEESA] Level D) TCL VOCs, SVOCs, pesticides and PCBs, and TAL inorganic analytes.

Three of the five Phase IIB surface soil samples were also analyzed to determine physical characteristics. The samples were analyzed for the following physical parameters: dry bulk density, sieve analysis, hydrometer analysis, Atterberg limits, and permeability.

Background screening criteria were established by collecting background samples across the installation from each USDA soil type identified at NAS Whiting Field. These data are presented in Subsection 3.3.1 of the GIR (HLA, 1998). The arithmetic mean of analytes detected in the background soil samples was calculated by summing individual analyte concentrations and then dividing the sum by the number of samples from which the analytes were detected. Surface soil sample analytical results were compared to twice the arithmetic mean of analyte concentrations detected in background surface soil samples associated with the Troup Loamy Sand and Lakeland Sand soil types. The statistical summary for the combined surface soil type background data and the surface soil sampling results are discussed in Section 5.3 of this report. Soil sample analytical data are presented in Appendix A of this report.

**3.2 SUBSURFACE SOIL ASSESSMENT.** The RI subsurface investigation at Site 2 included a PCPT investigation, split-spoon sampling conducted during a soil boring, and split-spoon sampling conducted during monitoring well installations.

Detailed lithologic descriptions for all monitoring wells and PCPT soundings are presented in Phase I Technical Memorandum No. 1, Geologic Assessment (ABB-ES, 1992a) and in Phase IIA Technical Memorandum No. 2, Geologic Assessment (ABB-ES, 1995a). A summary of the Site 2 lithology including descriptions from Phase IIB is also presented in Section 5.1 of this report.

Subsurface soil samples from Site 2 were compared to USEPA Region III Risk-Based Concentrations (RBCs), the Chapter 62-785, Florida Administrative Code (FAC), Soil Cleanup Target Levels (SCTLs) for residential and industrial scenarios, and a background subsurface soil data set for Whiting Field, which is presented in Subsection 3.3.1 of the GIR (HLA, 1998). Table 3-18 in the GIR presents a statistical summary of the background subsurface soil data at NAS Whiting Field (HLA, 1998).

**3.2.1 Piezocone Penetrometer Investigation** One PCPT exploration (WHF-2-CPT-1) was performed at Site 2 in April 1991. The PCPT exploration was completed to a total depth of 99 feet bls. The PCPT exploration consisted of a stainless-steel

cone tip (equipped with electronic sensors and connected to stainless-steel rods) that was hydraulically pressed into the overburden soils. Measurements of end-bearing resistance, friction resistance, and pore pressure were recorded from the sensors throughout the sounding. The analog signals from the cone tip sensors were digitized for data logging, and analyses of the digital data were completed in the field using a data acquisition software system. Based on the cone readings, a lithologic description of the soils was computed with the aid of the software package.

The cone tip was advanced until the friction resistance of the overburden soils exceeded the power of the hydraulic system (refusal); the exploration was then terminated. The primary purpose of extending the boring explorations was to collect *in situ* groundwater samples using the BAT screening technique. The BAT *in situ* groundwater sampling technique was described in Phase I Technical Memorandum No. 5, Groundwater Assessment (ABB-ES, 1995c). A summary of the sounding designations, completion dates, proposed and actual depths, and the lithologic descriptions for the sounds are presented in Phase IIA Technical Memorandum No. 2, Geologic Assessment (ABB-ES, 1995a).

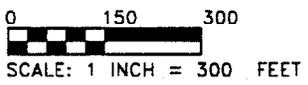
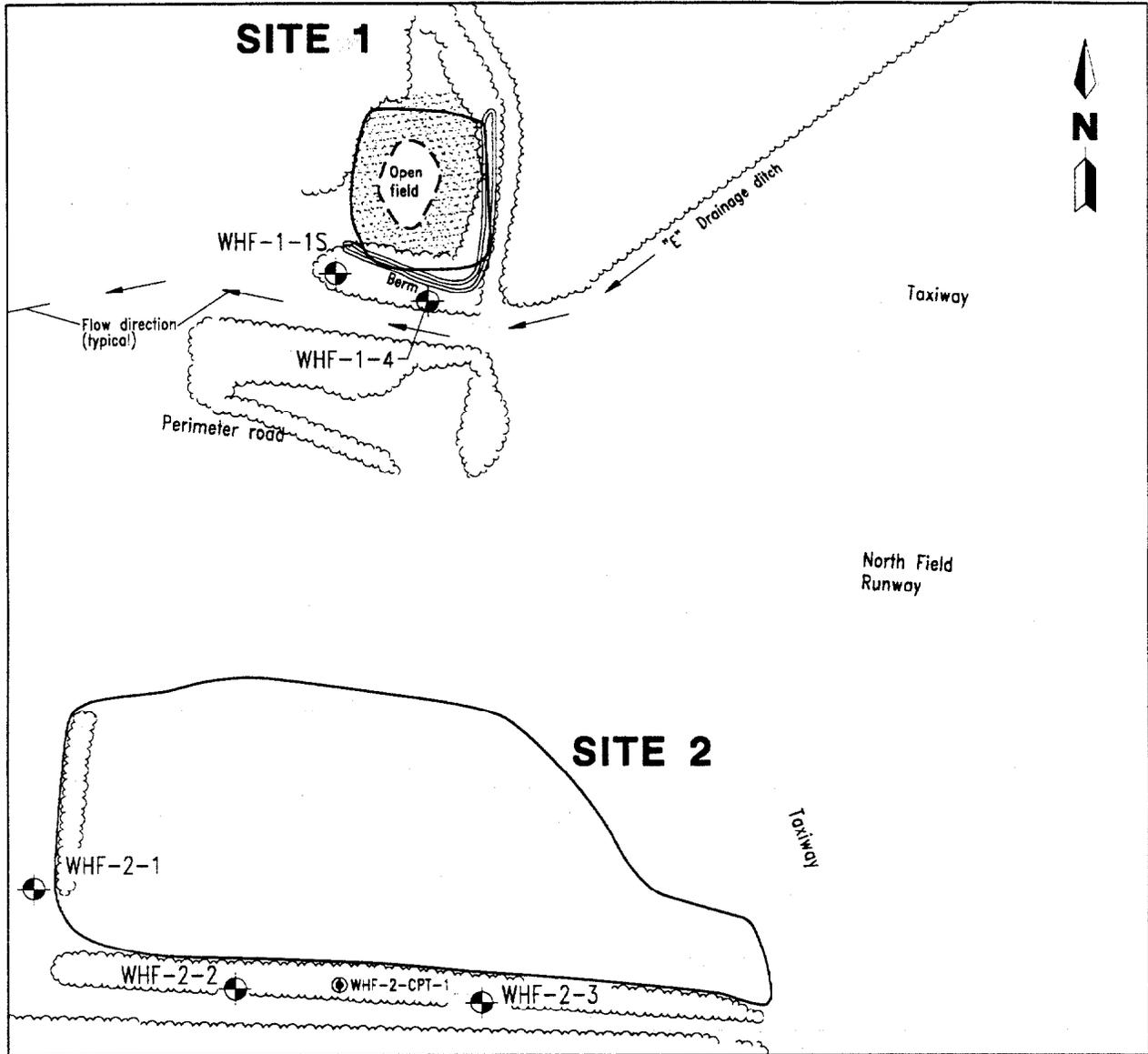
**3.2.2 Split Spoon Sampling** Six subsurface soil samples (2SB01A to 2SB01F) were collected at Site 2 on July 30 and 31, 1993. The samples were collected from selected intervals (5 to 7, 10 to 12, 15 to 17, 20 to 22, 50 to 52, and 65 to 70) ranging from 5 to 70 feet bls in soil boring 2-SB01 located within the depression area of Site 2 (see Figure 3-1).

Subsurface soil samples were compared to the subsurface soil background sample concentrations to assess whether or not analyte concentrations exceeded naturally occurring concentrations. Subsurface soil background concentrations are presented in Table 3-18 of the GIR (HLA, 1998). Sampling results are discussed in Section 5.4 of this report. Sampling methodology was followed as presented in Paragraph 2.1.3.5 of the GIR (HLA, 1998).

Lithologic data were also obtained by collecting subsurface soil samples at monitoring well locations (see Figure 3-2). A 2-foot split-spoon sample was collected for visual inspection by an HLA geologist. All data were entered into a bound logbook. Detailed soil descriptions and other pertinent data are presented in the boring logs for the soil boring investigation located in Phase IIA Technical Memorandum No. 2, Geologic Assessment (ABB-ES, 1995a) and in Section 5.1 of this report. Split-spoon samples were generally collected at 5-foot intervals during drilling of the monitoring wells. Monitoring well installations were conducted in conjunction with the hydrogeologic and groundwater investigations, which are summarized in Phase IIA Technical Memoranda 4 and 5, respectively (ABB-ES, 1995b and 1995c).

**3.3 GROUNDWATER ASSESSMENT.** Groundwater assessment activities included collecting a groundwater sample with a BAT sampler during Phase I and collecting groundwater samples from monitoring wells installed in Phases IIA and IIB.

During the Phase I investigation, a groundwater sample (WHF-02-WP-01-01) was collected at sampling location WHF-2-CPT-1 (Figure 3-2) using the BAT sampling technique. The BAT groundwater sampling program was conducted in April 1991 in conjunction with the PCPT subsurface exploration to confirm the potential for



LEGEND	
WHF-2-CPT-1	Approximate RI Phase I BAT sample location and designation
WHF-2-1	Monitoring well location and designation
	Area of planted pine trees
	Older tree line
	Approximate site boundary
BAT	Bengt-Arne-Torstensson
RI	Remedial Investigation
NAS	Naval Air Station

**FIGURE 3-2**  
**SITE 2, LOCATION OF**  
**BAT SAMPLE AND**  
**MONITORING WELLS**



**REMEDIAL INVESTIGATION REPORT**  
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**DISPOSAL AREA**

**NAS WHITING FIELD**  
**MILTON, FLORIDA**

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contamination of groundwater hydraulically downgradient from the site. Based on subsurface exploration data (lithology and pore pressure) collected from the PCPT soundings, the depth of the *in situ* BAT groundwater sample was determined. The groundwater sample was analyzed for TCL VOCs and TAL metals. The analytical results are presented in Subsection 5.5.1 of this report.

One groundwater monitoring well (WHF-2-1; Figure 3-2) was installed in 1993 during the Phase IIA investigation. Groundwater samples, WHF-2-1 and WHF-2-1A (a duplicate sample), were collected during Phase IIA from this monitoring well. Groundwater samples were collected from monitoring well WHF-2-1 and two additional monitoring wells (WHF-2-2 and WHF-2-3) installed in 1996 during Phase IIB. The monitoring well locations are presented on Figure 3-2, and the groundwater analytical data are discussed in Subsection 5.5.2. The groundwater analytical data are presented in Appendix B of this report.

During Phase IIA, the groundwater samples were collected from the monitoring well using a Teflon™ bailer after purging the monitoring wells with a submersible or bladder pump. Purging and sampling methodology was followed as presented in Paragraph 2.1.7.2 of the GIR (HLA, 1998). The groundwater samples were analyzed for CLP (NEESA Level C) TCL VOCs, SVOCs, pesticides and PCBs, and TAL inorganics.

During Phase IIB of the RI, groundwater samples were collected from the three monitoring wells installed at Site 2 on July 23 and 24, 1996, using low-flow sampling techniques. Purging and sampling methodology was followed as presented in Paragraph 2.1.7.2 of the GIR (HLA, 1998). The groundwater samples were analyzed for CLP (NEESA Level D) TCL VOCs, SVOCs, pesticides and PCBs, and TAL inorganics. Samples for TAL inorganics were unfiltered (total analysis) if turbidity was below 10 nephelometric turbidity units (NTUs). If turbidity was greater than 10 NTU, an additional groundwater sample was collected and filtered (dissolved-phase inorganics) using a 45-micron filter. The purpose of the additional groundwater sample was to assess uncertainty associated with a turbid unfiltered groundwater sample.

Analyses were also conducted to assess secondary water quality parameters and provide data for assessing remedial alternatives in the FS. The analyses included alkalinity, chloride, sulfates, hardness, ammonia nitrates, total Kjeldahl nitrogen, nitrate and nitrite, pH, phosphorous, total dissolved solids, and total organic carbon. Water quality parameter data are presented in Subsection 5.5.2 of this report.

**3.4 HYDROGEOLOGIC ASSESSMENT.** The hydrogeologic assessment of Site 2 also included three adjacent sites during the RI field program. The area investigated included Site 1 (Northwest Disposal Area), Site 2 (Northwest Open Disposal Area), and Sites 17 and 18 (Crash Crew Training Areas). The hydrogeologic field investigation activities included the collection of water-level data from 13 monitoring wells and conducting slug test analyses on 4 monitoring wells. Results of the Phase IIA hydrogeological assessment are presented in Phase IIA Technical Memorandum No. 4, Hydrogeologic Assessment (ABB-ES, 1995b). Monitoring well construction details are presented in Table 3-1. Results of the hydrogeologic assessment are also presented in Section 5.2 of this report.

**Table 3-1  
Summary of Monitoring Well Construction Details**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Monitoring Well Designation	RI Phase of Well Completion	Well Size (inches)	Land Surface Elevation (feet msl)	TOC Elevation (feet msl)	Total Well Depth (feet BTOC)	Approximate Screen Interval (feet BTOC)	Surface Casing Length (feet bls)
<b>Northwest Disposal and Crash Crew Training Areas</b>							
<b>Site 1, Northwest Disposal Area</b>							
WHF-1-1	VS	4	140.49	142.62	123.00	113 to 123	NA
WHF-1-1S	IIA	2	140.54	143.08	75.40	60 to 75	NA
WHF-1-2	IIA	2	142.59	145.61	78.80	63 to 78	NA
WHF-1-3	IIA	2	152.95	155.50	87.48	72 to 87	NA
WHF-1-4	IIB	2	--	151.86	80.39	70 to 80	NA
<b>Site 2, Northwest Open Disposal Area</b>							
WHF-2-1	IIA	2	148.48	150.80	87.42	72 to 87	NA
WHF-2-2	IIB	2	--	159.16	94.00	84 to 94	NA
WHF-2-3	IIB	2	--	160.63	93.35	83 to 93	NA
<b>Site 17, Crash Crew Training Area</b>							
WHF-17-1	VS	4	192.61	194.71	159.00	149 to 159	NA
WHF-17-1S	IIA	2	192.48	194.96	115.50	100 to 115	0 to 35
WHF-17-2	IIA	2	194.33	197.35	121.90	106 to 121	0 to 43
WHF-17-3	IIA	2	198.89	201.21	126.50	111 to 126	NA
<b>Site 18, Crash Crew Training Area</b>							
WHF-18-1	VS	4	161.56	163.57	120.20	110 to 120	NA
WHF-18-2	IIA	2	162.15	164.75	107.86	92 to 107	NA
WHF-18-3	IIA	2	172.73	175.64	112.90	97 to 112	NA
Notes: RI = Remedial Investigation. msl = mean sea level. TOC = top of casing. BTOC = below top of casing. bls = below land surface. VS = Verification Study. NA = not applicable. IIA = Remedial Investigation Phase IIA. IIB = Remedial Investigation Phase IIB. -- = not available.							

#### 4.0 SITE-SPECIFIC DATA QUALITY ASSESSMENT

This chapter describes how the data generated during Phase IIB of the RI at Site 2 were managed and evaluated. Section 4.1 describes the analytical program and data management for the RI at Site 2. Section 4.2 summarizes the precision, accuracy, representativeness, comparability, and completeness (PARCC) report on the data. Section 4.3 presents a summary of the Data Quality Assessment.

The soil and groundwater samples collected during Phase IIA of the RI were qualified according to USEPA functional guidelines for evaluation of organic (USEPA, 1991b) and inorganic (USEPA, 1988a) analytical data analyzed using USEPA CLP protocol. The data quality objective (DQO) assessment for the Phase IIA soil samples is presented in detail in RI Phase IIA Technical Memorandum No. 3 (ABB-ES, 1994). The DQO assessment for the Phase IIA groundwater samples is presented in detail in RI Phase IIA Technical Memorandum No. 5 (ABB-ES, 1995c).

4.1 ANALYTICAL PROGRAM. Environmental and quality control samples collected during the Phase IIB of the RI at Site 2 were analyzed using field screening and off-site laboratory analytical methods. Quality control data for Site 2 are included with sample delivery groups (SDGs) WF006, WF022, and WF023 for Site 1. These data were previously presented in the Northwest Disposal Area, Site 1, Remedial Investigation Report (ABB-ES, 1997). Environmental sampling locations are presented in Section 3.0 of this report, and sample results are presented in Section 5.0 and Appendix A (soil data) and Appendix B (groundwater data).

Environmental samples (surface soil, subsurface soil, and groundwater) were collected and analyzed by an off-site laboratory using SW-846 methodology (USEPA, 1986) for analysis of VOCs, SVOCs, pesticides, PCBs, metals, and cyanide. Some groundwater samples were also analyzed for wet chemistry analyses. The laboratory analytical program is described in more detail in Section 2.2 of the NAS Whiting Field GIR (HLA, 1998).

Analytical results obtained for all environmental samples during the RI sampling events were submitted as NEESA Level D (USEPA Level IV) analytical packages for VOCs, SVOCs, pesticides, PCBs, metals, cyanide, and wet chemistry.

4.2 DATA REVIEW. Data validation is the technical review of individual analytical results relative to the following criteria:

- DQOs and the QAPP in the NAS Whiting Field workplan (E. C. Jordan Co., Inc., 1990 and ABB-ES, 1995d).
- NEESA guidance document 20.2-047B, *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Program* (NEESA, 1988).
- USEPA, *Contract Laboratory Program National Functional Guidelines for Organic Data Review*, June 1991 (USEPA, 1991b).
- USEPA, *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, July 1988 (USEPA, 1988a).

The data validation process is described in Section 2.3 of the NAS Whiting Field GIR (HLA, 1998).

The data were reviewed, validated, and evaluated using the PARCC specified in the DQOs. PARCC criteria are described in Section 2.3 of the NAS Whiting Field GIR (HLA, 1998). The Site 2 Phase IIB soil and groundwater analytical data were validated by Laboratory Data Consultants, Inc. (LDC) of Carlsbad, California, in 1996. The Site 2 Phase IIB data include SDG WF006, WF022, and WF023. The subsections below summarize the PARCC criteria evaluation of the analytical data.

**4.2.1 Precision** Precision is a measure of the agreement or repeatability of a set of replicate results (relative percent difference, [RPD]) obtained from duplicate laboratory analyses of samples collected from the same location and depth interval. Precision for analytical data collected during the RI sampling events was evaluated using results of field duplicate samples, laboratory duplicate samples, matrix spike and matrix spike duplicate (MS/MSD) samples, and/or consecutive laboratory control samples. The evaluation of precision for the RI sampling event is presented in Table 4-1 and summarized below.

The RPD criteria were not met for three environmental samples (one soil and two groundwater) and associated duplicates for one organic (acetone) and several inorganic analytes. None of the organic analytical results were qualified during the data validation process based on RPD criteria for environmental and associated duplicate sample pairs.

The RPD criteria for eight inorganic analytes (aluminum, barium, beryllium, calcium, magnesium, mercury, potassium, and sodium) in one soil sample (02S00401) from SDG WF006 may not have been met because of sample heterogeneity. The inorganic analytical results were qualified during the data validation process based on the RPD evaluation criteria.

The RPD criteria for one VOC (acetone) and three inorganic analytes (aluminum, iron, and manganese) were not met for one groundwater sample (01G00102) and associated duplicate in SDG WF022. The RPD criteria for two inorganic analytes (selenium and cyanide) were not met for one groundwater sample (02G00301) and associated duplicate in SDG WF023.

**4.2.2 Accuracy** Accuracy is a measure of the agreement between the true value and the value measured using an analytical method (percent recovery). Accuracy also is evaluated during data validation by assessing initial and continuing calibration data for the analytical instrument. Accuracy for analytical data collected during the RI sampling events was assessed by evaluating percentage recoveries for MS/MSD samples, surrogate recoveries, laboratory control samples, and initial and continuing calibration standard results. The evaluation of recoveries for MS/MSD samples is presented in Table 4-2 and summarized below.

The percent recovery for some of the soil and groundwater samples was above or below the target range; therefore, some analytical results may be biased high or low. Some of the analytical results for SVOCs and inorganic analytes were qualified based on the evaluation of percent recovery.

A summary of the surrogate spike samples and the surrogate compounds that were outside control limits for the Phase IIB samples collected at Site 1 is presented in Table 4-3. The required control limits were also identified for each

**Table 4-1**  
**Precision Summary for Soil and Groundwater Field Duplicate Samples**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

SDG Number	Sample ID	Compound	Sample Concentration	Duplicate Concentration	RPD	Control Limits
<b>SOIL</b>						
WF006						
<b>Volatile Organic Compounds (µg/kg)</b>		02S00401	Acetone	ND	5	NC 50
<b>Pesticides and PCBs (µg/kg)</b>			Dieldrin	8.3	8.0	4 50
			alpha-Chlordane	5.6	5.1	9 50
			gamma-Chlordane	3.5	2.9	19 50
<b>Inorganic Analytes (mg/kg)</b>		02S00401	Aluminum	9,580	7,580	23 20
			Arsenic	3.9	4.0	3 30
			Barium	27.7	15.9	54 30
			Beryllium	0.31	0.13	81 30
			Calcium	14,900	9,900	40 20
			Chromium	13.6	14.0	3 30
			Cobalt	0.53	ND	NC 30
			Copper	4.3	3.8	12 30
			Iron	4,010	3,880	3 20
			Lead	10.9	11.6	6 20
			Magnesium	926	403	79 30
			Manganese	188	164	14 20
			Mercury	0.03	0.05	50 30
			Nickel	3.9	3.8	1 30
			Potassium	377	142	91 30
			Sodium	104	70.2	38 30
			Vanadium	12.9	11.7	10 30
			Zinc	13.1	12.5	5 30
			Cyanide	0.15	ND	NC 30

See notes at end of table.

**Table 4-1 (Continued)**  
**Precision Summary for Soil and Groundwater Field Duplicate Samples**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

SDG Number	Sample ID	Compound	Sample Concentration	Duplicate Concentration	RPD	Control Limits	
<b>GROUNDWATER</b>							
WF022							
<b>Volatile Organic Compounds (<math>\mu\text{g}/\text{l}</math>)</b>		01G00102	Acetone	4	2	67	40
<b>Inorganic Analytes (<math>\mu\text{g}/\text{l}</math>)</b>		01G00102	Aluminum	19.1	10.3	50	25
			Barium	15.6	15.6	0	25
			Beryllium	0.53	ND	NC	25
			Calcium	5,850	6,250	7	25
			Copper	ND	1.4	NC	25
			Iron	12.2	8.8	32	25
			Lead	1.3	1.5	14	25
			Magnesium	337	331	2	25
			Manganese	6.7	9.0	29	25
			Potassium	938	842	11	25
			Sodium	2,100	2,070	1	25
			Vanadium	ND	1.6	NC	25
			Zinc	10.2	11.4	11	25
			Cyanide	1.9	ND	NC	25
<b>GROUNDWATER</b>							
WF-23							
<b>Volatile Organic Compounds (<math>\mu\text{g}/\text{l}</math>)</b>		02G00301	Acetone	ND	10	NC	40
			Carbon disulfide	1	ND	NC	40
<b>Inorganic Analytes (<math>\mu\text{g}/\text{l}</math>)</b>		02G00301	Aluminum	79.3	84.6	6	25
			Barium	128	129	0.8	25
			Beryllium	0.39	ND	NC	25
			Calcium	113,000	113,000	0	25
			Iron	36.2	38.7	7	25
			Lead	1.4	1.3	7	25

See notes at end of table.

**Table 4-1 (Continued)**  
**Precision Summary for Soil and Groundwater Field Duplicate Samples**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

SDG Number	Sample ID	Compound	Sample Concentration	Duplicate Concentration	RPD	Control Limits
<b>Inorganic Analytes (<math>\mu\text{g}/\ell</math>) (Continued)</b>						
		Magnesium	9,560	9,560	0.3	25
		Manganese	13.5	13.7	1	25
		Nickel	7.8	9.6	21	25
		Potassium	4,610	4,580	0.7	25
		Selenium	1.2	0.66	58	25
		Sodium	2,200	2,240	2	25
		Vanadium	3.0	2.8	7	25
		Zinc	1.8	2.0	11	25
		Cyanide	4.5	2.0	77	25

$$RPD = 100 \times \frac{|D_1 - D_2|}{0.5(D_1 + D_2)}$$

Notes: SDG = sample delivery group.  
ID = identification.  
RPD = relative percent difference.  
 $\mu\text{g}/\text{kg}$  = micrograms per kilogram.  
ND = nondetect.  
NC = not calculable.  
PCB = polychlorinated biphenyl.  
 $\text{mg}/\text{kg}$  = milligrams per kilogram.  
 $\mu\text{g}/\ell$  = micrograms per liter.  
 $D_1$  = sample concentration.  
 $D_2$  = duplicate concentration.

**Table 4-2  
Accuracy Summary for MS/MSD Samples**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
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SDG Number	MS/MSD Sample	Analyte	% Recovery MS/MSD	Control Limits
WF006	<b>Soil</b> 02S00401			
	<b><u>Semivolatile Organic Compounds</u></b>			
		Phenol	-/92	26 to 90
		4-Chloro-3-methylphenol	-/104	26 to 103
		2,4-Dinitrotoluene	-/100	28 to 89
		Pyrene	29/30	35 to 142
	<b><u>Inorganic Analytes</u></b> <sup>1</sup>			
		Antimony	73.8	75 to 125
		Manganese	73.8	75 to 125
WF022	<b>Groundwater</b> BKG00101			
	<b><u>Semivolatile Organic Compounds</u></b>			
		4-Chloro-3-methylphenol	108/115	23 to 97
		4-Nitrophenol	88/93	10 to 80
		2,4-Dinitrotoluene	100/108	24 to 96
		Pentachlorophenol	106/118	9 to 103
WF023	<b>Groundwater</b> 02G00301			
	<b><u>Semivolatile Organic Compounds</u></b>			
		4-Nitrophenol	88/82	10 to 80
		2,4-Dinitrotoluene	97/-	24 to 96
		Pentachlorophenol	139/122	9 to 103

<sup>1</sup> MSD analyses are generally not performed for inorganic analysis and, therefore, only the percent recovery for the MS is reported.

Notes: SDG = sample delivery group.  
MS/MSD = matrix spike and matrix spike duplicate.  
% = percent.

surrogate compound. All the samples associated with these surrogates were qualified in accordance with the USEPA functional guidelines as presented in Subsection 3.3.4 of the GIR (HLA, 1998).

**Table 4-3  
Accuracy Summary for Surrogate Recoveries Outside QC Criteria**

Remedial Investigation Report  
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Naval Air Station Whiting Field  
Milton, Florida

SDG Number	Sample ID	Spiked Analyte	Surrogate Recovery (%R) <sup>1</sup>	QC Limits (percent)
WF023	01G00201	Decachlorobiphenyl	32/28	60-150
WF023	01G00301	Decachlorobiphenyl	49/47	60-150

<sup>1</sup> Reported as value for first column/second column.

Notes: QC = quality control.  
SDG = sample delivery group.  
ID = identification.  
%R = percent recovery.

Initial calibrations are performed to ensure the instrument is capable of producing acceptable qualitative and quantitative data for compounds on the volatile TCL. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve. Continuing calibrations are performed to ensure the instrument is capable of producing acceptable qualitative and quantitative data.

Continuing calibration establishes the 12-hour Relative Response Factor (RRF) on which the quantitations are based and checks satisfactory performance of the instrument on a day-to-day basis. Initial and continuing calibrations for organic analysis are measured by the percent Relative Standard Deviation (%RSD) for initial calibrations and the percent Difference (%D) for continuing calibrations. For inorganic analysis, the Initial Calibration Verification and continuing calibration verification are measured.

Table 4-4 summarizes the initial and continuing calibration details for the surface soil and groundwater samples collected at Site 2.

The evaluation of the %RSD for the initial calibrations and the %D for the continuing calibrations indicates that the response factors for the system performance check compounds generally met the required criteria for VOCs, SVOCs, pesticides, and PCBs. Analytes exhibiting an RRF that does not meet the minimum requirements were qualified as J/UJ.

**4.2.3 Representativeness** Representativeness is the degree to which the data obtained from an environmental sample accurately reflect the presence or absence of contamination at a site. Field quality control samples (including source water blanks, equipment rinse blanks, and trip blanks) and laboratory quality control samples (including method [organic analysis] and preparation blanks [inorganic analysis]) were used to assess representativeness. Representativeness

**Table 4-4**  
**Summary of Initial and Continuing Calibration for Site 2 Samples**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

SDG	Compound	Initial Calibration	Continuing Calibration	Qualifier
WF006	2,4-Dinitrophenol	--	33.1	UJ
	2,4-Dinitrophenol	--	27.0	UJ
	Diethylphthalate	--	30.1	UJ
	Diethylphthalate	--	27.1	UJ
	Alpha-BHC	21.7	--	UJ
	Alpha-BHC	20.3	--	UJ
WF022	4-Chloroaniline	--	31.6	J
	2,4-Dinitrophenol	--	27.6	J
	4,6-Dinitro-2-methylphenol	--	33.8	J
WF023	Acetone	30.2	33.2	J
	4-Nitroaniline	--	37.8	J
	Chrysene	--	27.8	J
	4,4-DDT	23.6	--	J

Notes: Calibration values expressed as percent recovery.

SDG = sample delivery group.

-- = not detected.

UJ = The analyte was not detected above the reported sample instrument detection limit (IDL); however, the reported concentration is approximate and may not reliably be presumed to be less than the IDL value.

BHC = benzene hexachloride.

J = The analyte was positively identified and is reported as an approximate concentration.

DDT = dichlorodiphenyltrichloroethane.

also is assessed by review of the adherence to extraction and analysis holding times. The evaluation of representativeness in field quality control samples for the RI sampling event is presented in Table 4-5 and summarized below.

**Trip Blanks.** Acetone was detected in sample 01T00101 at a concentration of 9 micrograms per liter ( $\mu\text{g}/\ell$ ). Environmental samples associated with the trip blanks with results greater than the instrument detection limit (IDL) but less than 10 times the amount detected in the trip blank were appropriately annotated with a J or UJ qualifier (LDC, 1996).

**Rinsate Blanks.** VOCs, if present, were not detected at concentrations exceeding their detection limits in the rinsate blanks. One SVOC, bis(2-ethylhexyl)phthalate, was detected in one of the rinsate blank samples at a concentration of 2  $\mu\text{g}/\ell$ . SVOCs, if present, were not detected in associated soil samples at concentrations exceeding their detection limits.

Metals detected at concentrations exceeding the IDL and less than the contract-required detection limits (CRDLs) are aluminum, calcium, cyanide, and zinc.

**Field Blank.** 2-Butanone and di-n-octylphthalate were detected in the field blank at concentrations of 2 J  $\mu\text{g}/\ell$  and 15  $\mu\text{g}/\ell$ , respectively. Environmental samples associated with the field blank with results greater than the IDL but less than 10 times the amount detected in the field blank were appropriately annotated with a UJ qualifier.

**Laboratory Method and Preparation Blanks.** Concentrations of methylene chloride, acetone, di-n-butylphthalate, and bis(2-ethylhexyl)phthalate were detected in the laboratory method blanks associated with SDGs WF006, WF022, or WF023.

Environmental samples associated with method blanks that contained methylene chloride and acetone with results greater than IDL but less than 10 times the amount detected in the laboratory preparation blanks were annotated with a UJ qualifier (LDC, 1996).

Aluminum, calcium, cobalt, copper, iron, magnesium, mercury, selenium, and sodium were detected in laboratory method blanks. Sample results greater than IDL but less than five times the amount detected in the laboratory preparation blanks were appropriately annotated with a J or UJ qualifier (LDC, 1996).

Sampling and analysis holding times for each analytical fraction were met in all samples.

Qualification of the environmental samples was required because of the detection of target analytes in laboratory and field blanks. Qualification of the RI data, based on blank contamination, was performed according to USEPA data validation guidelines (USEPA, 1988a and USEPA, 1991b).

**4.2.4 Comparability** Comparability is the confidence with which one data set can be compared with another and the degree to which the environmental data from each sampling event are considered equivalent. Comparability of the analytical data was assured by using standard operating procedures for sample collection, by

**Table 4-5  
Representativeness Summary for Site 2 Field Quality Control Samples**

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Sample Identifier:	01F00101	01R00101	01T00101	01R01101	01T01201
Collection Date:	06-DEC-95	06-DEC-95	05-DEC-95	23-JUL-96	22-JUL-96
Laboratory Sample No.:	G8876013	G8876012	G8864001	RB887005	RB887001
<b><u>Volatile Organic Compounds (µg/l)</u></b>					
Acetone	--	--	9 J	--	--
2-Butanone	2 J	--	--	--	--
<b><u>Semivolatile Organic Compounds (µg/l)</u></b>					
Di-n-octylphthalate	15	--	NA	--	NA
bis(2-Ethylhexyl)phthalate	--	2	NA	--	NA
<b><u>Pesticides and PCBs (µg/l)</u></b>					
None detected					
<b><u>Inorganic Analytes (µg/l)</u></b>					
Aluminum	--	--	NA	13.3 J	NA
Calcium	--	178 J	NA	--	NA
Zinc	--	2.9 J	NA	--	NA
Cyanide	--	--	NA	2.6 J	NA
Notes: µg/l = micrograms per liter. -- = analyte not detected. J = estimated value. NA = not analyzed. PCB = polychlorinated biphenyl.					

using standard chemical analytical methods, and by reporting the analytical results in standard units (SUs). The sampling, shipment, and analytical protocols were consistent with USEPA standard operating procedures and methodologies described in workplans for NAS Whiting Field throughout the period of the RI.

**4.2.5 Completeness** Completeness is the percentage of useable data reported and validated compared with the total number of measurements made. Useable data are those measurements that were not rejected (qualified with an "R") during the validation process. None of the analytical data were rejected. The goal for analytical completeness for the RI sampling event was 85 percent useable data. The completeness goal of 85 percent was met for all matrices and all parameters.

**4.3 SUMMARY** Based on the results of the QC sample analyses, the established precision and accuracy goals of the project were achieved (Table 4-6). Some field and/or laboratory derived contamination was present in some of the QC samples, which required the results from some of the environmental samples to be amended. QC sample results and data validation criteria indicate a 100 percent completeness was achieved, thus satisfying the 85 percent completeness goal. Standard methods of analysis and units of measure were used throughout the project, thus meeting the QC criteria and the DQOs presented in the workplan.

Overall, the data generated during the sampling event meet established DQOs and are acceptable for use in site characterization, risk assessment, and evaluation of corrective measures.

**Table 4-6  
Summary of DQO Assessment - PARCC Parameters**

Remedial Investigation Report  
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	Precision <sup>1</sup>	Accuracy <sup>2</sup>	Representativeness	Completeness (%)	Comparability
<b><u>Surface and Subsurface Soil Samples</u></b>					
TCL VOCs	Acceptable	Acceptable	Acceptable	100	Acceptable
TCL SVOCs	Acceptable	Acceptable	Acceptable	100	Acceptable
Pesticides and PCBs	Acceptable	Acceptable	Acceptable	100	Acceptable
TAL Metals and Total Cyanides	Acceptable	Acceptable	Acceptable	100	Acceptable

<sup>1</sup> Cumulative of sampling and analytical components.

<sup>2</sup> Analytical component.

Notes: All the units are expressed as the ratio of number of analytes meeting the quality control criteria to the total number of analytes.

DQO = data quality objective.

PARCC = precision, accuracy, reproducibility, completeness, and comparability.

% = percent.

TCL VOC = target compound list volatile organic compound.

TCL SVOC = target compound list semivolatile organic compound.

PCB = polychlorinated biphenyl.

TAL = target analyte list.

## 5.0 INVESTIGATIVE RESULTS

The RI Phase I investigation (ABB-ES, 1992c) at Site 2 consisted of collecting a groundwater sample using a PCPT and BAT sampler. The Phase IIA investigation included collecting one surface soil sample and six subsurface soil samples from a soil boring, installing one monitoring well, and collecting one groundwater sample. All samples were analyzed for TCL VOCs, SVOCs, pesticides, and PCBs and TAL inorganic analytes.

The Phase IIB investigation included collecting five surface soil samples, installing two monitoring wells, and collecting four groundwater samples. The samples were analyzed for TCL VOCs, SVOCs, pesticides, and PCBs and TAL inorganic analytes.

Below are results of the geologic and hydrogeologic assessment and the analytical results of the surface soil, subsurface soil, and groundwater sampling events.

**5.1 GEOLOGIC ASSESSMENT.** Surface soils were generally described as yellow to orange (fine- to very fine-grained) clayey sand or light tan (fine- to very fine-grained) silty sand. The shallow soil (2 to 7 feet bls) tended to be brown to red in color and contained interbedded sand silt and clay layers (ABB-ES, 1995a).

The lithology of soil beneath Site 2 consists predominantly of light colored, poorly graded (fine- to medium-grained) sands to a depth of at least 99 feet bls. Layers of clay and silt were thin (less than 1 inch in thickness) and infrequently encountered below 20 feet. One clay layer was encountered below 20 feet at the location of one monitoring well (WHF-2-1). The clay layer was thin, less than 1 inch in thickness, and was encountered at 60 feet bls (ABB-ES, 1995a).

Detailed descriptions can be found in the boring and monitoring well logs presented in the RI Phase IIA Technical Memorandum No. 2 (ABB-ES, 1995a).

A general discussion of the geology at NAS Whiting Field is presented in Subsection 1.4.5 of the GIR (HLA, 1998). Site 2 monitoring well boring logs are presented in Appendix E of this report.

**5.2 HYDROGEOLOGIC ASSESSMENT.** The hydrogeologic assessment included determining horizontal and vertical hydraulic gradients, hydraulic conductivities, and seepage velocities. The hydrogeologic assessment results are used to characterize the transport of human health and ecological chemicals of potential concern from the site by groundwater flow. Contaminant fate and transport for human health and ecological chemicals of potential concern at Site 2 is presented in Section 8.0 of this report.

**Groundwater Flow Direction.** Table 5-1 summarizes the results of the water-level measurements for the RI/FS sites in the Northwest Disposal and Crash Crew Training Areas during the RI field program. Interpretation of the potentiometric surface maps suggests that groundwater flow patterns for the measurement events on February 8 and 9, 1994 (Figure 5-1) and November 7 to 9, 1996, (Figure 5-2) are similar.

**Table 5-1**  
**Summary of Water-Level Elevations**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
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Monitoring Well Designation	Well TOC Elevation (msl)	Well Depth (feet BTOC)	September 30 and October 1, 1993		February 8 and 9, 1994		June 22 to 24, 1994	
			Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)
<b>Northwest Disposal and Crash Crew Training Areas</b>								
<b>Site 1, Northwest Disposal Area</b>								
WHF-1-1	142.62	123.00	64.70	77.92	66.00	76.62	66.26	76.36
WHF-1-1S	143.08	75.40	64.40	78.68	65.84	77.24	66.11	76.97
WHF-1-2	145.61	78.80	66.13	79.48	67.53	78.08	67.99	77.62
WHF-1-3	155.50	87.48	76.68	78.82	78.02	77.48	78.51	76.99
WHF-1-4	151.86	79.30	--	--	--	--	--	--
<b>Site 2, Northwest Open Disposal Area</b>								
WHF-2-1	150.80	87.42	77.96	72.84	79.18	71.62	79.00	71.80
WHF-2-2	159.16	91.70	--	--	--	--	--	--
WHF-2-3	160.63	91.60	--	--	--	--	--	--
<b>Site 17, Crash Crew Training Area</b>								
WHF-17-1	194.71	159.00	111.10	83.61	112.39	82.32	113.56	81.15
WHF-17-1S	194.96	115.50	111.29	83.67	112.60	82.36	113.78	81.18
WHF-17-2	197.35	121.90	114.05	83.30	115.35	82.00	116.52	80.83
WHF-17-3	201.21	126.50	117.52	83.69	117.12	84.09	117.53	83.68
<b>Site 18, Crash Crew Training Area</b>								
WHF-18-1	163.57	120.20	93.29	70.28	94.53	69.04	94.61	68.96
WHF-18-2	164.75	107.86	95.82	68.93	97.04	67.71	98.03	66.72
WHF-18-3	175.64	112.90	104.30	71.34	105.59	70.05	105.90	69.74
See notes at end of table.								

**Table 5-1 (Continued)**  
**Summary of Water-Level Elevations**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Monitoring Well Designation	Well TOC Elevation (msl)	Well Depth (feet BTOC)	October 10 to 13, 1994		January 10 to 13, 1995		April 19 and 20, 1995	
			Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)
<b>Northwest Disposal and Crash Crew Training Areas</b>								
<b>Site 1, Northwest Disposal Area</b>								
WHF-1-1	142.62	123.00	64.15	78.47	64.36	78.26	64.02	78.60
WHF-1-1S	143.08	75.40	63.92	79.16	64.13	78.95	63.80	79.28
WHF-1-2	145.61	78.80	65.72	79.89	65.91	79.70	65.57	80.04
WHF-1-3	155.50	87.48	76.23	79.27	76.32	79.18	76.10	79.40
WHF-1-4	151.86	79.30	--	--	--	--	--	--
<b>Site 2, Northwest Open Disposal Area</b>								
WHF-2-1	150.80	87.42	76.94	73.86	77.45	73.35	76.96	73.84
WHF-2-2	159.16	91.70	--	--	--	--	--	--
WHF-2-3	160.63	91.60	--	--	--	--	--	--
<b>Site 17, Crash Crew Training Area</b>								
WHF-17-1	194.71	159.00	111.49	83.22	110.94	83.77	110.97	83.74
WHF-17-1S	194.96	115.50	111.72	83.24	111.15	83.81	111.17	83.79
WHF-17-2	197.35	121.90	114.45	82.90	113.89	83.46	113.92	83.43
WHF-17-3	201.21	126.50	123.65	77.56	114.87	83.34	114.88	86.33
<b>Site 18, Crash Crew Training Area</b>								
WHF-18-1	163.57	120.20	92.28	71.29	92.50	71.07	92.35	71.22
WHF-18-2	164.75	107.86	94.76	69.99	94.97	69.78	94.85	69.90
WHF-18-3	175.64	112.90	103.55	72.09	103.48	72.16	103.46	72.18
See notes at end of table.								

**Table 5-1 (Continued)**  
**Summary of Water-Level Elevations**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

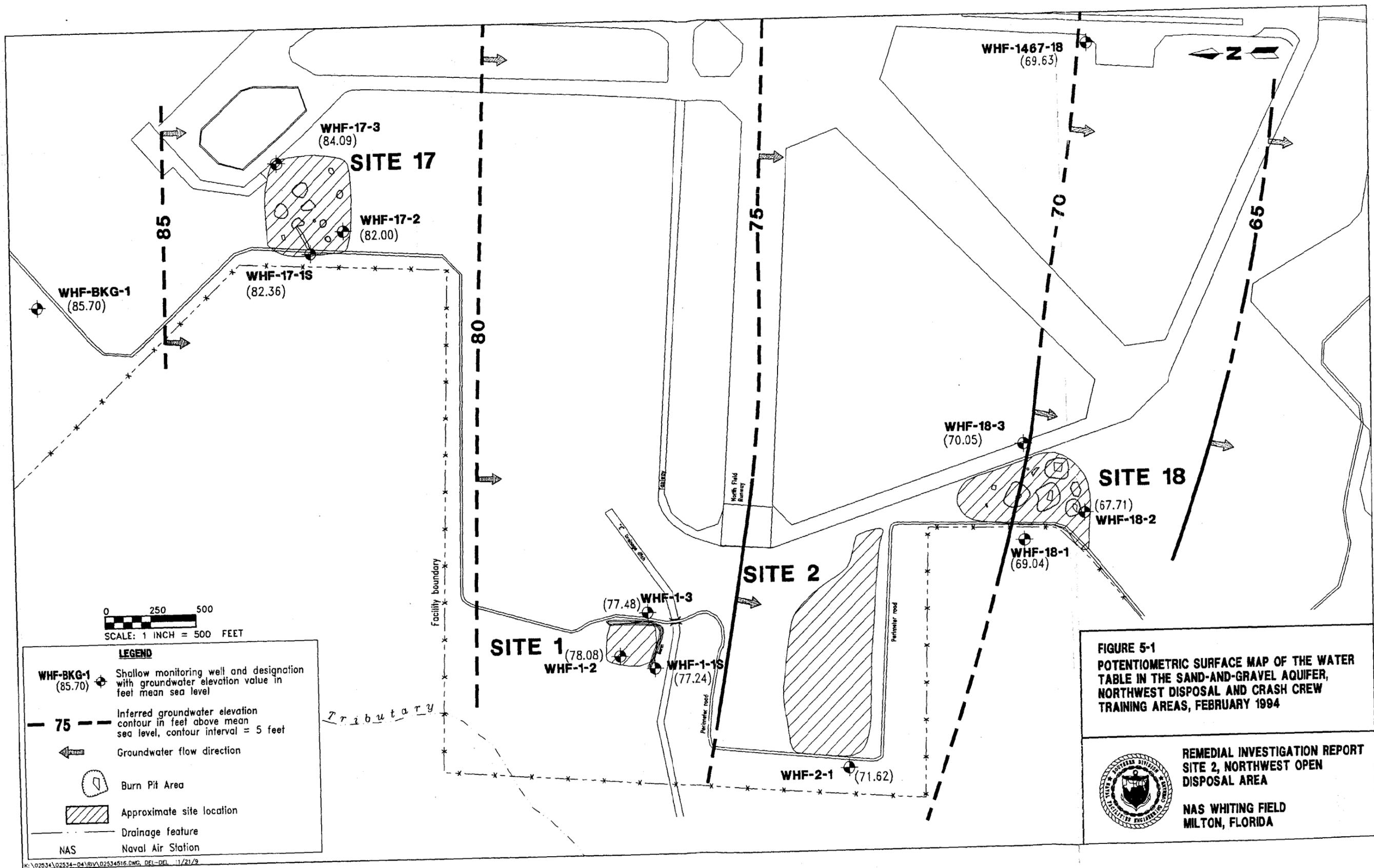
Monitoring Well Designation	Well TOC Elevation (msl)	Well Depth (feet BTOC)	July 28 and 29, 1995		October 12 to 14, 1995		January 19 and 20, 1996	
			Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)
<b>Northwest Disposal and Crash Crew Training Areas</b>								
<b>Site 1, Northwest Disposal Area</b>								
WHF-1-1	142.62	123.00	62.42	80.20	61.84	80.78	58.18	84.44
WHF-1-1S	143.08	75.40	62.12	80.96	61.58	81.50	57.81	85.27
WHF-1-2	145.61	78.80	63.86	81.75	63.27	82.34	59.59	86.02
WHF-1-3	155.50	87.48	74.33	81.17	74.03	81.47	70.08	85.42
WHF-1-4	151.86	79.30	--	--	--	--	--	--
<b>Site 2, Northwest Open Disposal Area</b>								
WHF-2-1	150.80	87.42	75.56	75.24	75.21	75.59	71.50	79.30
WHF-2-2	159.16	91.70	--	--	--	--	--	--
WHF-2-3	160.63	91.60	--	--	--	--	--	--
<b>Site 17, Crash Crew Training Area</b>								
WHF-17-1	194.71	159.00	109.17	85.54	108.85	85.86	104.88	89.83
WHF-17-1S	194.96	115.50	109.39	85.57	109.05	85.91	105.09	89.87
WHF-17-2	197.35	121.90	112.13	85.22	111.80	85.55	107.87	89.48
WHF-17-3	201.21	126.50	113.12	88.09	112.73	88.49	109.82	91.39
<b>Site 18, Crash Crew Training Area</b>								
WHF-18-1	163.57	120.20	90.76	72.81	91.09	72.48	86.81	76.76
WHF-18-2	164.75	107.86	93.28	71.47	93.69	71.06	89.37	75.38
WHF-18-3	175.64	112.90	101.93	73.71	102.13	73.51	97.58	78.06
See notes at end of table.								

**Table 5-1 (Continued)**  
**Summary of Water-Level Elevations**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Monitoring Well Designation	Well TOC Elevation (msl)	Well Depth (feet BTOC)	April 25 to 27, 1996		July 25 to 27, 1996		November 7 to 9, 1996	
			Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)	Depth to Groundwater (feet BTOC)	Groundwater Elevation (feet above msl)
<b>Northwest Disposal and Crash Crew Training Areas</b>								
<b>Site 1, Northwest Disposal Area</b>								
WHF-1-1	142.62	123.00	57.58	85.04	57.43	85.19	58.92	83.70
WHF-1-1S	143.08	75.40	57.13	85.95	57.09	85.99	59.53	83.55
WHF-1-2	145.61	78.80	58.78	86.83	58.76	86.85	60.18	85.43
WHF-1-3	155.50	87.48	69.40	86.10	69.23	86.27	70.63	84.87
WHF-1-4	151.86	79.30	66.27	85.59	66.17	85.69	67.62	84.24
<b>Site 2, Northwest Open Disposal Area</b>								
WHF-2-1	150.80	87.42	71.21	79.59	71.47	79.33	72.95	77.85
WHF-2-2	159.16	91.70	79.96	79.20	80.08	79.08	81.58	77.58
WHF-2-3	160.63	91.60	80.40	80.23	80.38	80.25	81.89	78.74
<b>Site 17, Crash Crew Training Area</b>								
WHF-17-1	194.71	159.00	103.44	91.27	102.82	91.89	103.96	90.75
WHF-17-1S	194.96	115.50	103.66	91.30	103.83	91.13	104.16	90.80
WHF-17-2	197.35	121.90	106.40	90.95	105.73	91.62	106.91	90.44
WHF-17-3	201.21	126.50	107.26	93.95	106.81	94.40	107.68	93.53
<b>Site 18, Crash Crew Training Area</b>								
WHF-18-1	163.57	120.20	86.69	76.88	86.62	76.95	88.05	75.52
WHF-18-2	164.75	107.86	89.37	75.38	89.32	75.43	90.73	74.02
WHF-18-3	175.64	112.90	97.57	78.07	97.51	78.13	98.70	76.94

Notes: TOC = top of casing.  
 msl = mean sea level.  
 BTOC = below top of casing.  
 -- = no data.



0 250 500  
SCALE: 1 INCH = 500 FEET

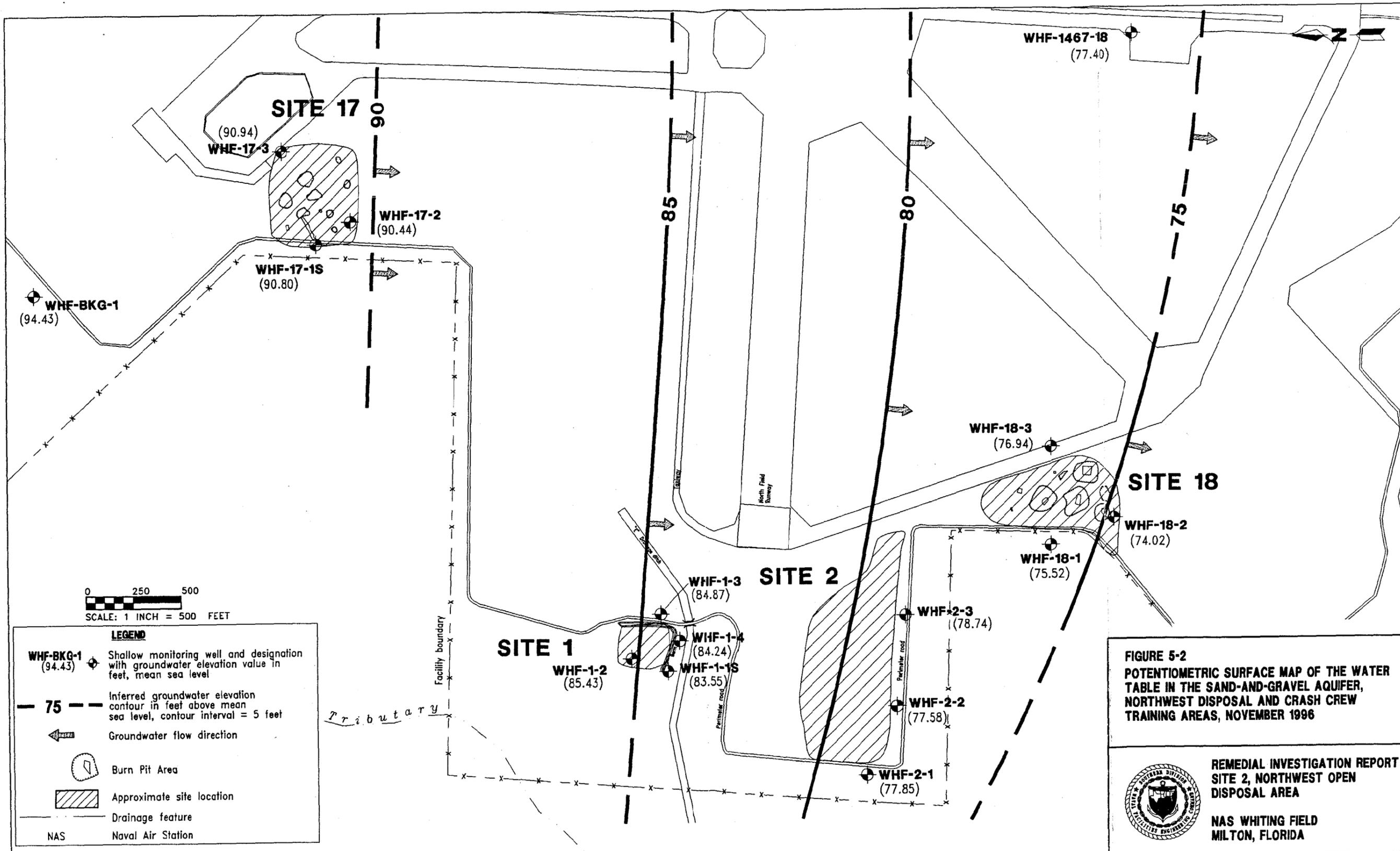
**LEGEND**

- WHF-BKG-1 (85.70) Shallow monitoring well and designation with groundwater elevation value in feet mean sea level
- 75 - - Inferred groundwater elevation contour in feet above mean sea level, contour interval = 5 feet
- Groundwater flow direction
- Burn Pit Area
- Approximate site location
- Drainage feature
- NAS Naval Air Station

**FIGURE 5-1**  
**POTENTIOMETRIC SURFACE MAP OF THE WATER TABLE IN THE SAND-AND-GRAVEL AQUIFER, NORTHWEST DISPOSAL AND CRASH CREW TRAINING AREAS, FEBRUARY 1994**

**REMEDIAL INVESTIGATION REPORT**  
**SITE 2, NORTHWEST OPEN DISPOSAL AREA**  
**NAS WHITING FIELD MILTON, FLORIDA**

00240FB22



0 250 500  
 SCALE: 1 INCH = 500 FEET

**LEGEND**

- WHF-BKG-1 (94.43) ◆ Shallow monitoring well and designation with groundwater elevation value in feet, mean sea level
- 75 - - - Inferred groundwater elevation contour in feet above mean sea level, contour interval = 5 feet
- ← Groundwater flow direction
- Burn Pit Area
- ▨ Approximate site location
- Drainage feature
- NAS Naval Air Station

**FIGURE 5-2**  
 POTENTIOMETRIC SURFACE MAP OF THE WATER TABLE IN THE SAND-AND-GRAVEL AQUIFER, NORTHWEST DISPOSAL AND CRASH CREW TRAINING AREAS, NOVEMBER 1996



**REMEDIAL INVESTIGATION REPORT**  
**SITE 2, NORTHWEST OPEN DISPOSAL AREA**  
 NAS WHITING FIELD  
 MILTON, FLORIDA

The potentiometric surface maps for the measurement events indicate a groundwater flow direction to the south-southwest. Facilitywide water table elevation data are provided in Appendix D of the GIR (HLA, 1998).

Horizontal Hydraulic Gradients. Table 5-2 provides a summary of the horizontal hydraulic gradients calculated for the Northwest Disposal and Crash Crew Training Areas. The horizontal hydraulic gradients in the area ranged from 0.0059 feet per foot (ft/ft) (monitoring wells WHF-18-2 and WHF-18-3) to 0.0016 ft/ft (monitoring wells WHF-17-1S and WHF-17-2). The average horizontal hydraulic gradient for each measurement event ranged from 0.0034 ft/ft for October 1994 to 0.0053 ft/ft for November 1996. The overall average horizontal hydraulic gradient for all measurement events from 1993 through 1996 was 0.0039 ft/ft.

Vertical Hydraulic Gradients. Table 5-3 presents a summary of the vertical hydraulic gradients calculated for the Northwest Disposal and Crash Crew Training Areas. The vertical hydraulic gradients were calculated using well pairs at Site 1 (monitoring wells WHF-1-1S and WHF-1-1) and Site 17 (monitoring wells WHF-17-1S and WHF-17-1). Values calculated for the paired monitoring wells ranged from 0.01580 ft/ft to 0.0005 ft/ft. Vertical hydraulic gradients were mostly in a downward direction; however, an upward gradient was observed on Site 17 during the July 25 to 27, 1996, survey and observed on Site 1 during the November 7 to 9, 1996, survey.

Hydraulic Conductivity and Seepage Velocity. Four slug tests were conducted in the Northwest Disposal and Crash Crew Training Areas during the RI. Table 5-4 summarizes the hydraulic conductivity values calculated for monitoring wells in the Northwest Disposal and Crash Crew Training Areas. Three trials of rising head slug tests were conducted in four monitoring wells in the Northwest Disposal and Crash Crew Training Areas.

Hydraulic conductivity data from monitoring well WHF-18-2 exceeded the 20 percent variance criteria in the data validation procedure and thus were rejected.

The validation of hydraulic conductivity data is presented in Section 2.3 in Table 2-2 of Technical Memorandum No. 4, Hydrogeologic Assessment (January) (ABB-ES, 1995b).

Average hydraulic conductivity values for individual monitoring wells ranged from 4.01 feet per day (ft/day) ( $1.42 \times 10^{-3}$  centimeters per second [cm/sec]) for WHF-17-2 to 19.47 ft/day ( $6.87 \times 10^{-3}$  cm/sec) for WHF-1-1S. The screen interval lithology (fine- to medium-grained sand) around monitoring wells WHF-1-1S and WHF-2-1 was almost five times more conductive than the lithology (poorly graded medium-grained sand) around WHF-17-2S. The geometric mean of the hydraulic conductivity data from Sites 1, 2, and 17 was 11.43 ft/day ( $4.03 \times 10^{-3}$  cm/sec).

Seepage Velocity. Table 5-5 summarizes the average linear pore water velocity (seepage velocities) for the water table zone of the sand and gravel aquifer for sites in the Northwest Disposal and Crash Crew Training Areas. The calculations used an assumed effective porosity of 0.35 for the site. The value represents silty through poorly graded sands (Fetter, 1988). Seepage velocities for individual sites ranged from 0.02 ft/day at Site 17 to 0.26 ft/day at Sites 1 and 2. The average of the seepage velocity values for the Northwest Disposal and Crash Crew Training Area sites was 0.17 ft/day (62 feet per year [ft/yr]).

**Table 5-2**  
**Summary of Horizontal Hydraulic Gradients**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Well Designation	Distance Between Wells (feet)	September 30 to October 1, 1993		February 8 and 9, 1994		June 22 to 24, 1994		October 10 to 13, 1994	
		Water Level (msl)	Horizontal Gradient (ft/ft)	Water Level (msl)	Horizontal Gradient (ft/ft)	Water Level (msl)	Horizontal Gradient (ft/ft)	Water Level (msl)	Horizontal Gradient (ft/ft)
<b>Northwest Disposal and Crash Crew Training Areas</b>									
WHF-17-1S	218	83.67	0.0017	82.36	0.0017	81.18	0.0016	83.24	0.0016
WHF-17-2		83.30		82.00		80.83		82.90	
WHF-18-3	511	71.34	0.0047	70.05	0.0046	69.74	0.0059	72.09	0.0041
WHF-18-2		68.93		67.71		66.72		69.99	
WHF-1-2	205	79.48	0.0039	78.08	0.0041	77.62	0.0032	79.89	0.0036
WHF-1-1S		78.68		77.24		76.97		79.16	
WHF-1-1S	1,201	78.68	0.0049	77.24	0.0047	76.97	0.0043	79.16	0.0044
WHF-2-1		72.84		71.62		71.80		73.86	
	<b>Average gradient</b>		0.0038		0.0038		0.0038		0.0034
<b>Northwest Disposal and Crash Crew Training Areas</b>									
WHF-17-1S	218	83.81	0.0016	83.79	0.0017	85.57	0.0016	85.91	0.0017
WHF-17-2		83.46		83.43		85.22		85.55	
WHF-18-3	511	72.16	0.0047	72.18	0.0045	73.71	0.0044	73.51	0.0048
WHF-18-2		69.78		69.90		71.47		71.06	
WHF-1-2	205	79.70	0.0037	80.04	0.0037	81.75	0.0039	82.34	0.0041
WHF-1-1S		78.95		79.28		80.96		81.50	
WHF-1-1S	1,201	78.95	0.0047	79.28	0.0045	80.96	0.0048	81.50	0.0049
WHF-2-1		73.35		73.84		75.24		75.59	
	<b>Average gradient</b>		0.0037		0.0036		0.0037		0.0039

See notes at end of table.

**Table 5-2 (Continued)**  
**Summary of Horizontal Hydraulic Gradients**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Well Designation	Distance Between Wells (feet)	January 19 and 20, 1996		April 25 to 27, 1996		July 25 to 27, 1996		November 7 to 9, 1996	
		Water Level (msl)	Horizontal Gradient (ft/ft)	Water Level (msl)	Horizontal Gradient (ft/ft)	Water Level (msl)	Horizontal Gradient (ft/ft)	Water Level (msl)	Horizontal Gradient (ft/ft)
<b>Northwest Disposal and Crash Crew Training Areas</b>									
WHF-17-1S	218	89.87	0.0018	91.30	0.0016	91.13	0.0022	90.80	0.0017
WHF-17-2		89.48		90.95		91.62		90.44	
WHF-18-3	511	78.06	0.0052	78.07	0.0053	78.13	0.0053	76.94	0.0057
WHF-18-2		75.38		75.38		75.43		74.02	
WHF-1-2	205	86.02	0.0037	86.83	0.0043	86.85	0.0042	85.43	0.0092
WHF-1-1S		85.27		85.95		85.99		83.55	
WHF-1-1S	1,201	85.27	0.0050	85.95	0.0053	85.99	0.0055	83.55	0.0047
WHF-2-1		79.30		79.59		79.33		77.85	
	<b>Average gradient</b>		0.0039		0.0041		0.0043		0.0053
Notes: msl = mean sea level. ft/ft = feet per foot.									

**Table 5-3  
Summary of Vertical Hydraulic Gradients**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Well Number	Bottom of Well Elevation (msl)	Vertical Distance Between Screens (feet)	September 30 and October 1, 1993			February 8 and 9, 1994		
			Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction	Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction
<b>Northwest Disposal and Crash Crew Training Areas</b>								
WHF-1-1S	67.68	48.06	78.68	0.0158	Downward	77.24	0.0129	Downward
WHF-1-1	19.62		77.92			76.62		
WHF-17-1S	79.46	43.75	83.67	0.0013	Downward	82.36	0.0009	Downward
WHF-17-1	35.71		83.61			82.32		
Well Number	Bottom of Well Elevation (msl)	Vertical Distance Between Screens (feet)	June 22 to 24, 1994			October 10 to 13, 1994		
			Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction	Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction
<b>Northwest Disposal and Crash Crew Training Areas</b>								
WHF-1-1S	67.68	48.06	76.97	0.0127	Downward	79.16	0.0144	Downward
WHF-1-1	19.62		76.36			78.47		
WHF-17-1S	79.46	43.75	81.18	0.0007	Downward	83.24	0.0005	Downward
WHF-17-1	35.71		81.15			83.22		
Well Number	Bottom of Well Elevation (msl)	Vertical Distance Between Screens (feet)	January 10 to 13, 1995			April 19 and 20, 1995		
			Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction	Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction
<b>Northwest Disposal and Crash Crew Training Areas</b>								
WHF-1-1S	67.68	48.06	78.95	0.0144	Downward	79.28	0.0141	Downward
WHF-1-1	19.62		78.26			78.60		
WHF-17-1S	79.46	43.75	83.81	0.0009	Downward	83.79	0.0011	Downward
WHF-17-1	35.71		83.77			83.74		

See notes at end of table.

**Table 5-3 (Continued)**  
**Summary of Vertical Hydraulic Gradients**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Well Number	Bottom of Well Elevation (msl)	Vertical Distance Between Screens (feet)	July 28 and 29, 1995			October 12 to 14, 1995		
			Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction	Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction
<b>Northwest Disposal and Crash Crew Training Areas</b>								
WHF-1-1S	67.68	48.06	80.96	0.0158	Downward	81.50	0.0150	Downward
WHF-1-1	19.62		80.20			80.78		
WHF-17-1S	79.46	43.75	85.57	0.0007	Downward	85.91	0.0011	Downward
WHF-17-1	35.71		85.54			85.86		
Well Number	Bottom of Well Elevation (msl)	Vertical Distance Between Screens (feet)	January 19 and 20, 1996			April 25 to 27, 1996		
			Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction	Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction
<b>Northwest Disposal and Crash Crew Training Areas</b>								
WHF-1-1S	67.68	48.06	85.27	0.0173	Downward	85.95	0.0189	Downward
WHF-1-1	19.62		84.44			85.04		
WHF-17-1S	79.46	43.75	89.87	0.0009	Downward	91.30	0.0007	Downward
WHF-17-1	35.71		89.83			91.27		
Well Number	Bottom of Well Elevation (msl)	Vertical Distance Between Screens (feet)	July 25 to 27, 1996			November 7 to 9, 1996		
			Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction	Groundwater Elevation (msl)	Vertical Gradient (ft/ft)	Vertical Flow Direction
<b>Northwest Disposal and Crash Crew Training Areas</b>								
WHF-1-1S	67.68	48.06	85.99	0.0166	Downward	83.55	-0.0031	Upward
WHF-1-1	19.62		85.19			83.70		
WHF-17-1S	79.46	43.75	91.13	-0.0174	Upward	90.80	0.0011	Downward
WHF-17-1	35.71		91.89			90.75		
Notes: msl = mean sea level. ft/ft = feet per foot.								

**Table 5-4  
Summary of Hydraulic Conductivity (K) Data from Slug Tests**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Well Number	Range of K (ft/day)	Number of Usable Runs	Average K (ft/min)	Average K (ft/day)	Average K (cm/sec)
<b>Shallow and Intermediate Monitoring Wells</b>					
<b>Site 1, Northwest Disposal Area</b>					
WHF-1-1S	18.09 to 20.33	3	0.0135	19.47	$6.87 \times 10^{-3}$
<b>Site 2, Northwest Open Disposal Area</b>					
WHF-2-1	16.79 to 20.35	3	0.0133	19.14	$6.75 \times 10^{-3}$
<b>Site 17, Crash Crew Training Area</b>					
WHF-17-2	3.67 to 4.50	2	0.0028	4.01	$1.42 \times 10^{-3}$
<b>Site 18, Crash Crew Training Area</b>					
WHF-18-2	R	R	R	R	R
<b>Geometric Mean</b>				11.43	$4.03 \times 10^{-3}$

Notes: Average is the arithmetic average.

ft/day = feet per day.  
ft/min = feet per minute.  
cm/sec = centimeters per second.  
R = data rejected.

**Table 5-5**  
**Summary of Seepage Velocities**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Investigation Area	Sites	Monitoring Well Pair	Horizontal <sup>1</sup> Gradient (ft/ft)	K <sup>2</sup> (ft/day)	Effective Porosity (n)	Seepage Velocity (ft/day)
Northwest Disposal and Crash Crew Training Area	1	WHF-1-1S and WHF-1-2	0.0043	19.47	0.35	0.24
	1 and 2	WHF-1-1S and WHF-2-1	0.0048	19.14	0.35	0.26
	17	WHF-17-1S and WHF-17-2	0.0017	4.01	0.35	0.02
<b>Arithmetic average</b>						<b>0.17</b>

<sup>1</sup> Horizontal gradients are the average value for all groundwater measurements performed between September 30, 1993, and November 9, 1996.

<sup>2</sup> The K is averaged where values are available for both wells in the well pair.

Notes: ft/ft = feet per foot.  
 K = hydraulic conductivity.  
 ft/day = feet per day.

5.3 SURFACE SOIL ASSESSMENT. Table 5-6 summarizes the frequency of detection, range of detection limits, range of detection concentrations, and background screening values for the combined background surface soil samples of the Troup Loamy Sand and Lakeland Sand soil types.

Table 5-7 summarizes the analytical results for organic and inorganic analytes detected in six surface soil samples and two duplicate samples at Site 2. The sample locations are shown on Figure 3-1.

Table 5-8 summarizes the frequency of detection, range of detection limits, range of detection concentrations, and background screening values for Site 2 surface soil samples.

In July 1998, the State of Florida promulgated Soil Cleanup Target Levels (SCTLs) for Chapter 62-785, FAC. Because groundwater contamination is indicated at the site, the Chapter 62-785, FAC, SCTLs for residential and industrial direct exposures and leachability are applicable for Site 2 at NAS Whiting Field. Leachability values are only compared to those compounds that exceeded the Chapter 62-785, FAC, GCTLs in site groundwater samples. Site 2 surface soil analytical results are compared to Chapter 62-785, FAC, SCTLs in Tables 5-6 and 5-8.

TCL VOCs. Chloroform was the only VOC detected in one (02S00101) of the six surface soil samples (Table 5-7). The detected concentration was below the USEPA Region III RBCs for residential and industrial soil and the Chapter 62-785, FAC, residential and industrial SCTLs (Table 5-8). Chloroform is a commonly recognized field or laboratory-derived contaminant according to the USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1991b).

TCL SVOCs. One SVOC (bis(2-ethylhexyl)phthalate) was detected in surface soil sample 2-SB01(0-2) and associated duplicate sample 2-SB01(0-2)D (Table 5-7). The detected concentrations were below USEPA Region III RBCs for residential- and industrial-use soil and the Chapter 62-785, FAC, residential and industrial SCTLs (Table 5-8). Bis(2-ethylhexyl)phthalate is a commonly recognized field or laboratory-derived contaminant according to the USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1991b).

Pesticides and PCBs. Four pesticide compounds (dieldrin, 4,4'-dichlorodiphenyl-trichloroethane [DDT], alpha-chlordane, and gamma-chlordane) were detected in two (2SB01[0-2] and 02S00401) of six surface soil samples collected at the site (Table 5-7). Only dieldrin exceeded the Chapter 62-785, FAC, leachability SCTL of 5  $\mu\text{g}/\ell$ . The detected concentrations of 4,4'-DDT, alpha chlordane, and gamma chlordane were below the USEPA Region III RBCs and the Chapter 62-785, FAC, leachability, residential, and industrial SCTL (Table 5-8).

TAL Metals and (Total) Cyanide. Eighteen TAL metals and cyanide were detected in the surface soil samples (Table 5-7). Nine TAL metals (arsenic, barium, beryllium, calcium, chromium, lead, magnesium, potassium, and vanadium) were detected in one or more samples at concentrations exceeding their respective background screening values (Table 5-8).

Detected concentrations of aluminum and iron exceeded the USEPA Region III RBCs for residential soil, but not the industrial-use soil values or Chapter 62-785,

**Table 5-6  
Comparison of Analytes Detected in Background Surface Soil Samples  
for the Troup Loamy Sand and Lakeland Sand**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Range of Detection Limits	Range of Detected Concentrations <sup>2</sup>	Background Screening Values <sup>3</sup>	USEPA Region III RBCs Residential/Industrial <sup>4</sup>	Soil Cleanup Target Levels Residential/Industrial/Leachability <sup>5</sup>
<b><u>TCL Volatile Organic Compounds (µg/kg)</u></b>						
None detected						
<b><u>TCL Semivolatile Organic Compounds (µg/kg)</u></b>						
None detected						
<b><u>Pesticides and PCBs (µg/kg)</u></b>						
None detected						
<b><u>Inorganic Analytes (mg/kg)</u></b>						
Aluminum	11/11	40 to 40	2,510 to 21,300	13,500	<sup>6</sup> 7,800/200,000	72,000/1,000,000/SPLP <sup>7</sup>
Antimony	2/11	2.6 to 12	2.9 to 5	8	<sup>6</sup> 3.1/82	26/240/na
Arsenic	11/11	2 to 2	0.655* to 3.7	2.6	<sup>8</sup> 0.43/3.8	0.8/ <sup>9</sup> 4.62/NA
Barium	11/11	40 to 40	2.7 to 26.2	18.8	<sup>9</sup> 550/14,000	105/87,000/NA
Beryllium	5/11	0.05 to 1	0.05 to 0.35	0.36	16/410	120/700/NA
Cadmium	3/11	0.58 to 1	0.22 to 0.9	0.98	<sup>6</sup> 3.9/100	75/1,300/NA
Calcium	11/11	1,000 to 1,000	82 to 401	446	--	--/--
Chromium	11/11	2 to 2	2.4 to 16.3	10	<sup>6</sup> 23/610	<sup>10</sup> 290/430/NA
Cobalt	8/11	0.33 to 10	0.75 to 3*	2.8	<sup>6</sup> 470/12,000	4,700/110,000/NA
Copper	9/11	5 to 5	2.1 to 8.5	8	<sup>6</sup> 310/8,200	105/140,000/NA
Iron	11/11	20 to 20	2,225* to 12,400	7,744	<sup>6</sup> 2,300/61,000	23,000/490,000/SPLP <sup>7</sup>
Lead	11/11	0.6 to 1	1.8 to 9.8	10.2	<sup>10</sup> 400	500/920/NA
Magnesium	11/11	1,000 to 1,000	62.85* to 316	244	--	--/--
Manganese	11/11	3 to 3	20.8* to 314	324	160/4,100	1,600/20,000/NA
Mercury	4/11	0.03 to 0.1	0.04 to 0.07	0.12	<sup>6</sup> 2.3/61	3.7/28/NA
Nickel	4/11	2.3 to 8	1.7 to 5.9	6.8	<sup>6</sup> 160/4,100	105/28,000/NA
Potassium	3/11	128 to 1,000	81.3* to 96.8	177	--	--/--
Selenium	5/11	0.39 to 1	0.15* to 0.4	0.46	<sup>6</sup> 39/1,000	390/10,000/NA
See notes at end of table.						

**Table 5-6 (Continued)**  
**Comparison of Analytes Detected in Background Surface Soil Samples**  
**for the Troup Loamy Sand and Lakeland Sand**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Range of Detection Limits	Range of Detected Concentrations <sup>2</sup>	Background Screening Values <sup>3</sup>	USEPA Region III RBCs Residential/Industrial <sup>4</sup>	Soil Cleanup Target Levels Residential/Industrial/Leachability <sup>5</sup>
<b>Inorganic Analytes (mg/kg) (Continued)</b>						
Silver	1/11	0.32 to 2	0.35 to 0.35	0.70	<sup>9</sup> 39/1,000	390/9,000/NA
Sodium	11/11	1,000 to 1,000	143 to 265*	382	--/--	--/--
Thallium	1/11	0.44 to 2	0.58* to 0.58*	1.16	<sup>9</sup> 0.55/14	--/--
Vanadium	11/11	10 to 10	4.95* to 31.1	19	<sup>6</sup> 55/1,400	15/7,700/NA
Zinc	10/11	4 to 4	4.3 to 16.3	15.8	<sup>9</sup> 2,300/61,000	23,000/560,000/NA
Cyanide	1/11	0.23 to 0.5	0.14 to 0.14	0.28	<sup>6</sup> 160/4,100	30/5,000/NA

<sup>1</sup> Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (excluding rejected values).

<sup>2</sup> Value indicated by an asterisk is the average of a sample and its duplicate. If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.

<sup>3</sup> The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.

<sup>4</sup> Source: USEPA Region III RBC Table (October 1, 1998).

<sup>5</sup> Chapter 62-785, Florida Administrative Code, July 6, 1998. Leachability values are only compared to those compounds that exceeded Chapter 62-785, Florida Administrative Code, GCTLs in site groundwater samples.

<sup>6</sup> The calculated values correspond to a noncancer hazard quotient of 0.1.

<sup>7</sup> Leachability values may be derived using the SPLP test to calculate site-specific SCTLs or may be determined using TCLP in the event oily wastes are present.

<sup>8</sup> The values correspond to a human cancer risk level of 1 in 1,000,000.

<sup>9</sup> Value is an FDEP-approved site-specific soil cleanup goal for arsenic at covered landfill sites, NAS Whiting Field (Appendix F; FDEP, 1998).

<sup>10</sup> USEPA memorandum dated July 14, 1994, from Elliott P. Laws to Regional Administrators. Subject: Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. (USEPA, 1994c).

Notes: USEPA = U.S. Environmental Protection Agency.

RBC = risk-based concentration.

TCL = target compound list.

µg/kg = micrograms per kilogram.

PCB = polychlorinated biphenyl.

mg/kg = milligrams per kilogram.

-- = criteria not available.

\* = average of a sample and its duplicate.

SPLP = synthetic precipitation leachate procedure.

TCLP = toxicity characteristic leachate procedure.

GCTL = groundwater cleanup target level.

SCTL = soil cleanup target level.

**Table 5-7**  
**Organic and Inorganic Analytes Detected in Surface Soil Samples**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Location Identifier:	2-SB01	2-SB01	02S001	02S002	02S003	02S004	02S004	02S005
Sample Identifier:	2-SB01(0-2)	2-SB01(0-2)D	02S00101	02S00201	02S00301	02S00401	02S00401D	02S00501
Collection Date:	31-JUL-93	31-JUL-93	06-DEC-95	06-DEC-95	06-DEC-95	05-DEC-95	05-DEC-95	06-DEC-96
Laboratory Sample No.:	94016001	94016002	G8876002	G8876003	G8876004	G8864007	G8864008	G8876005
<b><u>Volatile Organic Compounds (µg/kg)</u></b>								
Chloroform	--	--	5 J	--	--	--	--	--
<b><u>Semivolatile Organic Compounds (µg/kg)</u></b>								
bis(2-Ethylhexyl)phthalate	90 J	120 J	--	--	--	--	--	--
<b><u>Pesticides and PCBs (µg/kg)</u></b>								
Dieldrin	13 J	10 J	--	--	--	8.3 J	8	--
4,4'-DDT	3.9 J	3.4 J	--	--	--	--	--	--
alpha-Chlordane	--	--	--	--	--	5.6	5.1	--
gamma-Chlordane	--	--	--	--	--	3.5 J	2.9 J	--
<b><u>Inorganic Analytes (mg/kg)</u></b>								
Aluminum	5,000	5,950	9,230	1,150	7,160	9,580	7,580	5,310
Arsenic	0.91 J	0.73 J	1.9 J	0.95 J	2.1 J	3.9	4	2.6
Barium	8.2 J	8.5 J	27.1 J	1.7 J	10.4 J	27.7 J	15.9 J	14.7 J
Beryllium	--	--	0.45 J	--	0.11 J	0.31 J	0.13 J	0.16 J
Calcium	1,040 J	923 J	12,500	--	4,200	14,900	9,900	6,620
Chromium	4.9	5.8	6.4	1.5 J	5.3	13.6	14	4.7
Cobalt	--	--	0.59 J	--	--	0.53 J	--	--
Copper	--	--	3.6 J	--	--	4.3 J	3.8 J	4.8 J
Iron	2,990	3,470	3,880	799	3,750	4,010	3,880	2,560
Lead	18.9	12.7	7.4	1.4	10	10.9	11.6	9.3
Magnesium	115 J	142 J	1,890	11.3 J	286 J	926 J	403 J	1,310
Manganese	61.5	56.4	172 J	4 J	80 J	188 J	164 J	99.4 J

See notes at end of table.

**Table 5-7 (Continued)**  
**Organic and Inorganic Analytes Detected in Surface Soil Samples**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Location Identifier:	2-SB01	2-SB01	02S001	02S002	02S003	02S004	02S004	02S005
Sample Identifier:	2-SB01(0-2)	2-SB01(0-2)D	02S00101	02S00201	02S00301	02S00401	02S00401D	02S00501
Collection Date:	31-JUL-93	31-JUL-93	06-DEC-95	06-DEC-95	06-DEC-95	05-DEC-95	05-DEC-95	06-DEC-96
Laboratory Sample No.:	94016001	94016002	G8876002	G8876003	G8876004	G8864007	G8864008	G8876005

**Inorganic Analytes (mg/kg) (Continued)**

Mercury	--	--	0.01 J	--	0.01 J	0.03 J	0.05	0.01 J
Nickel	--	1.7 J	4.4 J	--	--	3.9 J	3.8 J	4.2 J
Potassium	--	--	567 J	--	--	377 J	142 J	247 J
Sodium	164 J	171 J	--	--	--	--	--	--
Vanadium	9.2 J	10.5 J	20.3	3.2 J	11.9	12.9	11.7	10.4 J
Zinc	--	12	6.2	--	7.5	13.1	12.5	9.7
Cyanide	--	--	--	--	--	0.15 J	--	0.1 J

Notes: D = duplicate sample.  
 $\mu\text{g}/\text{kg}$  = micrograms per kilogram.  
 -- = analyte, if present, was less than the detection limit.  
 J = estimated value.  
 PCB = polychlorinated biphenyl.  
 DDT = dichlorodiphenyltrichloroethane.  
 $\text{mg}/\text{kg}$  = milligrams per kilogram.

**Table 5-8**  
**Comparison of Analytes Detected in Surface Soil Samples**  
**to Background Screening and Benchmark Concentrations**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Range of Detection Limits	Range of Detected Concentrations <sup>2</sup>	Background Screening Values <sup>3</sup>	USEPA Region III RBCs Residential/Industrial <sup>4</sup>	Soil Cleanup Target Levels Residential/Industrial/Leachability <sup>5</sup>
<b>TCL Volatile Organic Compounds (µg/kg)</b>						
Chloroform	1/6	10 to 11	5 to 5	--	<sup>6</sup> 100,000/940,000	400/600/NA
<b>TCL Semivolatile Organic Compounds (µg/kg)</b>						
bis(2-Ethylhexyl)phthalate	1/6	350 to 3,600	105*	--	<sup>6</sup> 46,000/410,000	75,000/230,000/NA
<b>Pesticides and PCBs (µg/kg)</b>						
Dieldrin	2/6	3.5 to 18	8.2* to 12*	--	<sup>6</sup> 40/360	70/300/NA
4,4'-DDT	1/6	3.5 to 18.5	3.7*	--	<sup>6</sup> 1,900/17,000	3,200/13,000/NA
alpha-Chlordane	1/6	1.8 to 9.5	5.4*	--	<sup>6</sup> 1,800/16,000	3,000/11,000/NA
gamma-Chlordane	1/6	1.8 to 9.5	3.2*	--	<sup>6</sup> 1,800/16,000	3,000/11,000/NA
<b>Inorganic Compounds (mg/kg)</b>						
Aluminum	6/6	40 to 40	1,150 to 9,230	13,500	<sup>7</sup> 7,800/200,000	72,000/1,000,000/SPLP <sup>8</sup>
Arsenic	6/6	2 to 2	0.82* to 3.95*	2.6	<sup>9</sup> 0.43/3.8	0.8/ <sup>9</sup> 4.62/NA
Barium	6/6	40 to 40	1.7 to 27.1	18.8	<sup>7</sup> 550/14,000	105/87,000/NA
Beryllium	4/6	0.11 to 1	0.11 to 0.45	0.36	<sup>6</sup> 16/410	120/700/NA
Calcium	5/6	1,000 to 1,000	982* to 12,500	446	--/--	--/--/--
Chromium	6/6	2 to 2	1.5 to 13.8*	10	<sup>7</sup> 23/610	<sup>10</sup> 290/430/NA
Cobalt	2/6	10 to 10	0.59 to 2.8*	2.8	<sup>7</sup> 470/12,000	4,700/110,000/NA
Copper	3/6	5 to 5	3.6 to 4.8	8	<sup>7</sup> 310/8,200	105/140,000/NA
Iron	6/6	20 to 20	799 to 3,945*	7,740	<sup>7</sup> 2,300/61,000	23,000/490,000/SPLP <sup>8</sup>
Lead	6/6	0.6 to 0.6	1.4 to 15.8*	10.2	<sup>11</sup> 400	500/920/NA
Magnesium	6/6	1,000 to 1,000	11.3 to 1,890	244	--/--	--/--/--
Manganese	6/6	3 to 3	4 to 176*	324	<sup>7</sup> 160/4,100	1,600/20,000/NA
Mercury	4/6	0.03 to 0.1	0.01 to 0.04*	0.12	<sup>7</sup> 2.3/61	3.7/28/NA
Nickel	4/6	4.8 to 8	1.3* to 4.4	6.8	<sup>7</sup> 160/4,100	105/28,000/NA
Potassium	3/6	1,000 to 1,000	250 to 570	177	--/--	--/--/--
Sodium	1/6	1,000 to 1,000	168*	382	--/--	--/--/--

See notes at end of table.

**Table 5-8 (Continued)**  
**Comparison of Analytes Detected in Surface Soil Samples**  
**to Background Screening and Benchmark Concentrations**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Range of Detection Limits	Range of Detected Concentrations <sup>2</sup>	Background Screening Values <sup>3</sup>	USEPA Region III RBCs Residential/Industrial <sup>4</sup>	Soil Cleanup Target Levels Residential/Industrial/Leachability <sup>5</sup>
<b>Inorganic Compounds (mg/kg) (Continued)</b>						
Vanadium	6/6	10 to 10	3.2 to 20.3	19	<sup>7</sup> 55/1,400	15/7,700/NA
Zinc	5/6	4 to 4	6.2 to 12.8*	15.8	<sup>7</sup> 2,300/61,000	23,000/560,000/NA
Cyanide	2/6	0.05 to 0.5	0.1 to 0.2*	0.28	160/4,100	30/5,000/NA

<sup>1</sup> Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (excluding rejected values).

<sup>2</sup> Value indicated by an asterisk is the average of a sample and its duplicate. If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.

<sup>3</sup> The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.

<sup>4</sup> Source: USEPA Region III RBC Table (October 1, 1998).

<sup>5</sup> Chapter 62-785, Florida Administrative Code, July 6, 1998. Leachability values are only compared to those compounds that exceeded Chapter 62-785, Florida Administrative Code, Groundwater Cleanup Target Levels in site groundwater samples.

<sup>6</sup> The values correspond to a human cancer risk level of 1 in 1,000,000.

<sup>7</sup> The calculated values correspond to a noncancer hazard quotient of 0.1.

<sup>8</sup> Leachability values may be derived using the SPLP test to calculate site-specific SCTLs or may be determined using TCLP in the event oily wastes are present.

<sup>9</sup> Value is an Florida Department of Environmental Protection (FDEP)-approved site-specific soil cleanup goal for arsenic at covered landfill sites, Naval Air Station Whiting Field (Appendix F, FDEP, 1998).

<sup>10</sup> Values are for hexavalent chromium.

<sup>11</sup> USEPA memorandum dated July 14, 1994, from Elliott P. Laws to Regional Administrators. Subject: Revised Interim Soil Lead Guidance for CERCLA Sites and Resource Conservation and Recovery Act Corrective Action Facilities. (USEPA, 1994c).

Notes: USEPA = U.S. Environmental Protection Agency.

RBC = risk-based concentration.

TCL = target compound list.

µg/kg = micrograms per kilogram.

-- = criteria not available.

NA = not applicable.

\* = average of a sample and its duplicate.

PCB = polychlorinated biphenyl.

DDT = dichlorodiphenyltrichloroethane.

mg/kg = milligrams per kilogram.

SPLP = synthetic precipitation leachate procedure.

SCTL = soil cleanup target level.

FAC, SCTLs. Concentrations of arsenic exceeded the residential value of the USEPA Region III RBCs and the Chapter 62-785, FAC, SCTLs, but did not exceed the FDEP-approved site-specific soil cleanup goal of 4.62  $\mu\text{g}/\text{kg}$  for arsenic (Appendix F).

**5.4 SUBSURFACE SOIL ASSESSMENT.** Table 5-9 summarizes the analytical results for organic and inorganic analytes detected in six subsurface soil samples at Site 2. The six soil samples were collected at various depth intervals in soil boring 2-SB01. The soil boring location is shown on Figure 3-1. Table 5-10 summarizes the frequency of detection, range of detection limits, range of detection concentrations, and background screening values for Site 2 subsurface soil samples. Subsurface soil analytical results are compared to Chapter 62-785, FAC, industrial and leachability SCTLs.

**TCL VOCs.** TCL VOCs were not detected in the subsurface soil samples collected from soil boring 2-SB01 at Site 2.

**TCL SVOCs.** Two SVOCs (2-methylnaphthalene and phenanthrene) were detected in the subsurface soil samples collected from soil boring 2-SB01 (Table 5-9). 2-Methylnaphthalene was detected in two subsurface soil samples (2-SB01[5-7] and 2-SB01[10-12]) collected from depth intervals of 5 to 7 feet bls and 10 to 12 feet bls, respectively. Phenanthrene was detected in one subsurface soil sample (2-SB01[10-12]) collected from a depth interval of 10 to 12 feet bls. The detected concentrations were below the Chapter 62-785, FAC, industrial and leachability SCTLs (Table 5-10). There are no USEPA Region III RBCs for the detected compounds.

**Pesticides and PCBs.** Three pesticide compounds (dieldrin, alpha-chlordane, and gamma-chlordane) and one PCB compound (Aroclor-1260) were detected in three of six subsurface soil samples collected from soil boring 2-SB01 (Table 5-9). Dieldrin was detected in sample 2-SB01(5-7), alpha- and gamma-chlordane were detected in sample 2-SB01(10-12), and Aroclor-1260 was detected in samples 2-SB01(10-12) and 2-SB01(15-17). None of the compounds were detected in the background soil samples. The detected concentrations were below the respective USEPA Region III RBCs and Chapter 62-785, FAC, industrial and leachability SCTLs (Table 5-10).

**TAL Metals and (Total) Cyanide.** Seventeen inorganic analytes were detected in the subsurface soil samples from Site 2 (Table 5-9). Thirteen of the analytes (aluminum, barium, calcium, chromium, copper, iron, lead, magnesium, manganese, potassium, sodium, vanadium, and zinc) were detected in all six of the samples. Cyanide (total), if present, was not detected in the samples at concentrations that exceeded the detection limit.

Concentrations of calcium, manganese, potassium, and sodium exceeded the background screening values; however, all of the inorganic analytes detected in the subsurface soil samples were below the respective USEPA Region III RBCs and Chapter 62-785, FAC, industrial and leachability SCTLs (Table 5-10).

**5.5 GROUNDWATER ASSESSMENT.** The groundwater assessment at Site 2 consisted of collecting one groundwater sample using a BAT sampler during Phase I and collecting groundwater samples from onsite monitoring wells during Phases IIA and

**Table 5-9  
 Organic and Inorganic Analytes Detected in Subsurface Soil Samples**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Sample Identifier:	2-SB01(5-7)	2-SB01(10-12)	2-SB01(15-17)	2-SB01-(20-22)	2-SB01(50-52)	2-SB01(65-70)
Sample Depth Interval (feet bls):	5 to 7	10 to 12	15 to 17	20 to 22	50 to 52	65 to 70
Collection Date:	30-JUL-93	30-JUL-93	30-JUL-93	30-JUL-93	30-JUL-93	05-DEC-95
Laboratory Sample No.:	94015004	94015005	94015006	94015007	94015008	G8864004
<b><u>Volatile Organic Compounds (µg/kg)</u></b>						
None						
<b><u>Semivolatile Organic Compounds (µg/kg)</u></b>						
2-Methylnaphthalene	940 J	810 J	--	--	--	--
Phenanthrene	--	520 J	--	--	--	--
<b><u>Pesticides and PCBs (µg/kg)</u></b>						
Dieldrin	4 J	--	--	--	--	--
alpha-Chlordane	--	3.3 J	--	--	--	--
gamma-Chlordane	--	3.1 J	--	--	--	--
Aroclor-1260	--	320 J	31 J	--	--	--
<b><u>Inorganic Analytes (mg/kg)</u></b>						
Aluminum	3,760	2,380	2,090	525	63	221
Arsenic	0.54 J	0.37 J	0.25 J	0.13 J	--	--
Barium	7.4 J	3.7 J	10.4 J	1.5 J	0.54 J	0.67 J
Beryllium	--	--	0.15 J	--	0.11 J	--
Cadmium	0.17 J	0.24 J	0.22 J	--	0.24 J	--
Calcium	1,820	687 J	8,060	269 J	118 J	135 J
Chromium	3.6	3	1.9 J	1.9 J	1 J	1.4 J
Copper	1.8 J	1.6 J	1.1 J	0.83 J	0.43 J	0.61 J
Iron	2,170	1,750	775	669	256	325
See notes at end of table.						

**Table 5-9 (Continued)**  
**Organic and Inorganic Analytes Detected in Subsurface Soil Samples**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Sample Identifier:	2-SB01(5-7)	2-SB01(10-12)	2-SB01(15-17)	2-SB01-(20-22)	2-SB01(50-52)	2-SB01(65-70)
Sample Depth Interval (feet bls):	5 to 7	10 to 12	15 to 17	20 to 22	50 to 52	65 to 70
Collection Date:	30-JUL-93	30-JUL-93	30-JUL-93	30-JUL-93	30-JUL-93	05-DEC-95
Laboratory Sample No.:	94015004	94015005	94015006	94015007	94015008	G8864004
<b>Inorganic Analytes (mg/kg) (Continued)</b>						
Lead	4.9	2.6	1.9	0.73	0.25 J	0.36 J
Magnesium	261 J	78.8 J	134	26.3 J	16.4 J	14.6 J
Manganese	31.6	10.8	53.5	3.4	1.7 J	1.8 J
Potassium	138 J	104 J	343 J	153 J	154 J	90.3 J
Silver	--	--	--	--	0.42 J	--
Sodium	154 J	137 J	197 J	149 J	114 J	153 J
Vanadium	7 J	6.5 J	2.7 J	3.5 J	0.68 J	1.2 J
Zinc	5 J	4.4 J	4.1 J	2 J	3.1 J	2.2 J
<p>Notes: bls = below land surface.  <math>\mu\text{g}/\text{kg}</math> = micrograms per kilogram.                      J = estimated value.                      -- = analyte, if present, is at a concentration less than the detection limit.                      PCB = polychlorinated biphenyl.  <math>\text{mg}/\text{kg}</math> = milligrams per kilogram.</p>						

**Table 5-10  
Comparison of Analytes Detected in Subsurface Soil Samples  
to Background Screening and Benchmark Concentrations**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Range of Detection Limits	Range of Detected Concentrations <sup>2</sup>	Background Screening Values <sup>3</sup>	USEPA Region III RBCs Industrial <sup>4</sup>	Soil Cleanup Target Levels Industrial/Leachability <sup>5</sup>
<b>TCL Volatile Organic Compounds (µg/kg)</b>						
None detected						
<b>TCL Semivolatile Organic Compounds (µg/kg)</b>						
2-Methylnaphthalene	2/6	340 to 3,500	810 to 940	--	<sup>6</sup> 4,100,000	15,000,000/NA
Phenanthrene	1/6	340 to 3,500	520 to 520	--	--	29,000,000/NA
<b>Pesticides and PCBs (µg/kg)</b>						
Dieldrin	1/6	3.4 to 4	4 to 4	--	360	300/NA
alpha-Chlordane	1/6	1.8 to 2	3.3 to 3.3	--	16,000	11,000/NA
gamma-Chlordane	1/6	1.8 to 2	3.1 to 3.1	--	16,000	11,000/NA
Aroclor-1260	2/6	34 to 40	31 to 320	--	2,900	--/--
<b>Inorganic Analytes (mg/kg)</b>						
Aluminum	6/6	40 to 40	63 to 3,760	27,800	<sup>6</sup> 200,000	1,000,000/SPLP <sup>7</sup>
Arsenic	4/6	2 to 2	0.13 to 0.54	6.2	<sup>8</sup> 3.8	3.7/NA
Barium	6/6	40 to 40	0.54 to 10.4	15.8	<sup>6</sup> 14,000	87,000/NA
Beryllium	2/6	1 to 1	0.11 to 0.15	0.26	<sup>8</sup> 410	700/NA
Cadmium	4/6	1 to 1	0.17 to 0.24	0.92	<sup>6</sup> 100	1,300/NA
Calcium	6/6	1,000 to 1,000	118 to 8,060	444	--	--/--
Chromium	6/6	2 to 2	1 to 3.6	22.8	<sup>6</sup> 610	<sup>9</sup> 430/NA
Copper	6/6	5 to 5	0.43 to 1.8	8.8	<sup>8</sup> 8,200	140,000/NA
Iron	6/6	20 to 20	256 to 2,170	18,100	<sup>6</sup> 61,000	490,000/SPLP <sup>7</sup>
Lead	6/6	0.6 to 0.6	0.25 to 4.9	8.4	<sup>10</sup> 400	920/NA
Magnesium	6/6	1,000 to 1,000	14.6 to 261	272	--	--/--
Manganese	6/6	3 to 3	1.7 to 53.5	42.6	<sup>6</sup> 4,100	20,000/NA
Potassium	6/6	1,000 to 1,000	90.3 to 343	181	--	--/--
See notes at end of table.						



IIB. A comprehensive basewide groundwater investigation that will also characterize the Site 2 groundwater is currently being conducted at NAS Whiting Field. The results of the NAS Whiting Field basewide groundwater investigation will be reported in the Site 40 Remedial Investigation Report.

**5.5.1 Phase I Groundwater Samples** The RI Phase I investigation at Site 2 consisted of collecting a groundwater sample using a PCPT and BAT sampler in the south-central perimeter of the site (Figure 3-2). The groundwater sample was collected from 99 feet bls and analyzed for VOCs and TAL inorganic analytes at an off-site laboratory. Acetone and carbon disulfide were detected in the groundwater sample; however, the detected concentrations were interpreted by ABB-ES to be an artifact resulting from decontamination procedures because acetone and carbon disulfide were also detected at similar concentrations in the associated equipment blanks (ABB-ES, 1992c).

Seven inorganic analytes (barium, calcium, iron, magnesium, manganese, sodium, and zinc) were also detected in the groundwater sample; however, sodium was also detected in the associated equipment blank. Results of the PCPT and BAT sampling event are summarized in the RI Phase I Technical Memorandum No. 5 (ABB-ES, 1992c).

The groundwater sample collected using the BAT sampler is considered appropriate for preliminary screening but is not appropriate to support risk assessment conclusions or decision making relative to response actions.

**5.5.2 Phase II Groundwater Samples** Table 5-11 presents field parameter data and Table 5-12 presents the analytical results for groundwater samples collected at Site 2 during the Phase IIA and IIB sampling events. The location of the Site 2 monitoring wells is shown on Figure 3-2. Below is a discussion of the analytical results for the Phase IIA and IIB sampling events.

**Table 5-11  
Summary of Groundwater Field Parameters, Site 2**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Monitoring Well Designation	Date Sampled	pH (SU)	Temperature (°C)	Specific Conductance (µmhos/cm)	Turbidity (NTU)	Redox (mV)	DO (percent)
WHF 2-1	10-19-93	5.65	25.0	30	1,208	--	--
WHF 2-1	7-23-96	4.96	24.1	24	5.80	--	5.35
WHF 2-2	7-23-96	--	--	--	4.60	--	--
WHF 3-3	7-24-96	--	--	--	3.14	--	--

Notes: SU = standard unit.  
°C = degrees Celsius.  
µmhos/cm = micromhos per centimeter.  
NTU = nephelometric turbidity unit.  
Redox = oxidation reduction potential.  
mV = millivolt.  
DO = dissolved oxygen.  
-- = not measured.

Field Parameters. Representative measurements of the field parameters obtained during the purging of the monitoring wells are presented in Table 5-11. The pH values for groundwater samples collected at Site 2 ranged from 4.96 to 5.65 SUs. The pH values were below the lower range for the Florida secondary drinking water requirements of 6.5 SUs; however, they were within the range of values observed in background groundwater samples collected for NAS Whiting Field.

Temperature measurements ranged from 24.1 to 25.0 degrees Celsius, and the specific conductance ranged from 24 to 30 micromhos per centimeter. Turbidity measurement for the Phase IIA groundwater sample was 1,208 NTUs. Turbidity measurements for Phase IIB groundwater samples, collected using low-flow sampling methods, ranged from 3.14 to 5.80 NTUs. All of the Phase IIB groundwater samples except one (WHF-2-1) had turbidity measurements below the Florida public water supply treatment technique criteria of 5 NTUs.

Phase IIA Sampling Event. During Phase IIA of the RI, one groundwater sample and one duplicate sample were collected from the only existing Site 2 monitoring well (WHF-2-1) on October 19, 1993. Table 5-12 presents the analytical results for groundwater sample WHF2-1 and WHF2-1A (duplicate sample) collected at Site 2 during Phase IIA of the RI.

VOCs were not detected at concentrations that exceeded the IDL in groundwater samples collected from monitoring well WHF-2-1.

One SVOC, bis(2-ethylhexyl)phthalate, was detected only in the duplicate groundwater sample from shallow monitoring well WHF-2-1. The detected concentration (7  $\mu\text{g}/\text{l}$ ) slightly exceeded the Federal primary maximum contaminant level (MCL) and State GCTL of 6  $\mu\text{g}/\text{l}$ . Bis(2-ethylhexyl)phthalate is a commonly recognized field or laboratory derived contaminant according to USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1991b).

No pesticide or PCB compounds were detected in the groundwater sample.

Fifteen inorganic analytes were detected in the Phase IIA groundwater samples. Silver was the only inorganic analyte detected at a concentration (4.6  $\mu\text{g}/\text{l}$ ) exceeding the background screening criteria; however, it was not detected in the associated duplicate sample. Silver was not detected in the background groundwater samples at NAS Whiting Field (HLA, 1998).

Three analytes, aluminum, chromium, and iron, were detected at concentrations exceeding the Federal and State primary or secondary MCLs. The Federal and State MCLs for aluminum, chromium, and iron are 200  $\mu\text{g}/\text{l}$  (secondary standard), 50  $\mu\text{g}/\text{l}$  (primary standard), and 300  $\mu\text{g}/\text{l}$  (secondary standard), respectively.

Phase IIB Sampling Event. Table 5-12 presents the groundwater quality parameters measured in groundwater samples collected during Phase IIB of the RI. These parameters were within the range of values expected for the sand and gravel aquifer with the exception of alkalinity, hardness, and total dissolved solids, which are slightly higher and within the values expected for the Floridan aquifer (Florida Geological Survey, 1992). Table 5-13 provides basic statistical parameters of detected analyte concentrations in Site 2 Phase IIB groundwater samples including the frequency of detection, range, mean, and screening value. The range of analyte concentrations in Site 2 groundwater samples was compared in Table 5-13 to Federal applicable or relevant and appropriate requirements (ARARs) including Federal primary and secondary MCLs, and the Chapter 62-785,

**Table 5-12**  
**Organic, Inorganic, and Water Quality Parameters Measured in Groundwater Samples**

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Sampling Event:	Phase IIA		Phase IIB				
	WHF-2-1	WHF-2-1	WHF-2-1	WHF-2-1	WHF-2-2	WHF-2-3	WHF-2-3
Location Identifier:	WHF2-1	WHF2-1A	02G00101	02G00101F	02G00201	02G00301	02G00301D
Sample Identifier:	WHF2-1	WHF2-1A	02G00101	02G00101F	02G00201	02G00301	02G00301D
Collection Date:	19-OCT-93	19-OCT-93	23-JUL-96	23-JUL-96 (filtered sample)	23-JUL-96	24-JUL-96	24-JUL-96
Laboratory Sample No.:	90178002	90178004	RB887009	RB887010	RB887008	RB887012	RB887013
<b><u>Volatile Organic Compounds (µg/l)</u></b>							
Carbon disulfide	--	--	--	NA	--	1-J	--
<b><u>Semivolatile Organic Compounds (µg/l)</u></b>							
bis(2-Ethylhexyl)phthalate	--	7 J	1 J	NA	--	--	--
<b><u>Pesticides and PCBs (µg/l)</u></b>							
None detected				NA			
<b><u>Inorganic Analytes (µg/l)</u></b>							
Aluminum	12,700	11,200	248	--	--	79.3 J	84.6 J
Barium	60.9 J	57 J	42.3 J	38.7 J	92.2 J	128 J	129 J
Beryllium	1.4 J	1.3 J	0.52 J	--	--	0.39 J	--
Calcium	1,320 J	1,290 J	1,360 J	2,080 J	64,800	113,000	113,000
Chromium	163	144	4.1 J	--	--	--	--
Copper	39.2	34.1	2.4 J	1.6 J	--	--	--
Iron	74,200	66,500	1,280	--	59.7 J	--	--
Lead	5.8	4.8	--	--	--	--	--
Magnesium	1,390 J	1,380 J	1,030 J	982 J	8,650	9,560	9,590
Manganese	46	42.4	5 J	4 J	3.4 J	13.5 J	13.7 J
Nickel	--	--	--	--	--	7.8 J	9.6 J
Potassium	954 J	996 J	650 J	--	6,850	4,610 J	4,580 J
See notes at end of table.							

**Table 5-12 (Continued)**  
**Organic, Inorganic, and Water Quality Parameters Measured in Groundwater Samples**

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Sampling Event:	Phase IIA		Phase IIB				
	WHF-2-1	WHF-2-1	WHF-2-1	WHF-2-1	WHF-2-2	WHF-2-3	WHF-2-3
Location Identifier:	WHF2-1	WHF2-1A	02G00101	02G00101F	02G00201	02G00301	02G00301D
Sample Identifier:	WHF2-1	WHF2-1A	02G00101	02G00101F	02G00201	02G00301	02G00301D
Collection Date:	19-OCT-93	19-OCT-93	23-JUL-96	23-JUL-96 (filtered sample)	23-JUL-96	24-JUL-96	24-JUL-96
Laboratory Sample No.:	90178002	90178004	RB887009	RB887010	RB887008	RB887012	RB887013
<b>Inorganic Analytes (µg/l) (Continued)</b>							
Selenium	--	--	--	--	--	1.2 J	0.66 J
Silver	4.6 J	--	--	--	--	--	--
Sodium	1,280 J	1,310 J	1,110 J	1,150 J	1,980 J	2,200 J	2,240 J
Thallium	--	--	--	--	--	--	0.6 J
Vanadium	169	153	4.2 J	1.9 J	--	3 J	--
Zinc	21.8	20.2	19.3 J	--	--	--	--
<b>Groundwater Quality (mg/l)</b>							
Alkalinity as CaCO <sub>3</sub>	NA	NA	--	NA	142	253	255
Hardness as CaCO <sub>3</sub>	NA	NA	--	NA	198	332	326
Nitrate-nitrite	NA	NA	0.97	NA	6.61	9.34	8.94
Phosphorous-P, total	NA	NA	0.12	NA	--	--	--
Sulfate	NA	NA	0.63	NA	43.4	48	48.9
Total dissolved solids	NA	NA	24	NA	240	370	366
Total Kjeldahl nitrogen	NA	NA	--	NA	0.3	0.4	--
Total organic carbon	NA	NA	--	NA	3.9	6.5	6.6
<p>Notes: NA = not analyzed.  µg/l = micrograms per liter.  -- = analyte, if present, is at a concentration less than the detection limit.  J = estimated value.  mg/l = milligrams per liter.  CaCO<sub>3</sub> = calcium carbonate.</p>							

**Table 5-13**  
**Comparison of Analytes Detected in Phase IIB Groundwater Samples**  
**to Background Screening and Benchmark Concentrations**

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Analyte	Frequency of Detection <sup>1</sup>	Range of Detected Analyte Concentration <sup>2</sup>	Mean Analyte Concentration	Background Screening Values <sup>3</sup>	Federal MCLs <sup>4</sup>	Florida GCTL <sup>5</sup>
<b><u>TCL Volatile Organic Compounds (µg/l)</u></b>						
Carbon disulfide	1/3	3*	3.0	--	--	700
<b><u>Semivolatile Organic Compounds (µg/l)</u></b>						
bis(2-Ethylhexyl)phthalate	1/3	1	1.0	--	6	6
<b><u>Inorganic Analytes (µg/l)</u></b>						
Aluminum	2/3	82* to 248	165	654	<sup>6</sup> 200	200
Barium	3/3	42.3 to 129*	87.7	72.6	2,000	2,000
Beryllium	2/3	0.27* to 0.52	0.4	0.94	4	4
Calcium	3/3	1,360 to 113,000*	59,700	3,320	--	--
Chromium	1/3	4.1	4.1	30	100	100
Copper	1/3	2.4	2.4	10.8	<sup>6</sup> 100	1,000
Iron	2/3	59.7 to 1,280	670	964	<sup>6</sup> 300	300
Magnesium	3/3	1,030 to 9580*	6,420	2,430	--	--
Manganese	3/3	3.4 to 13.6*	7.3	42.8	<sup>6</sup> 50	50
Nickel	1/3	7.8*	8.7	42.8	100	100
Potassium	3/3	650 to 6850	4,030	1,530	--	--
Selenium	1/3	0.93*	0.93	0.98	50	50
Sodium	3/3	1,110 to 2,220	1,770	4,770	<sup>7</sup> --	160,000
Thallium	1/3	0.45*	0.45	--	2	2
Vanadium	2/3	2.2* to 4.2	3.2	3.8	--	49
Zinc	1/3	19.3	19.3	200	<sup>6</sup> 5000	5,000

See notes at end of table.

**Table 5-13 (Continued)**  
**Comparison of Analytes Detected in Phase IIB Groundwater Samples  
to Background Screening and Benchmark Concentrations**

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<sup>1</sup> Frequency of detection is the fraction of total samples analyzed in which the analyte was detected.

<sup>2</sup> Value indicated by an asterisk is the average of the sample and its duplicate. If the target analyte was not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.

<sup>3</sup> Background screening values for organic compounds are the arithmetic mean concentrations; for inorganic analytes it is two times the arithmetic mean concentrations. The latter values are used for analyte screening in risk assessment.

<sup>4</sup> Federal MCLs are maximum permissible concentrations of contaminants in water delivered to a user by a public water system.

<sup>5</sup> Source: Chapter 62-785, Florida Administrative Code, Groundwater Cleanup Target Levels.

<sup>6</sup> Secondary MCL.

<sup>7</sup> No MCL has been determined for sodium but a reporting limit of 20,000  $\mu\text{g}/\text{l}$  has been established.

Notes: MCL = maximum contaminant level.

$\mu\text{g}/\text{l}$  = micrograms per liter.

NA = no applicable standard currently exists.

TCL = target compound list.

\* = average of a sample and its duplicate.

TAL = target analyte list.

-- = criteria not available.

FAC, GCTLs. The results of the Phase IIA groundwater sampling event are not considered to be representative of the groundwater conditions at the site due to sample turbidity; therefore, they are not reported in Table 5-13.

Volatile Organic Compounds. One VOC, carbon disulfide, was detected in a groundwater sample collected from monitoring well WHF-2-3. Currently, there is no Federal MCL for carbon disulfide. The detected concentration did not exceed the Chapter 62-785, FAC, GCTL. Carbon disulfide is a commonly recognized field or laboratory derived contaminant according to USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1991b).

Semivolatile Organic Compounds. One SVOC (bis(2-ethylhexyl)phthalate) was detected in a groundwater sample collected from monitoring well WHF-2-1 at Site 2. The detected concentration (1  $\mu\text{g}/\ell$ ) was below the Federal primary MCL and Chapter 62-785, FAC, GCTL of 6  $\mu\text{g}/\ell$ . Bis(2-ethylhexyl)phthalate is a commonly recognized field or laboratory derived contaminant according to USEPA's *Contract Laboratory Program Functional Guidelines for Organic Data Review* (USEPA, 1991b).

Pesticides and Polychlorinated Biphenyls. No pesticide or PCB compounds were detected in any Phase IIB groundwater samples.

Inorganic Analytes. Sixteen inorganic analytes, including aluminum, barium, beryllium, calcium, chromium, copper, iron, magnesium, manganese, nickel, potassium, selenium, sodium, thallium, vanadium, and zinc were detected in groundwater samples collected from Site 2 monitoring wells. Two of the analytes, aluminum and iron, were detected in groundwater samples collected from monitoring well WHF-2-1 at concentrations exceeding their respective Federal secondary MCLs and Chapter 62-785, FAC, GCTLs of 200  $\mu\text{g}/\ell$  (aluminum) and 300  $\mu\text{g}/\ell$  (iron).

Filtered Groundwater Samples. One filtered sample for TAL inorganics analysis (metals only) was collected from monitoring well WHF-2-1 during the Phase IIB RI for comparison purposes only. Table 5-12 contains a summary of analytes detected in the filtered sample (sample identifier 02G00101F). Comparison of the analytical results between the filtered sample and the corresponding unfiltered sample indicates that fewer analytes are detected in the filtered sample. In addition, analyte concentrations in the filtered sample are generally lower than the corresponding concentrations in the unfiltered sample.

The data indicate that aluminum and iron, which were not detected in the filtered sample, are present as colloids or suspended sediment and are not dissolved in the groundwater.

One volatile, one semivolatile, and 16 inorganic analytes were detected in the Phase IIB groundwater samples. Only aluminum and iron were detected at concentrations that exceed the Federal or Chapter 62-785, FAC, GCTLs.

The number and concentration of inorganic analytes detected in groundwater samples collected during the 1996 sampling event are generally lower than the corresponding samples collected during the 1993 sampling event. The low-flow sampling procedure resulted in less turbid groundwater samples collected during Phase IIB than those collected during Phase IIA. Because the low flow sampling method produces less turbid samples that are more representative of the surficial aquifer than those obtained with a bailer, the preferred data set was from the Phase IIB sampling event.

**Table 5-14**  
**Summary of Analytical Results Detected in Site 1 Groundwater Samples**

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Well Identifier:	Phase II A Sampling Event				Phase II B Sampling Event						
	WHF-1-1S	WHF-1-1	WHF-1-2	WHF-1-3	WHF-1-1S	WHF-1-1	WHF-1-1	WHF-1-2	WHF-1-2	WHF-1-3	WHF-1-4
Sample Identifier:	WHF1-1B	WHF1-1	WHF1-2	WHF1-3	01G00101	01G00102	01G00102D	01G00201	01G00201F	01G00301	01G00401
Collect Date:	18-OCT-93	18-OCT-93	19-OCT-93	15-OCT-93	19-JUL-96	19-JUL-96	19-JUL-96	22-JUL-96	22-JUL-96	23-JUL-96	22-JUL-96
Laboratory Sample No.:	90177002	90177001	90178001	90175002	RB873007	RB873008	RB873009	RB887003	RB887004	RB887006	RB887002
<b>Volatile Organic Compounds (µg/l)</b>											
Carbon disulfide	--	--	--	--	1 J	--	--	--	NA	--	--
<b>Semivolatile Organic Compounds (µg/l)</b>											
bis(2-Ethylhexyl)phthalate	--	--	--	--	--	--	--	--	NA	2 J	--
<b>Pesticides and PCBs (µg/l)</b>											
beta-BHC	0.019 J	0.025 J	--	--	--	--	--	--	NA	--	--
<b>Inorganic Analytes (µg/l)</b>											
Aluminum	30,700	132 J	61,700	10,800	--	--	--	842	--	202	--
Barium	72.7 J	5.7 J	118 J	28.9 J	15.6 J	15.6 J	15.6 J	71.4 J	26 J	21.3 J	19.7 J
Beryllium	2.2 J	0.48 J	10 J	0.89 J	--	0.53 J	--	0.51 J	--	--	0.53 J
Calcium	3,120 J	1,070 J	1,090 J	1,300 J	796 J	5,850	6,250	2,730 J	2,070 J	960 J	712 J
Chromium	111	--	1,150	24.7	--	--	--	7.2 J	--	5.8 J	--
Cobalt	5.5 J	--	--	--	--	--	--	--	--	--	--
Copper	68.4	2.3 J	36.8 J	12.2 J	--	--	1.4 J	2.4 J	--	1.6 J	--
Iron	104,000	65.9 J	318,000	15,800	--	--	--	2,630	--	256	246
Lead	20.4	1.7 J	36.2	4.7	--	--	--	--	--	--	--
Magnesium	2,280 J	314 J	1,810 J	1260 J	719 J	337 J	331 J	807 J	712 J	717 J	644 J
Manganese	243	14.8 J	374	57.4	6.7 J	6.7 J	9 J	10.5 J	4.8 J	4.4 J	3.4 J
Mercury	0.23	--	0.36	--	--	--	--	--	--	--	--
Nickel	13.8 J	--	210	--	--	--	--	9.6 J	--	11 J	7.4 J
See notes at end of table.											

**Table 5-14 (Continued)**  
**Summary of Analytical Results Detected in Site 1 Groundwater Samples**

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Well Identifier:	Phase II A Sampling Event				Phase II B Sampling Event						
	WHF-1-1S	WHF-1-1	WHF-1-2	WHF-1-3	WHF-1-1S	WHF-1-1	WHF-1-1	WHF-1-2	WHF-1-2	WHF-1-3	WHF-1-4
Sample Identifier:	WHF1-1B	WHF1-1	WHF1-2	WHF1-3	01G00101	01G00102	01G00102D	01G00201	01G00201F	01G00301	01G00401
Collect Date:	18-OCT-93	18-OCT-93	19-OCT-93	15-OCT-93	19-JUL-96	19-JUL-96	19-JUL-96	22-JUL-96	22-JUL-96	23-JUL-96	22-JUL-96
Laboratory Sample No.:	90177002	90177001	90178001	90175002	RB873007	RB873008	RB873009	RB887003	RB887004	RB887006	RB887002
<b>Inorganic Analytes (<math>\mu\text{g}/\text{l}</math>) (Continued)</b>											
Potassium	2,420 J	614 J	3,090 J	1,220 J	714 J	938 J	842 J	634 J	458 J	554 J	--
Silver	5.8 J	--	--	--	--	--	--	--	--	--	--
Sodium	2,510 J	1,980 J	2,670 J	2,340 J	1,550 J	2,100 J	2,070 J	2,330 J	2,260 J	2,070 J	1980 J
Vanadium	268	--	1,360	77.5	--	--	1.6 J	9 J	--	--	1.3 J
Zinc	50	--	109	22.5	--	--	--	90.8	58.2	70.2	--
Cyanide	--	--	2.5 J	--	--	1.9 J	--	--	--	--	--
Notes: D = duplicate sample. F = filtered sample. $\mu\text{g}/\text{l}$ = micrograms per liter. -- = analyte not detected. J = estimated value. PCB = polychlorinated biphenyl. BHC = benzene hexachloride. NA = not analyzed.											

## 6.0 HUMAN HEALTH RISK ASSESSMENT

A human health risk assessment (HHRA) has been conducted as part of the RI/FS for Site 2 at NAS Whiting Field. The purpose of the HHRA is to characterize the risks associated with the potential exposures to site-related chemicals. This HHRA is conducted in accordance with the following guidance documents:

- USEPA's *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)* (USEPA, 1989b)
- *Guidance for Data Useability in Risk Assessment (Part A), Final* (USEPA, 1992a)
- Region IV Risk Assessment Guidance documents (USEPA, 1995b)
- Chapter 62-785, FAC, Brownfields Cleanup Criteria Rule (FDEP, 1998)

The methodology for the HHRA is described in Chapter 2.0 of the GIR (HLA, 1998). The HHRA methodology presented in the GIR (HLA, 1998) consists of the following steps:

- data evaluation,
- selection of chemicals of potential concern,
- exposure assessment,
- toxicity assessment, and
- risk characterization.

The HHRA was prepared prior to the promulgation of the Chapter 62-785, FAC, SCTLs and GCTLs. A comparison of the SCTLs and the compounds detected in the Site 2 soil samples is presented in Chapter 5.0. No additional human health chemicals of potential concern (HHPCPs) were identified in the HHRA based on the SCTLs and GCTLs.

The number of HHPCPs evaluated in the risk assessment was reduced by comparing the detected compounds to the Chapter 62-785, FAC, SCTLs and GCTLs. The risk estimates were generated previously using HHPCPs that do not exceed the Chapter 62-785, FAC, SCTLs, and GCTLs; therefore, they may be considered conservative.

Site 2 is located in the Northwest Open Disposal Area at Whiting Field. The location, physical description, and history associated with Site 2 are described in Chapter 1.0 of this report. During the RI, surface soil, subsurface soil, and groundwater were collected from Site 2. Sampling locations and the sampling rationale are presented in Chapters 3.0 and 5.0 of this report.

**6.1 DATA EVALUATION.** The data evaluation involves numerous activities, including sorting data by medium, evaluating analytical methods, evaluating sample quantitation limits, and evaluating quality of data with respect to qualifiers and codes.

The DQOs for collecting environmental samples and conducting laboratory analyses are described in the GIR (HLA, 1998). Chemical analyses were performed in accordance with the CLP Statement of Work. The analytical results were

evaluated, using the national functional guidelines (USEPA, 1988a; USEPA, 1991b) to assess the laboratory's compliance with the analytical methodology. The analytical data were reviewed, validated, and evaluated using the PARCC criteria specified in the DQOs. Based on a third party's evaluation of the analytical data's conformance with the DQOs, the data presented in this report are acceptable for use in this HHRA.

Sample quantitation limits (SQLs) are compared to Federal USEPA, USEPA Region III RBCs, and Florida screening values. Surface and subsurface soil SQLs were compared to Region III RBCs for soil and Chapter 62-785, FAC, SCTLs for residential and industrial scenarios, respectively. Groundwater SQLs were compared to Chapter 62-785, FAC, GCTLs, and Region III Drinking Water and Health Advisories MCLs and secondary MCLs. Analyte-specific SQLs that are above RBCs, Federal USEPA, and Florida screening values are identified and discussed in the uncertainty analysis.

**6.2 SELECTION OF HUMAN HEALTH CHEMICALS OF POTENTIAL CONCERN.** The human health chemicals of potential concern (HHPCs) were selected using USEPA Region IV criteria as per the methodology described in Section 2.5 of the GIR (HLA, 1998). This selection of HHPC methodology considers (1) frequency of detection, (2) consistency with background conditions, (3) a comparison to regulatory and risk-based screening values, and (4) presence in blanks or laboratory quality control samples.

For each medium, the following criteria will be employed to exclude detected analytes from the list of HHPCs. Each criterion by itself is justification for excluding the analyte:

Less than 5 Percent Frequency of Detection. If an analyte has a frequency of detection (number of samples in which the analyte is detected divided by the number of samples analyzed for that analyte) less than 5 percent (USEPA, 1995b) and is not selected as an HHPC in another medium, it is not selected as an HHPC. These selection criteria are used only when there are 20 or more samples in the media of concern.

Less than Background Screening Concentrations. If the maximum detected concentration of an analyte is less than twice the arithmetic mean of the background concentration (inorganics only), the analyte is not selected as an HHPC (USEPA, 1995b). The background screening values for surface soil, groundwater, and subsurface soil are identified below.

- A representative surface soil background data set consisting of Troup Loamy Sand and Lakeland Sand are used for background screening of Site 2 surface soil samples. The background screening values used in the risk assessment are presented in Table 6-1. The background surface soil data used for screening surface soils at Site 2 are presented in Tables 3-8 and 3-10 of the GIR report (HLA, 1998).
- Background subsurface soil sample locations for Whiting Field are identified on Figure 3-10 and are discussed in Subsection 3.3.1 of the GIR (HLA, 1998). Tables 3-15 through 3-17 of the GIR report present background screening concentrations for various types of subsurface soil. All background subsurface soil data were combined into one data

**Table 6-1**  
**Selection of Human Health Chemicals of Potential Concern**  
**for Surface Soil**

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Analyte	Frequency of Detection <sup>1</sup>	Range of Reporting Limits	Range of Detected Concentrations	Mean of Detected Concentrations <sup>2</sup>	Background Screening Concentration <sup>3</sup>	Selected Screening Concentration <sup>4</sup>	Analyte HHCP? (Yes/No)	Reason <sup>5</sup>
<b><u>Volatile Organic Compounds (µg/kg)</u></b>								
Chloroform	1/6	10 to 11	5	5	NA	600	No	S
<b><u>Semivolatile Organic Compounds (µg/kg)</u></b>								
bis(2-Ethylhexyl)phthalate	1/6	350 to 3,600	105*	105	NA	46,000	No	S
<b><u>Pesticides and PCBs (µg/kg)</u></b>								
alpha-Chlordane	1/6	1.8 to 9.5	5.4*	5.4	NA	490	No	S
gamma-Chlordane	1/6	1.8 to 9.5	3.2*	3.2	NA	490	No	S
4,4-DDT	1/6	3.5 to 18.5	3.7*	3.7	NA	1,900	No	S
Dieldrin	2/6	3.5 to 18	8.2* to 12*	9.8	NA	40	No	S
<b><u>Inorganic Analytes (mg/kg)</u></b>								
Aluminum	6/6	NA	1,150 to 9,230	6,150	13,500	7,800	No	B
Arsenic	6/6	NA	0.82* to 3.95*	2.1	2.6	0.43	Yes	
Barium	6/6	NA	1.7 to 27.1	14	18.8	550	No	S
Beryllium	4/6	0.11 to 1.0	0.11 to 0.45	0.24	0.36	16	No	S
Calcium	5/6	1,000	982* to 12,500	7,340	446	1,000,000	No	S
Chromium	6/6	NA	1.5 to 13.8*	6.2	10	23	No	S
Cobalt	2/6	1.1 to 10	0.59 to 2.8*	1.7	2.8	470	No	B, S
Copper	3/6	5	3.6 to 4.8	4.1	8	310	No	B, S
Cyanide	2/6	0.05 to 0.5	0.1 to 0.2*	0.15	0.28	160	No	B, S
Iron	6/6	NA	799 to 3,950	3,030	7,740	2,300	No	B
Lead	6/6	NA	1.4 to 15.8*	9.2	10.2	400	No	S
Magnesium	6/6	NA	11.3 to 1,890	715	244	460,468	No	S
Manganese	6/6	NA	4 to 176*	98.4	324	160	No	B, S
Mercury	4/6	0.03 to 0.1	0.01 to 0.04*	0.02	0.12	2.3	No	B, S

See notes at end of table.

**Table 6-1 (Continued)**  
**Selection of Human Health Chemicals of Potential Concern**  
**for Surface Soil**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Range of Reporting Limits	Range of Detected Concentrations	Mean of Detected Concentrations <sup>2</sup>	Background Screening Concentration <sup>3</sup>	Selected Screening Concentration <sup>4</sup>	Analyte HHCP? (Yes/No)	Reason <sup>5</sup>
<b>Inorganic Analytes (mg/kg) (Continued)</b>								
Nickel	4/6	4.8 to 8	1.3* to 4.4	3.4	6.8	160	No	B, S
Potassium	3/6	1,000	250 to 570	358	177	1,000,000	No	S
Sodium	1/6	1,000	168*	168	382	1,000,000	No	B, S
Vanadium	6/6	NA	3.2 to 20.3	11.3	19	55	No	S
Zinc	5/6	4	6.2 to 12.8*	8.6	15.8	2,300	No	B, S

<sup>1</sup> Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).

<sup>2</sup> The mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.

<sup>3</sup> The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.

<sup>4</sup> For all chemicals except the essential nutrients (calcium, magnesium, potassium, and sodium), the lower of the U.S. Environmental Protection Agency (USEPA) Region III Risk-Based Concentration (RBC) for residential soil exposure per January 1993 guidance ("Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening," USEPA/903/R-93-001) or the Chapter 62-785, Florida Administrative Code, soil cleanup target levels (FDEP, 1998) was used for screening. Actual values are taken from the USEPA Region III RBC Tables dated October 1, 1998, and are based on an excess lifetime cancer risk of  $1 \times 10^{-6}$  or an adjusted hazard quotient of 0.1. For the essential nutrients, screening values were derived based on recommended daily allowances. Values are presented in Appendix C of the General Information Report. Lead value is from Revised Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OSWER Directive 9355.4-12).

<sup>5</sup> Analyte was included or excluded from the risk assessment for the following reasons:

B = the maximum detected concentration did not exceed the background screening concentration; therefore, the analyte will not be considered further.

S = the maximum detected concentration did not exceed the screening concentration; therefore, the analyte will not be considered further.

Notes: The average of a sample and its duplicate is used for all table calculations.

Samples: 02S00101, 02S00201, 02S00301, 02S00401, 02S0051 & 2-SB01 (0-2ft). Note: Sample 02S004DDL was not used in the risk assessment because the data were rejected during validation.

Sample duplicates: 02S00401D and 2-SB01 (0-2ft)D.

Background samples: BKG-SL-01 through BK-SL-10, BKS00101, BKS00201, BKS00301, BKS00401, and BKS00501.

Background duplicate sample: BKS00201D and BK-SL-09A.

HHCP = human health chemical of potential concern.

$\mu\text{g}/\text{kg}$  = micrograms per kilogram.

NA = not applicable.

\* = value is the average of a sample and its duplicate.

mg/kg = milligrams per kilogram.

PCB = polychlorinated biphenyl.

DDT = dichlorodiphenyltrichloroethane.

set for background screening due to the limited number of background samples of certain soil types. Table 3-18 in the GIR (HLA, 1998) presents the summary statistics used for screening Site 2 subsurface soil contamination against background conditions.

- Background groundwater sample locations are identified on Figure 3-12 and are discussed in Section 3.3.3 of the GIR (HLA, 1998). Table 3-21 in the GIR report presents background screening data for groundwater. Table 3-24 in the GIR report presents the summary statistics used for screening the groundwater at Site 2.

Less than Risk-Based Screening Concentrations, Standards, and Guidelines. If the maximum detected concentration of the analyte in a medium is less than its corresponding adjusted USEPA Region III RBC (USEPA, 1997b), and less than Federal and Florida standards and guidelines, the analyte is not selected as a HHCP (USEPA, 1995b). The target hazard quotient, in the USEPA Region III RBC table, is 1 and the target cancer risk is  $1 \times 10^{-6}$ . All RBCs based on noncarcinogenic effects are adjusted for a target hazard quotient of 0.1 per Region IV guidance (USEPA, 1995b).

The residential and industrial soil RBCs are used for surface and subsurface soil, respectively. No RBC is available for lead in soil due to a lack of toxicity data. Based on USEPA recommendation, a screening level of 400 mg/kg for lead under residential land use is used as the RBC for lead in soil (USEPA, 1994b). The maximum detected concentrations of analytes in surface soil are also compared to Chapter 62-785, FAC, residential SCTLs. The maximum detected concentration of any organic analyte in surface soil or subsurface soil that was also detected in groundwater (above a standard or guideline) is compared to the Florida Leaching Value reference for that analyte.

Tap water RBCs (March 1997), Federal MCLs (February 1996) and Florida Guidance Concentrations (June 1994) are used for tap water. No RBC is available for lead in groundwater; therefore, the treatment technology action level for lead in drinking water of 15  $\mu\text{g}/\ell$  is used (USEPA, 1994a).

Less than Essential Nutrient Screening Values. An essential nutrient is not selected as an HHCP if the maximum detected concentration of the essential nutrient (i.e., sodium, potassium, magnesium, chloride, iodine, phosphorus, and calcium) in a medium is below a toxic level and consistent with or only slightly above its background concentration. The derivation of essential nutrient screening values is presented in the GIR.

Detected concentrations were not screened using the iron essential nutrient value; however, if iron is determined to be a risk driver, a comparison of the risk concentrations against the essential nutrient level for iron will be presented in the uncertainty section for that medium.

If the analyte meets any of the above criteria, is not a member of the same chemical class as other HHCPs in the medium, and is not a breakdown product of other HHCPs in the medium, then the analyte is not selected as a chemical of potential concern (CPC). In situations where multiple screening values are available, a chemical is excluded only if its maximum detected concentration is less than all of the corresponding screening values. Appendix C presents the RBCs, regulatory guidance values, and ARARs that are used in HHCP selection.

After applying these criteria with professional judgment, HHCCPCs are identified for each medium. HHCCPC selection for each medium is presented below in Subsections 6.2.1 through 6.2.3.

**6.2.1 Site 2 Surface Soil** Six samples (02S00101, 0200201, 0200301, 0200401, 02S00501, 2-SB01 [0-2]) and duplicates at 002S00401D and 02-SB01 (0-2)D were collected from Site 2 (Figure 3-1). VOCs, SVOCs, pesticides, and inorganic data from all of these samples are evaluated in this HHRA. Table 6-1 identifies only one inorganic analyte (arsenic) selected as an HHCCPC for surface soil at Site 2.

**6.2.2 Site 2 Subsurface Soil** Two subsurface soil samples, 2-SB01 (5-7) and 2-SB01 (10-12), were collected from Site 2 (Figure 3-1). Subsurface soil samples from intervals greater than 15 feet were not included in the risk assessment data set. SVOCs, pesticides, PCBs, and inorganic data from these samples are evaluated in this HHRA. Table 6-2 presents the HHCCPCs selection for subsurface soil at Site 2. No analytes were selected as HHCCPCs in the subsurface soil.

**6.2.3 Site 2 Groundwater** Three groundwater samples (02G00101, 02G00201, and 02G00301 and its duplicate, 02G00301D) were collected from Site 2 (Figure 3-2). Sample 2G00101F was not evaluated in the risk assessment because the sample was filtered in the field. Only unfiltered groundwater samples collected in 1996 were considered in this HHRA. VOCs, SVOCs, and inorganic data from these samples are evaluated in this HHRA. One inorganic compound (iron) was selected as an HHCCPC in the groundwater (Table 6-3).

**6.3 EXPOSURE ASSESSMENT.** The exposure assessment methodology is described in Subsection 2.5.3 of the GIR (HLA, 1998). This process involves several steps:

- characterization of the exposure setting in terms of the physical characteristics and the populations that may potentially be exposed to site-related chemicals;
- identification of potential exposure pathways and receptors; and
- quantification of exposure for each population in terms of the amount of chemical ingested, inhaled, or absorbed through the skin from all complete exposure pathways.

Summaries of potential exposure pathways to chemicals detected at Site 2 are presented on Figure 6-1.

The potential pathways including medium and route of exposure, the potentially exposed population, and the rationale for pathway selection or exclusion are provided in Table 6-4 and are described in more detail in Subsections 6.3.1 through 6.3.3. Receptor-specific exposure parameters for each exposure scenario are presented in Appendix C to the GIR (HLA, 1998). Risk calculation spreadsheets in Appendix C to this RI report also contain the assumed exposure parameters and quantitation of exposures.

**6.3.1 Site 2 Surface Soil** No humans currently reside or work at Site 2. Site 2 may be developed eventually for residential land use; therefore, the residential receptor will be evaluated as part of the hypothetical future land-use scenario. Currently, there are no buildings presently at the site; therefore, exposure of

**Table 6-2**  
**Selection of Human Health Chemicals of Potential Concern**  
**for Subsurface Soil**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Range of Reporting Limit	Range of Detected Concentrations	Mean of Detected Concentrations <sup>2</sup>	Background Screening Concentration <sup>3</sup>	Selected Screening Concentration <sup>4</sup>	Analyte HHCP? (Yes/No)	Reason <sup>5</sup>
<b>Semivolatile Organic Compounds (µg/kg)</b>								
2-Methylnaphthalene	2/2	NA	810 to 940	875	NA	15,000,000	No	S
Phenanthrene	1/2	3,500	520	520	NA	29,000,000	No	S
<b>Pesticides and PCBs (µg/kg)</b>								
Aroclor-1260	1/2	35	320	320	NA	2,900	No	S
Dieldrin	1/2	3.5	4	4	NA	300	No	S
alpha-Chlordane	1/2	1.8	3.3	3.3	NA	11,000	No	S
gamma-Chlordane	1/2	1.8	3.1	3.1	NA	11,000	No	S
<b>Inorganic Analytes (mg/kg)</b>								
Aluminum	2/2	NA	2,380 to 3,760	3,070	27,800	200,000	No	B, S
Arsenic	2/2	NA	0.37 to 0.54	0.46	6.2	3.7	No	B, S
Barium	2/2	NA	3.7 to 7.4	5.6	15.8	14,000	No	B, S
Cadmium	2/2	NA	0.17 to 0.24	0.21	0.92	100	No	B, S
Calcium	2/2	NA	687 to 1,820	1,250	444	1,000,000	No	S
Chromium	2/2	NA	3.0 to 3.6	3.3	22.8	430	No	B, S
Copper	2/2	NA	1.6 to 1.8	1.7	8.8	8,200	No	B, S
Iron	2/2	NA	1,750 to 2,170	1,960	18,100	61,000	No	B, S
Lead	2/2	NA	2.6 to 4.9	3.8	8.4	400	No	B, S
Magnesium	2/2	NA	78.8 to 261	170	272	460,468	No	B, S
Manganese	2/2	NA	10.8 to 31.6	21.2	42.6	4,100	No	B, S
Potassium	2/2	NA	104 to 138	121	181	1,000,000	No	B, S
Sodium	2/2	NA	137 to 154	146	ND	1,000,000	No	S
Vanadium	2/2	NA	6.5 to 7	6.8	45	1,400	No	B, S
Zinc	2/2	NA	4.4 to 5	4.7	15.6	61,000	No	B, S
See notes at end of table.								

**Table 6-2 (Continued)**  
**Selection of Human Health Chemicals of Potential Concern**  
**for Subsurface Soil**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

<sup>1</sup> Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).

<sup>2</sup> The mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.

<sup>3</sup> The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.

<sup>4</sup> For all chemicals except the essential nutrients (calcium, magnesium, potassium, and sodium), these lesser of the U.S. Environmental Protection Agency (USEPA) Region III Risk-Based Concentration (RBC) tables (October 1, 1998) or Chapter 62-785, Florida Administrative Code, SCTLs were used for screening. Values taken from the USEPA Region III RBC Tables dated October 1, 1998, and are based on an excess lifetime cancer risk of  $1 \times 10^{-6}$  or an adjusted hazard quotient of 0.1. For the essential nutrients, screening values were derived based on recommended daily allowances. Values are presented in Appendix C of the General Information Report. Lead value is from Revised Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OSWER Directive 9355.4-12).

<sup>5</sup> Analyte was included or excluded from the risk assessment for the following reasons:

B = the maximum detected concentration did not exceed the background; therefore, the analyte will not be considered further.

S = the maximum detected concentration did not exceed the screening concentration; therefore, the analyte will not be considered further.

Notes: The average of a sample and its duplicate is used for all table calculations.

Samples: 2-SB01(5-7ft) and 2-SB01(10-12ft).

Background samples: BKB00101, BKB00102, BKB00201, BKB00202, BKB00301, BKB00302, BKB00401, BKB00402, BKB00501, BKB00502, BKB00601, BKB00602, BKB00701, BKB00702.

Background duplicate samples: BKB00401D and BKB00602D.

HHPCP = human health chemical of potential concern.

$\mu\text{g}/\text{kg}$  = micrograms per kilogram.

NA = not applicable.

PCB = polychlorinated biphenyl.

$\text{mg}/\text{kg}$  = milligrams per kilogram.

ND = no data.

SCTL = soil cleanup target level.

**Table 6-3**  
**Selection of Human Health Chemicals of Potential Concern**  
**for Unfiltered Groundwater**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Range of Reporting Limit	Range of Detected Concentrations <sup>2</sup>	Mean of Detected Concentrations <sup>3</sup>	Background Screening Concentration <sup>4</sup>	Selected Screening Concentration <sup>5</sup>	Analyte HHPCP? (Yes/No)	Reason <sup>6</sup>
<b>Volatile Organic Compounds (µg/l)</b>								
Carbon disulfide	1/3	10	3*	3	NA	100	No	S
<b>Semivolatile Organic Compounds (µg/l)</b>								
bis(2-Ethylhexyl)phthalate	1/3	10	1	1	NA	4.8	No	S
<b>Inorganic Analytes (µg/l)</b>								
Aluminum	2/3	58.8	82.0* to 248	165	654	50	No	B
Barium	3/3	NA	42.3* to 129*	87.7	72.6	260	No	S
Beryllium	2/3	0.15 to 0.3	0.27* to 0.52	0.4	0.94	0.016	No	B
Calcium	3/3	NA	1,360 to 113,000*	59,700	3,320	1,055,398	No	S
Chromium	1/3	2	4.1	4.1	30	18	No	B, S
Copper	1/3	1.1	2.4	2.4	10.8	150	No	B, S
Iron	2/3	37.5	59.7 to 1,280	670	964	300	Yes	
Magnesium	3/3	NA	1,030 to 9,580*	6,420	2,430	118,807	No	S
Manganese	3/3	NA	3.4 to 13.6*	7.3	42.8	50	No	B, S
Nickel	1/3	7.3	8.7*	8.7	42.8	73	No	B, S
Potassium	3/3	NA	650 to 6,850	4,030	1,530	297,016	No	S
Selenium	1/3	0.6	0.93*	0.93	0.98	18	No	B, S
Sodium	3/3	NA	1,110 to 2,220*	1,770	4,770	160,000	No	B, S
Thallium	1/3	0.3 to 0.6	0.45*	0.45	ND	2	No	S
Vanadium	2/3	1.2 to 1.4	2.2* to 4.2	3.2	3.8	26	No	S
Zinc	1/3	1.9 to 2	19.3	19.3	200	1,100	No	B, S

See notes at end of table.

**Table 6-3 (Continued)**  
**Selection of Human Health Chemicals of Potential Concern**  
**for Unfiltered Groundwater**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

<sup>1</sup> Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).

<sup>2</sup> A value indicated by an asterisk is the average of a sample and its duplicate. For duplicate samples having one nondetect, one-half of the contract-required quantification limit/contract-required detection limit is used as a surrogate concentration for the nondetect.

<sup>3</sup> The mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.

<sup>4</sup> The background screening value is twice the average of detected concentrations for inorganic analytes in background samples.

<sup>5</sup> For all chemicals except the essential nutrients (calcium, magnesium, potassium, and sodium), the lesser of the U.S. Environmental Protection Agency (USEPA), Region III Risk-Based Concentration (RBC) table for tap water exposure per January 1993 guidance ("Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening," EPA/903/R-93-001) or the Chapter 62-785, Florida Administrative Code, Groundwater Cleanup Target Levels was used for screening. Actual values are taken from the USEPA Region III RBC tables dated December 1, 1998, and are based on a excess lifetime cancer risk of  $1 \times 10^{-6}$  or an adjusted hazard quotient of 0.1. For the essential nutrients, screening values were derived based on recommended daily allowances. Values are presented in Appendix C of the General Information Report.

<sup>6</sup> Analyte was included or excluded from the risk assessment for the following reasons:

B = the maximum detected concentration did not exceed the background screening concentration; therefore, the analyte will not be considered further.

S = the maximum detected concentration did not exceed the screening concentration; therefore, the analyte will not be considered further.

Notes: The average of a sample and its duplicate is used for all table calculations.

Samples: 02G00101 through 02G00301.

Duplicate sample: 02G00301D.

Background samples: BKG00101 through BKG00103, BKG00201 through BKG00203, BKG00301 through BKG00303.

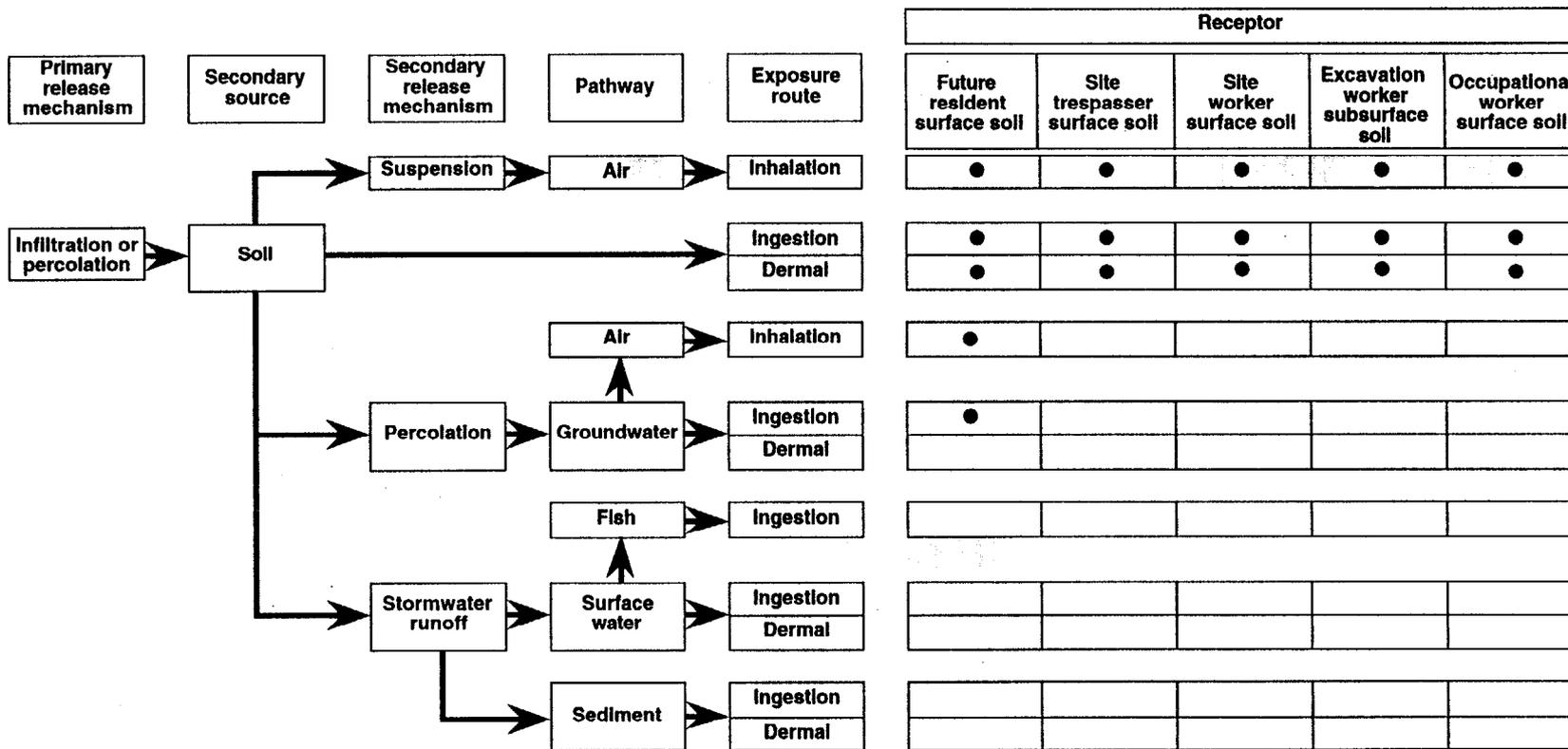
Background duplicate sample: BKG00101D.

\* = average of a sample and its duplicate.

HHPCP = human health chemical of potential concern.

$\mu\text{g}/\text{l}$  = micrograms per liter.

NA = not applicable.



**NOTE:**  
NAS = Naval Air Station

**FIGURE 6-1  
SITE 2, COMPLETE EXPOSURE PATHWAYS  
FOR HUMAN RECEPTORS**



**REMEDIAL INVESTIGATION REPORT  
SITE 2, NORTHWEST OPEN  
DISPOSAL AREA**

**NAS WHITING FIELD  
MILTON, FLORIDA**

**Table 6-4**  
**Summary of Potential Exposure Pathways**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Medium of Exposure	Route of Exposure	Potentially Exposed Population	Selected for Evaluation ?	Reason for Selection or Evaluation
<b>Current Land Use</b>				
Surface soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Resident (adult and child)	No	No humans currently reside or work at Site 2. Adolescents and adults may be exposed to contaminants in the surface soil while trespassing. Site maintenance workers may be exposed to contaminants in surface soil while performing routine maintenance activities.
		Trespasser (adult and adolescent)	Yes	
		Occupational worker (adult)	No	
		Site maintenance worker (adult)	Yes	
		Excavation worker (adult)	No	
Subsurface soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Excavation worker (adult)	No	An excavation worker could be exposed to soils during excavation activities, but no excavation activities are ongoing. No HHCPs were selected.
Groundwater	Ingestion of groundwater as drinking water and inhalation of volatile showering.	Resident (adult)	No	There are no current exposures to groundwater. Inhalation of volatiles while showering is not a complete exposure pathway because no VOCs were selected as HHCPs.
<b>Future Land Use</b>				
Surface soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Resident (child and adult)	Yes	If Site 2 is developed for residential or commercial use, residents, excavation workers, and occupational workers could be exposed to chemicals in surface soil. Exposure of trespassers and site maintenance workers to chemicals in surface soil are also possible as described above.
		Trespasser (adolescent and adult)	Yes	
		Occupational worker (adult)	Yes	
		Site maintenance worker (adult)	Yes	
		Excavation worker (adult)	Yes	
Subsurface soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Excavation worker (adult)	Yes	An excavation worker could be exposed to subsurface soil during utility work or construction activities. No HHCPs were selected.
See notes at end of table.				

**Table 6-4 (Continued)**  
**Summary of Potential Exposure Pathways**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Medium of Exposure	Route of Exposure	Potentially Exposed Population	Selected for Evaluation ?	Reason for Selection or Evaluation
<b><u>Future Land Use</u></b>				
Groundwater	Ingestion of groundwater as drinking water and inhalation of volatiles while showering.	Resident (adult and child)	Yes	If Site 2 or areas hydraulically downgradient from Site 2 are developed for residential use, drinking water wells in the surficial aquifer could be influenced by contaminants in the groundwater associated with Site 2. Therefore, future residents could be exposed to contaminants in the surficial aquifer. Inhalation of volatiles while showering is not a complete exposure pathway because no VOCs were selected as HHPCs.
Notes: HHPC = human health chemical of potential concern. VOC = volatile organic compound.				

occupational workers will be only considered as part of the future land-use scenario. One possible future exposure scenario includes excavation activities, such as installation of utility lines. There is also the potential that Site 2 could be reopened and used for yard waste disposal such as leaves and tree limbs. Additionally, workers could be exposed at Site 2 during tree harvesting, although this is not currently planned. Therefore, it is possible that currently a site maintenance worker could be exposed at the site as could an adult and adolescent trespasser.

Exposures of potential future residents (adult and child), potential future occupational workers, current and future site maintenance workers, future excavation workers, and current and future trespassers (adult and child) to surface soil contaminants through ingestion, dermal contact, and inhalation of particulates are evaluated in this HHRA.

**6.3.2 Site 2 Subsurface Soil** Currently, there are no exposures to subsurface soil at Site 2 because there are no excavation or construction activities on site. Additionally, there were no HHCPs identified in subsurface soil. Therefore, potential current and future exposure scenarios to subsurface soil are not evaluated in this HHRA.

**6.3.3 Site 2 Groundwater** Currently, groundwater at Site 2 is not used for any potable or nonpotable purpose nor are there plans to use the water resource in the foreseeable future. However, in the event that Site 2 or areas hydraulically downgradient of Site 2 are developed for residential use, the exposure pathway to chemicals in groundwater could become complete. Therefore, hypothetical future domestic use of the surficial aquifer (adult and child ingestion) is evaluated in this HHRA as a worst-case estimate of potential future exposures (i.e., future potential worker scenarios are not evaluated). Inhalation of volatiles and dermal contact with groundwater while showering is not evaluated because no VOCs were selected as HHCPs.

**6.3.4 Exposure Point Concentrations** Exposure point concentrations (EPCs) for all HHCPs in surface soil and groundwater are calculated according to Paragraph 2.5.3.3 of the GIR (HLA, 1998). This quantification process involves developing assumptions regarding exposure conditions and exposure scenarios for each receptor to estimate the total amount of contaminants that a hypothetical receptor may ingest, dermally absorb, or inhale from each exposure pathway. The ultimate goal of this step, as defined in USEPA guidance, is to identify the combination of these exposure variables or parameters that results in the most intense level of exposure that may "reasonably" be expected to occur under current and future site conditions (USEPA, 1989b).

The EPCs for HHCPs in surface soil and groundwater are presented in Tables 6-5 and 6-6. The EPCs were used with receptor-specific exposure parameters to quantify exposures to the HHCPs, as shown in the risk calculation spreadsheets in Appendix C to this report.

**6.4 TOXICITY ASSESSMENT.** The toxicity assessment methodology is described in Subsection 2.5.4 of the GIR (HLA, 1998). The toxicity assessment evaluates the available evidence on the potential adverse effects associated with exposure to each HHCP. This information is used to develop a relationship between the extent of exposure and the likelihood or severity of adverse human health

**Table 6-5**  
**Exposure Point Concentrations**  
**for Human Health Chemicals of Potential Concern**  
**for Surface Soil**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Maximum Detected Concentration	95% UCL <sup>2</sup>	Exposure Point Concentration <sup>3</sup>
<b>Inorganic Analytes (mg/kg)</b>				
Arsenic	6/6	3.95	NC	3.95
<p><sup>1</sup> Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).</p> <p><sup>2</sup> Ninety-five percent UCL of the arithmetic mean is calculated using all samples. One-half the contract-required quantitation limit/contract-required detection limit is used as a surrogate for nondetects. The UCL is not calculated when there are less than 10 total samples.</p> <p><sup>3</sup> Exposure point concentration is the lower of either the 95 percent UCL concentration or maximum detected concentration.</p> <p>Notes: % = percent.            UCL = upper confidence limit (see footnote 2).            mg/kg = milligrams per kilogram.            NC = not calculated.</p>				

**Table 6-6**  
**Exposure Point Concentrations for Human Health Chemicals**  
**of Potential Concern for Unfiltered Groundwater**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Maximum Detected Concentration	Arithmetic Mean <sup>2</sup>	Exposure Point Concentration <sup>3</sup>
<b>Inorganic Analytes (µg/l)</b>				
Iron	2/3	1,280	453	453
<p><sup>1</sup> Frequency of detection is the number of samples in which the analyte was detected over the number of samples analyzed.</p> <p><sup>2</sup> Arithmetic mean of all samples calculated using one-half the contract-required quantitation limit/contract-required detection limit for nondetects.</p> <p><sup>3</sup> Exposure point concentration equals the arithmetic mean. If the maximum detected concentration is less than the arithmetic mean, the maximum detected concentration is the exposure point concentration.</p> <p>Note: µg/l = micrograms per liter.</p>				

effects. Two steps are typically associated with toxicity assessment: hazard identification and dose-response assessment.

- Hazard identification is the process of determining if exposure to an agent can cause a particular adverse health effect and, more importantly, if that effect will occur in humans. The objectives of the hazard identification in the HHRA are to (1) identify which of the contaminants detected at the site are potential hazard and (2) summarize their potential toxicity in brief nontechnical language.
- A dose-response assessment is conducted to characterize and quantify the relationship between intake, or dose, of an HHCP and the likelihood of a toxic effect or response. There are categories of toxic effects evaluated in this HHRA: carcinogenic and noncarcinogenic. Following USEPA guidance for HHRA (USEPA, 1989b), these two endpoints (cancer and noncancer) are evaluated separately. As a result of the dose-response assessment, identified dose-response values are used to estimate the incidence of adverse effects as a function of human exposure to a chemical.

Appendix C to this report contains brief toxicity summaries for HHCPs identified in surface soil, and groundwater at Site 2. Appendix C to this report also contains dose-response information for the HHCPs (Tables C-27 through C-32). Dose-response values used in this HHRA were current as of April 1997 for Integrated Risk Information System (IRIS) and November 1995 for Health Effects Assessment Summary Tables (HEAST).

**6.5 RISK CHARACTERIZATION.** Risk characterization is the final step in the risk assessment process. This step involves the integration of the exposure and toxicity assessments into a qualitative or quantitative expression of potential human health risks associated with contaminant exposure. Quantitative estimates of both carcinogenic and noncarcinogenic risks are made for each HHCP and each complete exposure pathway identified in the exposure assessment. The risk characterization methodology is described in Subsection 2.5.5 of the GIR (HLA, 1998).

Risk estimates for potential exposures to surface soil and groundwater under current and hypothetical future land use scenarios are discussed in Subsections 6.5.1 through 6.5.3. These risk estimates are then compared to USEPA and FDEP carcinogenic and noncarcinogenic target levels.

The USEPA guidelines, established in the NCP, indicate that the total lifetime cancer risk due to exposure to the HHCPs at a site, by each complete exposure pathway, should not exceed a range of 1 in 1,000,000 ( $1 \times 10^{-6}$ ) to 1 in 10,000 ( $1 \times 10^{-4}$ ) (USEPA, 1990). FDEP has indicated that chemical-specific risks greater than one in one million ( $1 \times 10^{-6}$ ) warrant further consideration.

A hazard quotient (HQ) less than 1 indicates that noncarcinogenic toxic effects are not expected to occur due to HHCP exposure. Hazard indices (HIs) greater than 1 may be indicative of a possible noncarcinogenic toxic effect, but the circumstances must be evaluated on a case-by-case basis (USEPA, 1989b). As the HI increases, so does the likelihood that adverse effects might be associated with exposure. Both USEPA and FDEP consider that chemicals with HIs greater than

than 1 warrant further evaluation and require an evaluation of the specific noncarcinogenic effects.

Table 6-7 summarizes the cancer and noncancer risk under a current land-use scenario for Site 2. Table 6-8 summarizes the cancer and noncancer risk under a hypothetical future land-use scenario for Site 2.

**6.5.1 Site 2 Surface Soil** The risk calculations for surface soil exposure are shown in Tables C-4 through C-17 in Appendix C to this report. Below are evaluations of the current and hypothetical future land-use exposure pathways for surface soil.

**Current Land Use.** The cancer risks associated with current exposure to surface soil (ingestion, dermal contact, and fugitive dust inhalation) are  $2 \times 10^{-6}$  for an aggregate (combined adult and adolescent) trespasser, and  $8 \times 10^{-7}$  for a site maintenance worker. Both receptors' cancer risk values are below the USEPA acceptable cancer risk range of 1 in 10,000 to 1 in 1,000,000. However, the trespasser risk exceeds the Florida target level. The noncancer risks associated with surface soil ingestion, dermal contact, and fugitive dust inhalation under current land use (adolescent trespasser, adult trespasser, and site worker) are below USEPA's target HI of 1. Figures 6-2 and 6-3 present summaries of cancer risks and HIs, respectively, associated with exposure scenarios under current land use.

**Hypothetical Future Land.** The cancer risks associated with hypothetical future exposure to surface soil (ingestion, dermal contact, and fugitive dust inhalation) are  $2 \times 10^{-5}$  for an aggregate resident (combined adult and child),  $2 \times 10^{-6}$  for an aggregate trespasser (combined adult and adolescent),  $3 \times 10^{-6}$  for an occupational worker,  $8 \times 10^{-7}$  for a site maintenance worker, and  $5 \times 10^{-8}$  for an excavation worker. All of these hypothetical future receptor risks are within or below the USEPA acceptable cancer risk range; however, the hypothetical future residential, trespasser, or occupational worker risk exceeds the Florida level of concern of  $1 \times 10^{-6}$ . Figure 6-4 presents a summary of cancer risks associated with exposure scenarios under future land use.

The noncancer risks associated with surface soil ingestion, dermal contact, and fugitive dust inhalation under a hypothetical future land use (adult and child) resident, trespasser (adult and child), occupational worker, site worker, and excavation worker are below USEPA's and FDEP's target HI of 1. Figure 6-5 presents a summary of HIs associated with exposure scenarios under future land use.

**6.5.2 Site 2 Groundwater** The risk calculations for groundwater exposure are shown in Tables C-18 and C-19 in Appendix C to this report. Currently, there are no water supply wells at the site (potable and nonpotable); thus, there is no human exposure to groundwater. Therefore, there are no current summary figures.

No carcinogenic CPCs were selected for groundwater; therefore, there is no potential future receptor carcinogenic risk summary figure.

The noncancer risks associated with a hypothetical future use of groundwater ingestion are 0.2 for the adult resident and 0.4 for the child resident. Both of these HIs do not exceed USEPA's or Florida's target HI of 1. Figure 6-6 presents a summary of the noncancer risk to hypothetical future residents. There

**Table 6-7  
Risk Summary Current Land Use**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Land Use	Exposure Route	HI	ELCR
<b>Current Land Use</b>			
Surface Soil:			
Adult Trespasser:	Incidental ingestion	0.002	$4 \times 10^{-7}$
	Dermal contact	0.0002	$6 \times 10^{-7}$
	Inhalation of particulates	ND	$9 \times 10^{-11}$
	Total Adult Trespasser:	0.003	$1 \times 10^{-6}$
Adolescent Trespasser:	Incidental ingestion	0.004	$3 \times 10^{-7}$
	Dermal contact	0.0003	$4 \times 10^{-7}$
	Inhalation of particulates	ND	$5 \times 10^{-11}$
	Total Adolescent Trespasser:	0.004	$7 \times 10^{-7}$
Total Risk to Trespasser (Adult and Adolescent) Exposed to Surface Soil:		NC	$2 \times 10^{-6}$
Site Maintenance Worker:	Incidental ingestion	0.001	$3 \times 10^{-7}$
	Dermal contact	0.0002	$5 \times 10^{-7}$
	Inhalation of particulates	ND	$1 \times 10^{-10}$
	Total Site Maintenance Worker:	0.001	$8 \times 10^{-7}$
Notes: HI = hazard index. ELCR = excess lifetime cancer risk. ND = no dose-response data for this exposure route were available for human health chemicals of potential concern in this medium. NC = not calculated because child and adult HIs are not additive.			

**Table 6-8  
Risk Summary Future Land Use**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

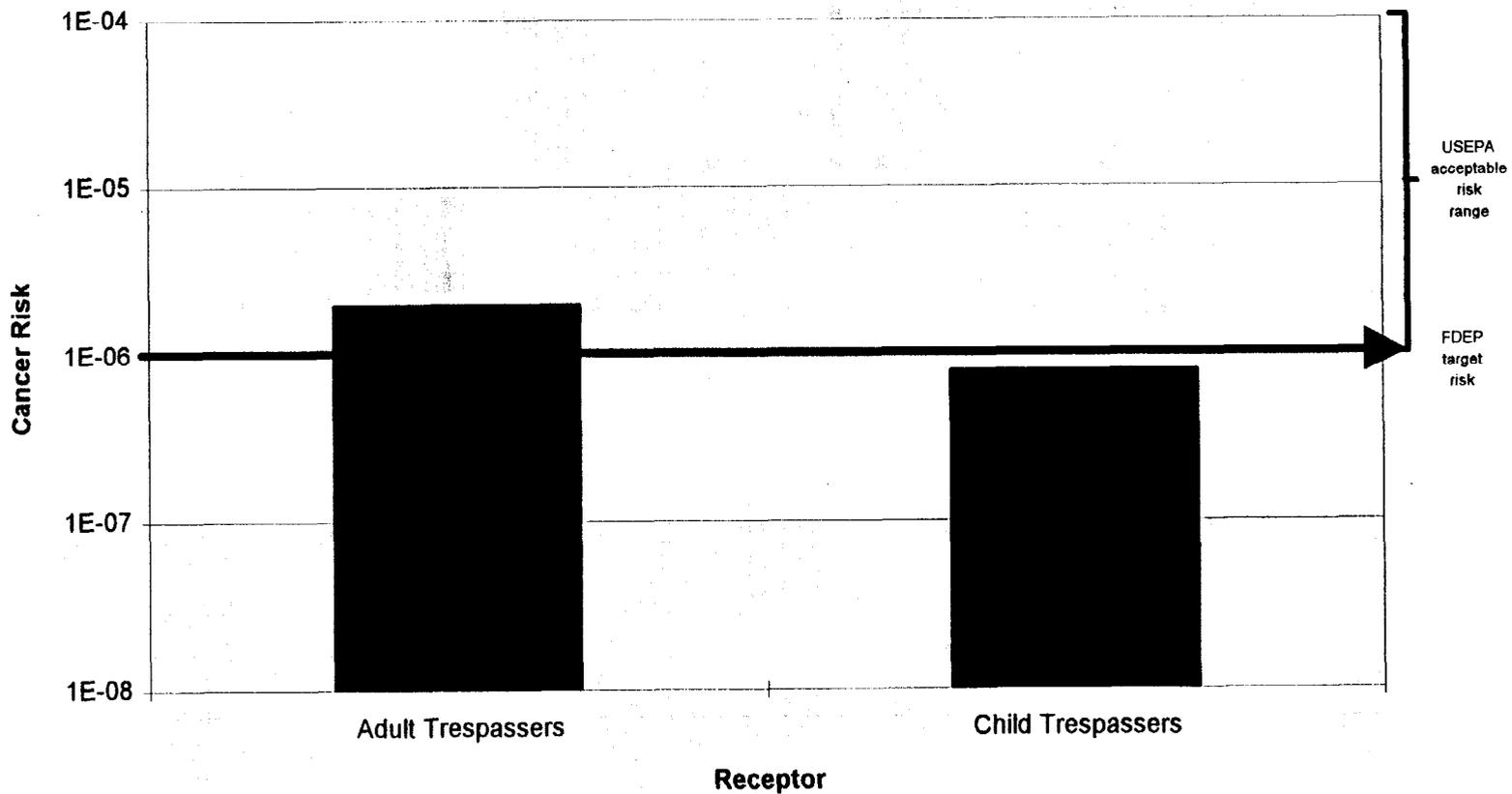
Land Use	Exposure Route	HI	ELCR
<b>Future Land Use</b>			
Surface Soil:			
Adult Trespasser:	Incidental ingestion	0.002	$4 \times 10^{-7}$
	Dermal contact	0.0002	$6 \times 10^{-7}$
	Inhalation of particulates	ND	$9 \times 10^{-11}$
	Total Adult Trespasser:	0.003	$1 \times 10^{-6}$
Adolescent Trespasser:	Incidental ingestion	0.004	$3 \times 10^{-7}$
	Dermal contact	0.0003	$4 \times 10^{-7}$
	Inhalation of particulates	ND	$5 \times 10^{-11}$
	Total Adolescent Trespasser:	0.004	$7 \times 10^{-7}$
Total Risk to Trespasser (Adult and Adolescent) Exposed to Surface Soil:		NC	$2 \times 10^{-6}$
Adult Resident:	Incidental ingestion	0.02	$4 \times 10^{-6}$
	Dermal contact	0.002	$5 \times 10^{-6}$
	Inhalation of particulates	ND	$3 \times 10^{-9}$
	Total Adult Resident:	0.02	$9 \times 10^{-6}$
Child Resident:	Incidental ingestion	0.2	$9 \times 10^{-6}$
	Dermal contact	0.003	$2 \times 10^{-6}$
	Inhalation of particulates	ND	$4 \times 10^{-9}$
	Total Child Resident:	0.2	$1 \times 10^{-5}$
Total Risk to Resident (Adult and Child) Exposed to Surface Soil:		NC	$2 \times 10^{-5}$
Occupational Worker:	Incidental ingestion	0.006	$1 \times 10^{-6}$
	Dermal contact	0.001	$2 \times 10^{-6}$
	Inhalation of particulates	ND	$1 \times 10^{-9}$
	Total Occupational Worker:	0.007	$3 \times 10^{-6}$
See notes at end of table.			

**Table 6-8 (Continued)**  
**Risk Summary Future Land Use**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Land Use	Exposure Route	HI	ELCR
<b>Future Land Use (Continued)</b>			
Site Maintenance Worker:	Incidental ingestion	0.001	$3 \times 10^{-7}$
	Dermal contact	0.0002	$5 \times 10^{-7}$
	Inhalation of particulates	ND	$1 \times 10^{-10}$
	Total Site Maintenance Worker:	0.001	$8 \times 10^{-7}$
Excavation Worker:	Incidental ingestion	0.007	$5 \times 10^{-8}$
	Dermal contact	0.0002	$6 \times 10^{-10}$
	Inhalation of particulates	ND	$2 \times 10^{-14}$
	Total Excavation Worker:	0.008	$5 \times 10^{-8}$
<b>Groundwater:</b>			
Adult Resident:	Ingestion of Groundwater as Drinking Water	0.2	NE
	Total Adult Resident:	0.2	NE
Child Resident:	Ingestion of Groundwater as Drinking Water	0.4	NE
	Total Child Resident:	0.4	NE
	Total Risk to Resident (Adult and Child) Exposed to Ground Water:	NC	NE
	Total Risk to Resident (Adult and Child) Exposed to Groundwater and Surface Soil:	NC	$2 \times 10^{-5}$

Notes: HI = hazard index.  
ELCR = excess lifetime cancer risk.  
NC = not calculated because child and adult HIs are not additive.  
ND = no dose-response data for this exposure route were available for HHCPs in this medium.  
NE = not evaluated, no carcinogenic CPC selected.



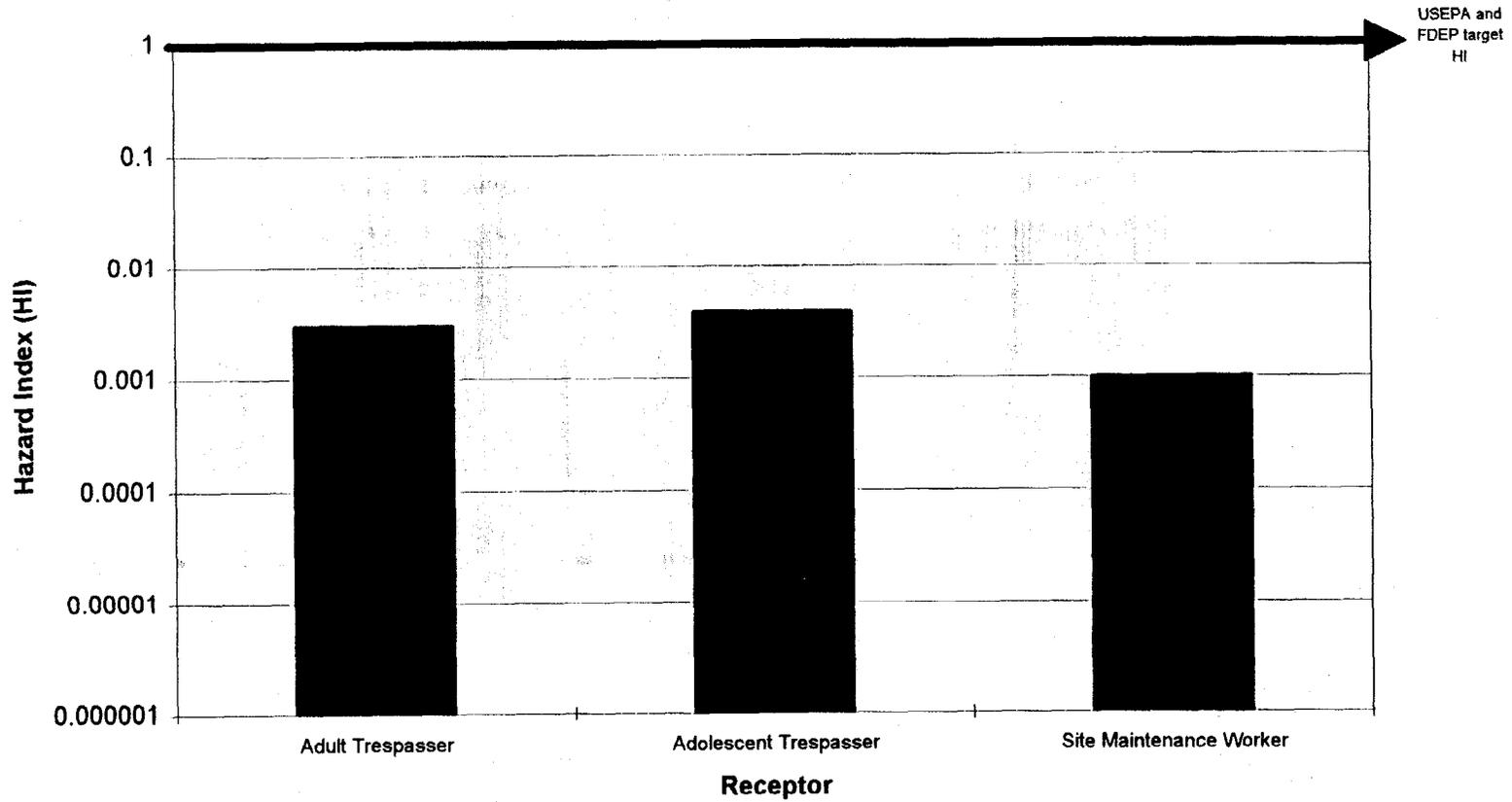
NOTES:  
USEPA = U.S. Environmental Protection Agency  
FDEP = Florida Department of Environmental Protection

**FIGURE 6-2  
CANCER RISK SUMMARY  
CURRENT LAND USE FOR SURFACE SOIL  
AT SITE 2**



**REMEDIAL INVESTIGATION REPORT  
SITE 2, NORTHWEST OPEN  
DISPOSAL AREA**

**NAVAL AIR STATION WHITING FIELD  
MILTON, FLORIDA**

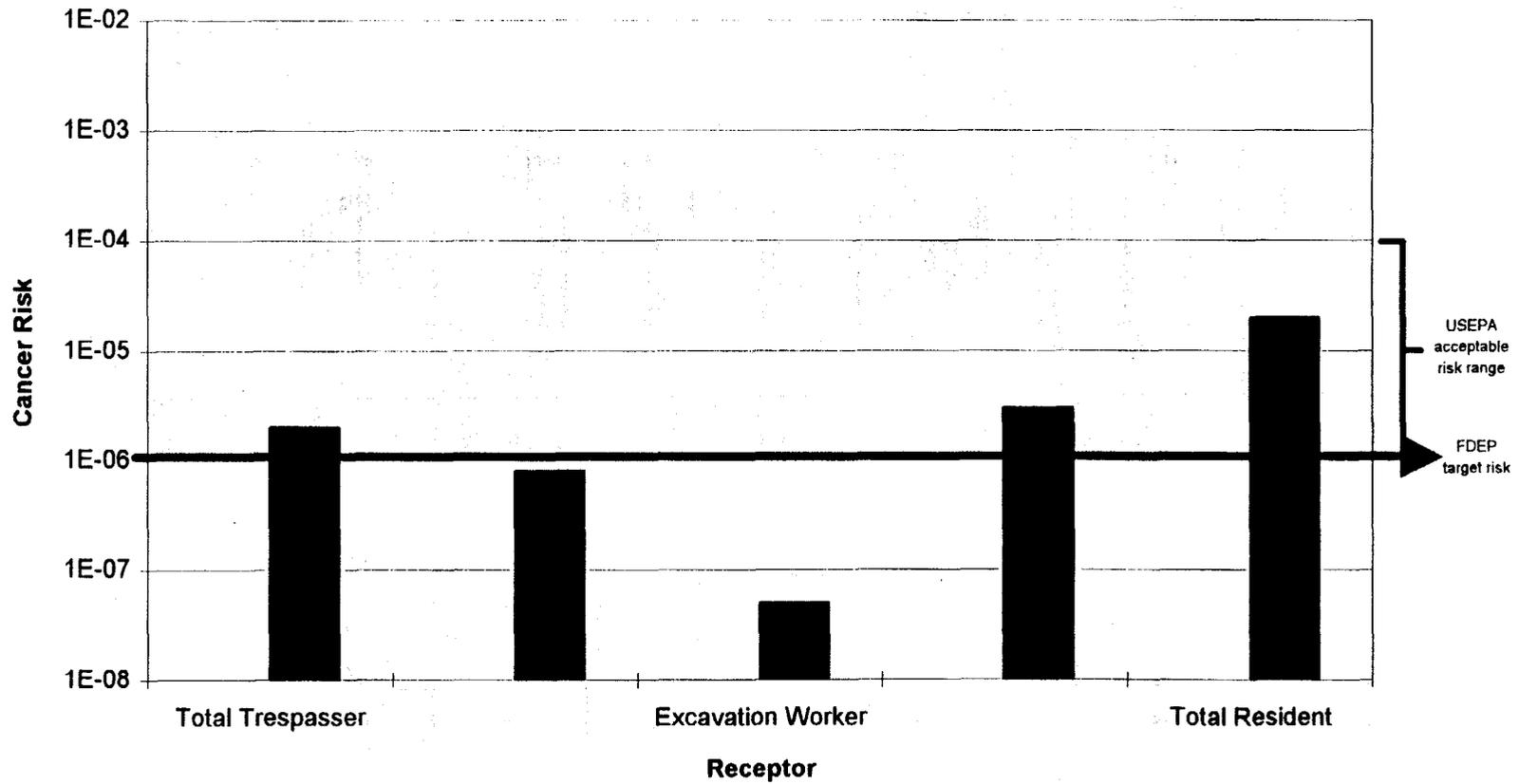


NOTES:  
USEPA = U.S. Environmental Protection Agency  
FDEP = Florida Department of Environmental Protection

**FIGURE 6-3  
NONCANCER RISK SUMMARY  
CURRENT LAND USE FOR SURFACE SOIL  
AT SITE 2**



**REMEDIAL INVESTIGATION REPORT  
SITE 2, NORTHWEST OPEN  
DISPOSAL AREA  
  
NAVAL AIR STATION WHITING FIELD  
MILTON, FLORIDA**



**NOTES:**

USEPA = U.S. Environmental Protection Agency

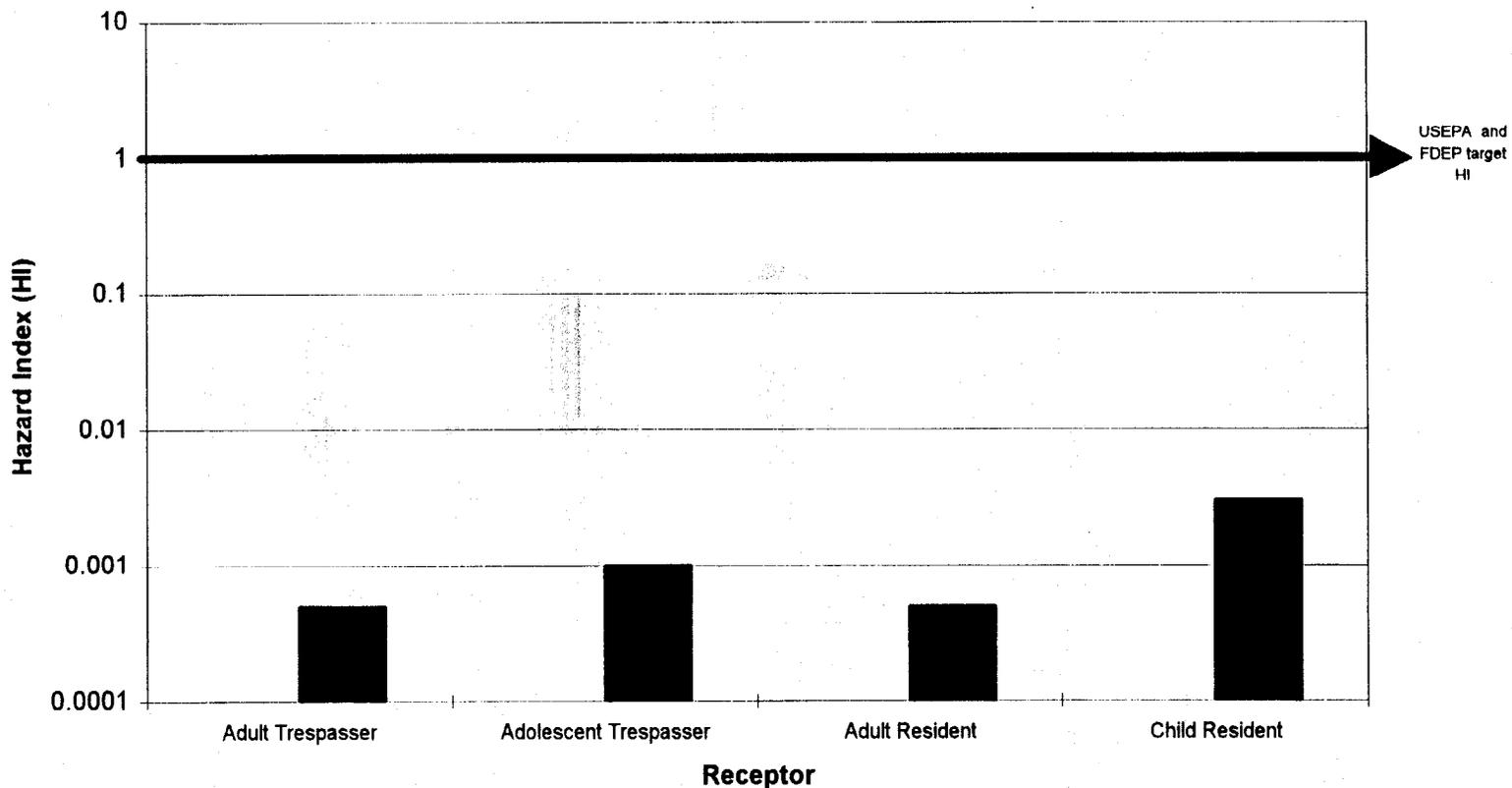
FDEP = Florida Department of Environmental Protection

**FIGURE 6-4  
CANCER RISK SUMMARY  
FUTURE LAND USE FOR SURFACE SOIL  
AT SITE 2**



**REMEDIAL INVESTIGATION REPORT  
SITE 2, NORTHWEST OPEN  
DISPOSAL AREA**

**NAVAL AIR STATION WHITING FIELD  
MILTON, FLORIDA**



**NOTES:**

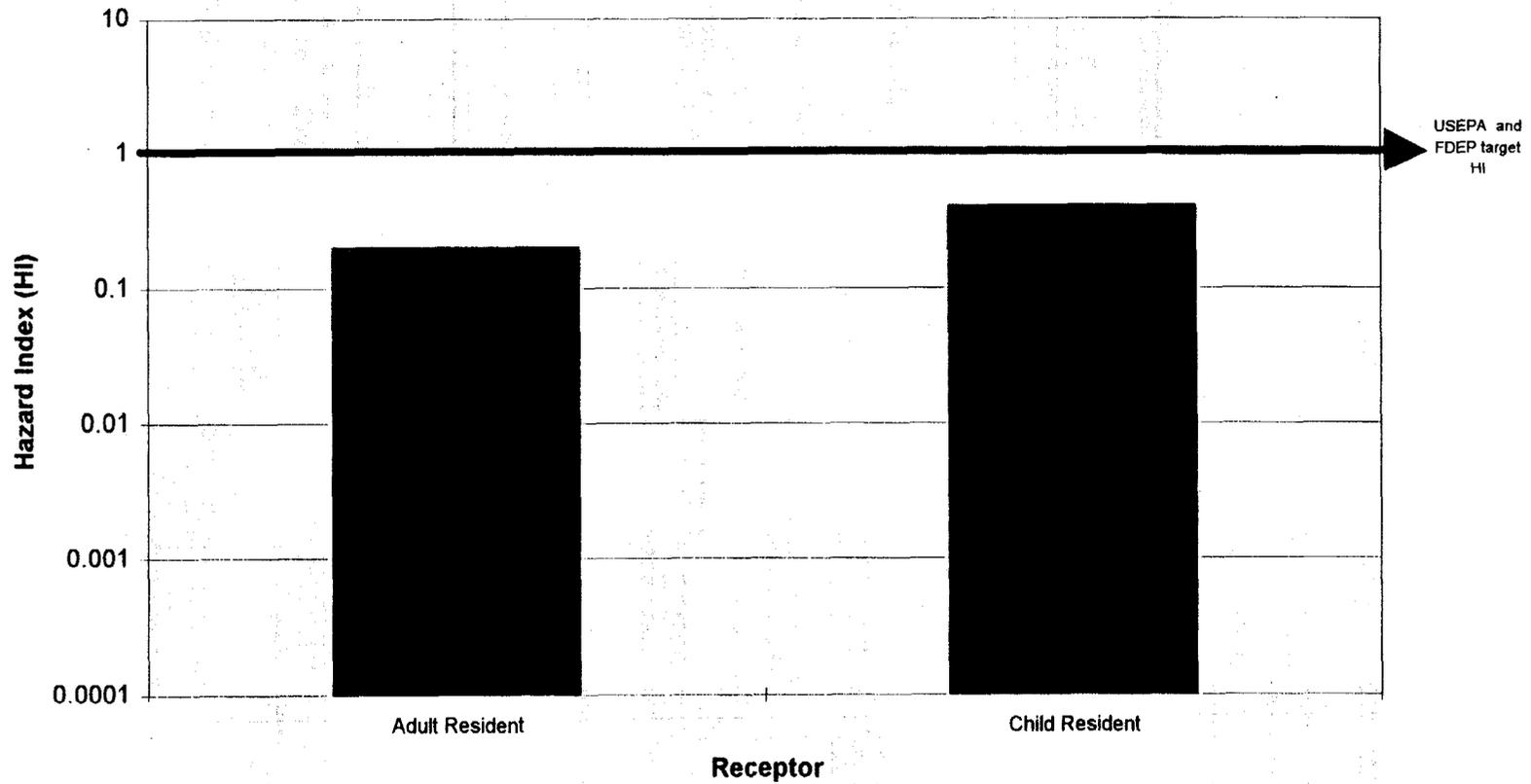
USEPA = U.S. Environmental Protection Agency  
FDEP = Florida Department of Environmental Protection

**FIGURE 6-5  
NONCANCER RISK SUMMARY  
FUTURE LAND USE FOR SURFACE SOIL  
AT SITE 2**



**REMEDIAL INVESTIGATION REPORT  
SITE 2, NORTHWEST OPEN  
DISPOSAL AREA**

**NAVAL AIR STATION WHITING FIELD  
MILTON, FLORIDA**



**NOTES:**

USEPA = U.S. Environmental Protection Agency  
FDEP = Florida Department of Environmental Protection

**FIGURE 6-6  
NONCANCER RISK SUMMARY  
FUTURE LAND USE FOR GROUNDWATER  
AT SITE 2**



**REMEDIAL INVESTIGATION REPORT  
SITE 2, NORTHWEST OPEN  
DISPOSAL AREA**

**NAVAL AIR STATION WHITING FIELD  
MILTON, FLORIDA**

are no carcinogenic CPCs selected for groundwater; therefore, there is no potential future receptor carcinogenic risk summary figure.

**6.5.3 Site 2 Cumulative Risk** USEPA Region IV guidance requires an assessment of a cumulative receptor risk. In this HHRA, only the hypothetical future residential receptor could potentially be exposed to both surface soils and groundwater. The cumulative risk to a hypothetical future residential receptor is only associated with exposure to surface soil because there were no carcinogenic HHCPs in groundwater. The cumulative risk of  $2 \times 10^{-5}$  is within the USEPA target risk range, but exceeds the Florida target risk levels. The cumulative noncancer risk to potential future residential receptors from surface soil and groundwater is below the USEPA and Florida target HI of 1.

**6.6 UNCERTAINTY ANALYSIS.** General uncertainties associated with the collection, analysis, and evaluation of data; exposure assessment; toxicity assessment; and the risk estimation process are discussed in Paragraph 2.5.5.1 of the GIR (ABB-ES, 1998). Site-specific uncertainties that are important for the interpretation of the calculated risk estimates for surface soil, subsurface soil, and groundwater at Site 2 are discussed below.

- The lack of inhalation reference concentrations for the HHCPs in surface soil may have resulted in underestimates of the HIs associated with exposure to surface soil at Site 2; however, these noncancer risks are not likely to be significant when compared to oral risks that are fully characterized.
- The surface soil carcinogenic risk is driven by metals (arsenic and beryllium) that are naturally occurring. It is uncertain whether or not this risk to potential future residents and occupational workers is actually due to past site operations.

The risks associated with background screening concentrations of arsenic and beryllium (2.59 mg/kg and 0.26 mg/kg, respectively) also exceed the FDEP acceptable residential levels (0.8 mg/kg and 0.2 mg/kg, respectively) and would result in an exposure pathway risk of  $5 \times 10^{-6}$ . Therefore, the risks associated with site-related arsenic and beryllium may be overestimated.

- According to the methodology described in the GIR (HLA, 1998) (Paragraph 2.5.3.3), central tendency carcinogenic risk to potential future receptors that have risks exceeding Florida levels of concern was evaluated. The central tendency evaluation coupled with the upper 95 percent UCL concentration and reasonable but less conservative exposure parameters is designed to provide a probable risk level (USEPA, 1995b).

The hypothetical future adult and child resident, adult and adolescent trespasser, and future occupational worker reasonable maximum exposure (RME) carcinogenic risk exceeded its target of  $1 \times 10^{-6}$ . The central tendency carcinogenic risk results for hypothetical future residential receptors and the central tendency exposure parameters are presented in Tables C-22 and C-26 in Appendix C of this report. The central tendency-parameters differ from the RME exposure scenario by using a combination of 50 percentile and 90 percentile exposure parameters.

The central tendency exposure parameters used in this HHRA are presented in Appendix C Tables C-20 through C-24 and are derived from USEPA Region VI guidance (USEPA, 1992a). The central tendency aggregate residential risk is  $4 \times 10^{-6}$ . The central tendency for the trespasser risk is  $3 \times 10^{-6}$ . The central tendency for the hypothetical future occupational worker risk is  $3 \times 10^{-7}$ . The central tendency carcinogenic risk level for hypothetical future resident and trespasser slightly exceeds the Florida target level of  $1 \times 10^{-6}$ , while the occupational worker risk levels meet the Florida target level.

The risk range  $1 \times 10^{-5}$  to  $4 \times 10^{-6}$  presented by the RME and central tendency exposure scenarios for hypothetical future residential receptors,  $2 \times 10^{-6}$  to  $3 \times 10^{-6}$  for aggregate trespassers, and  $3 \times 10^{-6}$  to  $3 \times 10^{-7}$  for occupational workers, are useful as information to provide perspective for the risk manager and compliance with USEPA guidance (USEPA, 1995b).

- The SQLs were compared to the risk-based screening criteria and Florida and State regulatory guidelines for all analytes not selected as HHCPs to assess whether or not the detection limits were adequate to detect analytes at levels of concern (SQLs of analytes with 100 percent frequency of detection were not evaluated). Two analytes (bis(2-ethylhexyl)phthalate and dieldrin) detected in surface soil exceeded the screening concentration. Two analytes (Aroclor-1260 and dieldrin) in subsurface soil exceeded the screening concentration. One analyte, bis(2-ethylhexyl)phthalate, which was detected in groundwater, exceeded the screening concentration. The risks from these analytes may be underestimated if the chemicals are in fact present at a concentration above the respective risk-based screening criteria.
- Some uncertainty is associated with the representativeness of the groundwater analytical data used to complete the risk evaluation at Site 2. Generally, because the low-flow purging and sampling method was used, turbidity in the unfiltered groundwater samples was minimal. However, the analytical results from some of the unfiltered samples may be biased high for inorganic concentrations as a result of suspended solids.

**6.7 REMEDIAL GOAL OPTIONS.** Remedial goal options (RGO) tables are presented for each medium with a total excess lifetime cancer risk (ELCR) greater than  $1 \times 10^{-4}$  or an HI greater than 1 per USEPA guidance, and for media with chemicals whose EPCs exceed Florida standards. The RGO concentrations are calculated using the scenario representing the highest estimated risk for a given medium. Based on the above criteria, RGOs are developed for each chemical with a total ELCR greater than  $1 \times 10^{-6}$  or an HQ greater than 0.1. Analytes whose EPCs exceed Florida standards are also presented in the RGO tables.

RGOs and available Federal regulatory and FDEP risk-based criteria are intended to provide the basis for the development of remedial alternatives in the FS. The RGO values are not actual or proposed cleanup levels, but are provided to assist risk-management decision making in the FS.

The analytes with carcinogenic risks in surface soil that exceed Florida's risk management criteria of  $1 \times 10^{-6}$  as well as those that exceed FDEP Residential Soil Cleanup Goals are presented in Table 6-9.

The carcinogenic risks associated with groundwater did not exceed Florida's risk management criteria of  $1 \times 10^{-6}$ . Table 6-10 presents the RGOs for these analytes that exceed Florida guidance concentrations.

**6.8 SUMMARY OF HUMAN HEALTH RISK ASSESSMENT FOR SITE 2.** HHCPs were identified and risks were estimated for surface soil, subsurface soil, and groundwater associated with Site 2. The following conclusions were drawn based on this HHRA:

- The HHCPs detected in surface soil and groundwater samples do not pose unacceptable carcinogenic or noncarcinogenic risks to the receptors evaluated based on an evaluation of the samples using USEPA guidelines and target risk ranges.
- The total ELCR associated with surface soil by a hypothetical future resident ( $2 \times 10^{-5}$ ), current and future trespasser ( $2 \times 10^{-6}$ ), and occupational worker ( $3 \times 10^{-6}$ ) exceeded Florida's target level of  $1 \times 10^{-6}$ .
- The background levels of arsenic at the site exceed Florida Soil Residential Cleanup Goals and may result in an unacceptable carcinogenic risk. It is likely that the naturally occurring concentrations of arsenic contribute to the FDEP target risk level exceedance. Additionally, it is uncertain whether or not the detected concentrations of arsenic is related to the disposal of waste at Site 2.
- The central tendency risks to a hypothetical future resident and occupational worker and current and future trespasser met the Florida risk level of  $1 \times 10^{-6}$ . Central tendency and RME residential risks provide the risk managers and decision makers with a perspective of the true potential risk range to future residents.

Based on the carcinogenic and noncancer assessment of risks in this HHRA, it is unlikely that the soils or groundwater at Site 2 pose an unacceptable hazard to current or potential future receptors.

**Table 6-9**  
**Summary of Remedial Goal Options for**  
**Surface Soil**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Range of Detected Concentrations	Exposure Point Concentration	Total Excess Lifetime Cancer Risk (Based on Risk to Future Resident [adult and child])			Total Hazard Index (Based on Risk to Child Resident)			Florida Soil Cleanup Goal (Residential) <sup>1</sup>	Florida Soil Cleanup Goal (Leaching) <sup>2</sup>	Background Screening Concentration
			10 <sup>-4</sup>	10 <sup>-5</sup>	10 <sup>-6</sup>	3	1	0.1			
<b>Inorganic Analytes (mg/kg)</b>											
Arsenic	0.82 to 3.95	3.95	NR	NR	0.4	NR	NR	NR	0.8	NC	2.59

<sup>1</sup> Values are for residential soil, from Florida Department of Environmental Protection memoranda titled "Soil Cleanup Goals for Florida," dated September 29, 1995, and "Applicability of Soil Cleanup Goals for Florida," dated January 19, 1996.

<sup>2</sup> Values are from the Florida Department of Environmental Protection memorandum titled "Soil Cleanup Goals for Florida," dated September 29, 1995.

Notes: mg/kg = milligrams per kilogram.

NR = not reported because the calculated remedial goal option exceeds the exposure point concentration.

NC = not calculated.

**Table 6-10**  
**Summary of Remedial Goal Options for**  
**Groundwater**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Analyte	Range of Detected Concentrations	Exposure Point Concentration	Total Excess Lifetime Cancer Risk (Based on Risk to Resident (adult and child))			Total Hazard Index (Based on Risk to Child Resident)			Florida Groundwater Guidance Concentration <sup>1</sup>	Federal MCL <sup>2</sup>	Background Screening Concentration
			10 <sup>-4</sup>	10 <sup>-5</sup>	10 <sup>-6</sup>	3	1	0.1			
<b>Inorganic Analytes (µg/l)</b>											
Iron	59.7 to 1,280	453	NA	NA	NA	NA	NA	NA	300	300	964
<sup>1</sup> Florida Department of Environmental Protection Groundwater Guidance Concentrations from June 1994. <sup>2</sup> Federal MCLs are taken from USEPA Drinking Water Regulations and Health Advisories from February 1996.  Notes: MCL = maximum contaminant level. µg/l = micrograms per liter. NA = not applicable. ND = not detected in any background sample.											

## 7.0 ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment (ERA) evaluates the potential for adverse effects to ecological receptors associated with exposure to chemicals from Site 2, Northwest Open Disposal Area, NAS Whiting Field. The ERA for Site 2 follows the methodologies described in the NAS Whiting Field GIR (HLA, 1998), and current guidance materials for ERAs at Superfund sites including the following:

- "Framework for Ecological Risk Assessment" (USEPA, 1992b)
- *Supplemental Guidance to RAGS: Region 4 Bulletins* (USEPA, 1995a)
- "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments" (USEPA, 1997c)

Recent risk assessment guidance including the USEPA "Eco Update" bulletins (issued since 1991) and recent publications (e.g., Maughan, 1993; Suter, 1993) were also consulted.

This ERA was conducted to assess whether or not ecological receptors are potentially exposed to chemicals detected in environmental samples collected from the site at concentrations that could cause adverse effects to ecological receptors. The Site 2 ERA consists of eight sections:

- Site Characterization (Section 7.1) describes current ecological conditions at the site;
- Problem Formulation (Section 7.2) establishes the goals and focus of the assessment and identifies major factors to be considered;
- Hazard Assessment and Selection of Ecological Chemicals of Potential Concern (ECPCs) (Section 7.3) consist of a review of analytical data and identifies chemicals present at the site that may pose ecological risks;
- Exposure Assessment (Section 7.4) identifies relevant site-specific exposure pathways and quantifies the magnitude and frequency of exposure;
- Ecological Effects Assessment (Section 7.5) identifies a dose-response relationship for each ECPC and potential receptor;
- Risk Characterization (Section 7.6) integrates exposure and concentration-toxicity response information to derive an estimate of the likelihood of adverse effects;
- Uncertainty Analysis (Section 7.7) describes assumptions of the ERA process that may influence the risk assessment conclusions; and
- Summary of Ecological Risks (Section 7.8) presents evaluations of potential risks to ecological receptors.

7.1 SITE CHARACTERIZATION. NAS Whiting Field Site 2, Northwest Open Disposal Area, is approximately 12 acres in size and is located on the west side of the north runway (see Figure 1-2). The installation maintains the area around the runways, including Site 2, as a noise and safety buffer.

The site originally was used as a borrow pit, and currently has steep sides approximately 15 to 20 feet from ground surface. After the site was no longer used as a source of fill material, it became an open disposal area primarily for construction and demolition debris. Wastes, which were disposed of at the site from 1976 and until 1984, included asphalt, wood, tires, furniture, scrap metal, and crushed paint cans. Generally the debris was placed directly on the surface; however, several areas contain debris stacked in piles. Further information on the site history and layout is provided in Section 1.2 of this report.

The vegetative community at Site 2 is characterized as old-field community. Approximately half the site is covered with the vine kudzu (*Pueraria lobata*). The remaining areas are sparsely covered with limited diversity and almost no saplings. Herbaceous plants found at the site include broomsedge (*Andropogon sp.*), golden rod (*Solidago spp.*), ragweed (*Ambrosia artemisiifolia*), sand spur (*Cenchrus sp.*), partridge pea (*Chamaecrista fasciculata*), verbena (*Verbena spp.*), and ageratum (*Conoclinium coelestinum*).

Adjacent areas, located to the south and west of Site 2, consist of planted pine forests. These areas are part of the base's forestry program for planting and harvesting of pine trees, primarily longleaf and slash pines (*Pinus palustris* and *P. elliotii*, respectively). The forestry program includes controlled burns and timber harvesting activities. These forestry management activities provide a variety of habitats and food sources. Currently, the areas south and west of the site are reaching a mature status with a well-developed canopy and an open understory typical of upland pine forests of the southeastern United States. Site 2 is bounded by a young (7 to 15 years) pine forest to the east and an open kudzu-covered field to the north.

Southeastern pine forests, such as those surrounding Site 2, provide habitats for a diverse array of birds, including insectivorous gleaners of pine needles and bark, flycatchers, seed-eaters, and nocturnal and diurnal aerial predators (Wolfe et al., 1988). The pine forests surrounding Site 2 are likely to host such an assemblage of species. Birds of prey, such as owls and hawks, may also nest in these woodland areas and feed at Site 2.

It is likely that the terrestrial invertebrate biomass at Site 2 serves as a forage base for a variety of wildlife species, including amphibians, reptiles, small birds, and small mammals. Small reptiles, mammals, and birds may forage in Site 2's open areas, while returning to the adjacent forested area for protection. Predatory birds and mammals inhabiting the surrounding pine flatwoods areas may also be attracted to the site's open areas. The adjacent forested area is sufficiently large to provide cover and feeding habitat for larger predatory animals (e.g., foxes, owls, and hawks).

Mammals that may occur in pine flatwoods include the Eastern cottontail rabbit (*Sylvilagus floridanus*), hispid cotton rat (*Sigmodon hispidus*), cotton mouse (*Peromyscus gossypinus*), armadillo (*Dasypus novemcinctus*), and white-tailed deer (*Odocoileus virginianus*). Predatory mammals such as the red fox (*Vulpes vulpes*) and gray fox (*Urocyon cinereoargenteus*) may feed on small mammals in these areas.

Certain species that potentially reside at NAS Whiting Field are protected by Federal and/or State laws. A list of State or federally protected species is provided in Appendix G of the GIR (HLA, 1998). Observations made during an ecological survey of NAS Whiting Field indicate that no State or federally listed rare, threatened, or endangered species or species of concern are known to inhabit Site 2 (Nature Conservancy, 1997).

No areas of standing water or hydrophytic vegetation were observed at the site. The site contains no suitable aquatic habitat. Therefore, no surface water sediment samples were collected or evaluated in the ERA. A discussion of the hydrogeology of Site 2 is presented in Section 5.2 of this report. Groundwater is approximately 60 to 80 feet bls. Based on potentiometric maps, groundwater flows southwest toward Clear Creek, several thousand feet from the site (see Figures 5-1 and 5-2 in Section 5.2 of this report).

**7.2 PROBLEM FORMULATION.** Problem formulation is the initial step of the ERA process. Problem formulation consists of identification of receptors, identification of exposure pathways for those receptors, and the assessment and measurement endpoints selected based on information gathered from the site characterization.

**7.2.1 Identification of Receptors** Ecological receptors that may potentially utilize the available open field and adjacent pine forest habitats at Site 2 include terrestrial wildlife (i.e., mammal, birds, reptiles, and amphibians), plants, and invertebrates. Terrestrial flora and fauna potentially using NAS Whiting Field are identified in the GIR (HLA, 1998). As previously discussed, aquatic receptors are not evaluated in the ERA because no aquatic habitats exist at Site 2.

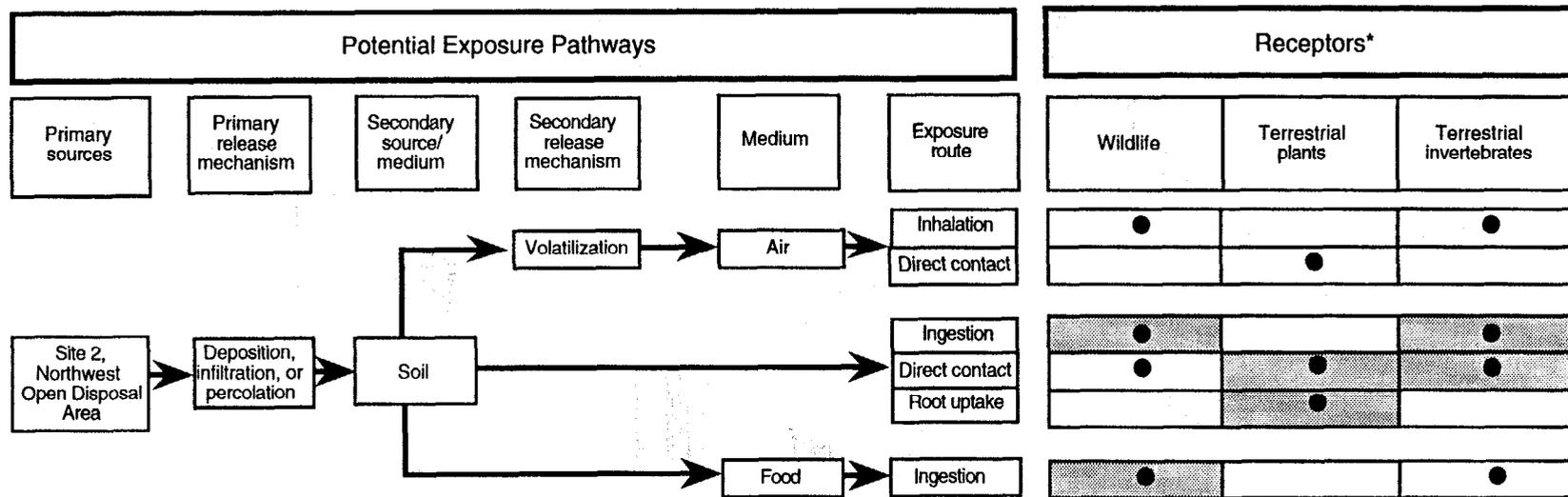
**7.2.2 Identification of Exposure Pathways** A complete exposure pathway includes a source of contamination, an exposure route, and a receptor. Exposure pathways are identified for three groups of receptors (terrestrial wildlife, terrestrial plants, and terrestrial invertebrates). A conceptual model of the exposure pathways from the source to the ecological receptors is depicted in the contaminant pathway model on Figure 7-1. As previously discussed in Section 7.1, exposure pathways are not evaluated for surface water, sediment, or groundwater.

Not all potential routes of exposure are evaluated in the contaminant pathway model. This limitation is necessary to focus the risk evaluation on pathways for which (1) contaminant exposures are the highest and most likely to occur, and (2) adequate toxicity data for completion of risk analyses are available.

The general approach used to identify exposure pathways for the three groups of receptors is explained below.

**Terrestrial Wildlife.** The wildlife exposure routes believed to contribute the highest potential chemical exposures include ingestion of soil and food items that contain chemicals as a result of accumulation from site media.

An assumption is made that fur, feathers, or chitinous exoskeleton limits the transfer of contamination across the dermis; therefore, exposures related to dermal contact were not evaluated. Exposures related to inhalation were also not



**NOTE:**  
ERA = ecological risk assessment

\* Shading indicates the exposure pathways that are quantitatively evaluated for receptors in the Site 2 ERA. Nonshaded pathways are not evaluated because they are not considered significant pathways.

**FIGURE 7-1  
CONTAMINANT PATHWAY MODEL FOR  
ECOLOGICAL RECEPTORS**



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evaluated because this pathway is generally considered an insignificant route of exposure except in unusual circumstances, such as immediately following a spill or release.

Potential contaminant exposures for reptiles and amphibians exist at NAS Whiting Field; however, these exposures were not evaluated in the ERA due to a lack of available data relating chemical exposures to adverse responses. It should be noted that the lack of available toxicity data for these taxa does not imply that adverse responses do not occur.

Terrestrial Plants and Invertebrates. Terrestrial plants and soil invertebrates may be exposed to contamination in surface soil by direct contact with or ingestion of surface soil. The ingestion exposure routes include the ingestion of soil and food items containing chemicals accumulated from Site 2 surface soil. Terrestrial plants may also be exposed to contamination in groundwater through uptake of water by their roots. Because groundwater is 85 to 90 feet bls and not likely to come into contact with plants, the direct groundwater exposure pathway is not being evaluated.

7.2.3 Identification of Endpoints The assessment and measurement endpoints selected for the Site 2 ERA are listed in Table 7-1. Assessment endpoints represent the ecological component to be protected, whereas the measurement endpoints approximate or provide a measure of the achievement of the assessment endpoint. The assessment endpoint selected for the Site 2 ERA is the survival and maintenance of receptor populations and communities at Site 2.

The measurement endpoints used to gauge the likelihood of population-level effects are chemical-specific toxicological benchmark values reported in the literature that are based on laboratory-measured survival, growth, and reproductive effects. Table 7-1 presents the assessment endpoint, endpoint species, measurement endpoint, and decision point (i.e., the level at which additional evaluation occurs).

Three hypotheses were developed to gauge potential risks associated with exposure to Site 2 surface soil. These hypotheses are designed for multiple species and trophic levels and represent both individual and community dynamics. Hypotheses for the Site 2 ERA include the following:

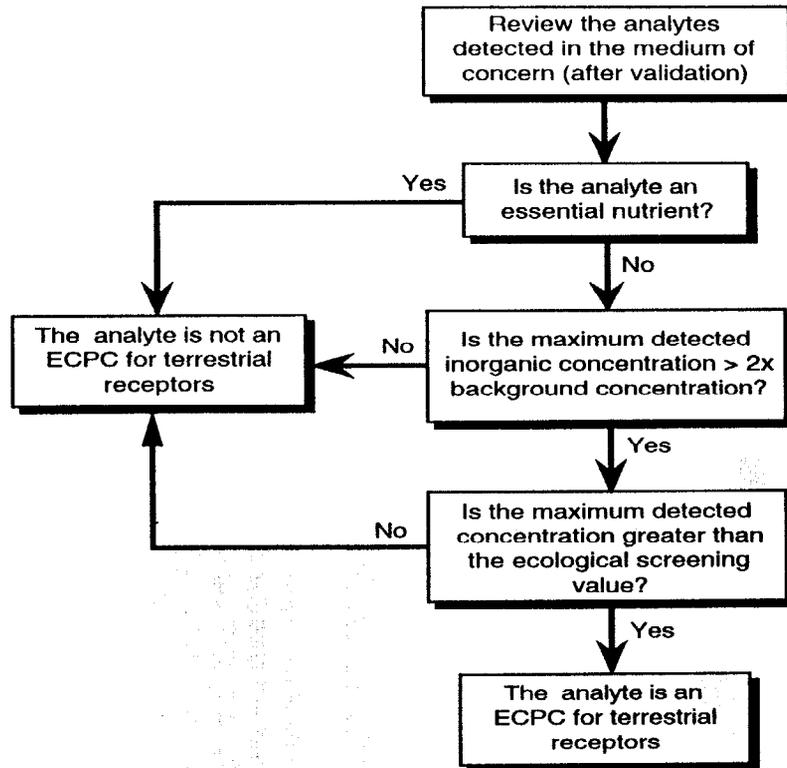
- Are ECPCs present in the surface soil at concentrations sufficiently high to reduce plant populations, availability of plant cover, or invertebrates such that small mammal and bird populations could be effected?
- Are ECPC concentrations in plants and invertebrates sufficiently high as to adversely affect foraging small mammal or bird populations?
- Are bioaccumulating chemicals sufficiently high to reduce survivability, growth, or reproduction of top predators (i.e., foxes and owls)?

7.3 HAZARD ASSESSMENT AND SELECTION OF ECPCS. The hazard assessment includes a review of analytical data and selection of ECPCS. ECPCS are analytes detected in surface soil that could present a potential risk for ecological receptors. The process for selecting ECPCS is depicted on Figure 7-2. Additional details

**Table 7-1**  
**Endpoints Selected for**  
**Ecological Risk Assessment, Site 2**

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Assessment Endpoint	Receptor	Measurement Endpoint	Decision Point
Reduction in the biomass of terrestrial plants used as forage material.	Terrestrial plants	Chemical concentrations (mg/kg) detected in surface soil samples that result in adverse effects on growth, reproduction, or survival of terrestrial plants.	The maximum detected chemical concentration (mg/kg) TRV detected in surface soil samples is greater than the TRV for terrestrial plants.
Reduction in the abundance of earthworms used as forage material.	Terrestrial invertebrates	Chemical concentrations (mg/kg) detected in surface soil samples that result in adverse effects on survival (i.e., LC <sub>50</sub> studies) of terrestrial invertebrates or measured adverse effects on reproduction and growth.	The maximum detected chemical concentration (mg/kg) detected in surface soil samples is greater than the TRV for terrestrial invertebrates.
Protection of small mammals and birds that forage on soil invertebrates and terrestrial plants.  Protection of top predators that prey on small mammals and birds.	Wildlife species	Oral chemical doses (mg/kg BW/day) based on measured adverse effects on growth, reproduction, or survival (i.e., NOAEL, LOAEL, and LD <sub>50</sub> studies) of mammalian or avian laboratory test populations.	Comparison of potential dietary exposures in mammalian and avian wildlife with literature-derived TRVs HQ > 1 indicates potential risk.
Notes: mg/kg = milligrams per kilogram. BW/day = body weight per day. LD <sub>50</sub> = lethal dose to 50 percent of a test population. LC <sub>50</sub> = lethal concentration to 50 percent of a test population. HQ = hazard quotient. TRV = toxicity reference value. NOAEL = no observed adverse effect level. LOAEL = lowest observed adverse effect level. > = greater than.			



**NOTES:**

ECPC = ecological contaminant of potential concern  
> = greater than  
x = times

**FIGURE 7-2  
ECOLOGICAL CONTAMINANT OF POTENTIAL  
CONCERN SELECTION PROCESS**



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regarding the ECPC selection process are provided in Subsection 2.4.2 of the GIR (HLA, 1998). Analytical data for Site 2 were evaluated pursuant to national guidance, *Guidance for Data Useability in Risk Assessment (Parts A and B)* (USEPA, 1992c).

Inorganic chemicals representative of background conditions were not selected as ECPCs. In accordance with USEPA Region IV guidance (USEPA, 1991c), an inorganic analyte was not selected as an ECPC if the highest detected concentration in surface soil was less than two times the average detected inorganic concentration in background samples.

A site-specific background investigation was conducted at NAS Whiting Field, and the findings are presented in Paragraph 3.3.1.1 of the GIR (HLA, 1998). The site-specific background study used for Site 2 consisted of 11 surface soil locations (BKG-SL-01, BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKG-SL-09, BKG-SL-10, BKS00101, BKS00201, BKS00401, and BKS00501) and two duplicate background samples (BKG-SL-09D and BKS00201D). Background sample locations are shown on Figure 3-10 of the GIR (HLA, 1998).

The highest detected concentrations were compared against representative site-specific background soil screening concentrations to eliminate chemicals that are unlikely to be site related. The maximum detected concentration of each analyte was also compared to an ecological screening value. For surface soil, the ecological screening value used was the Dutch Soil Criteria "A," which refers to background concentration in surface soil, issued by the U.S. Fish and Wildlife (Beyer, 1990). Table 7-2 presents the site-specific background and ecological screening values.

If the maximum detected concentration of an analyte is less than two times the average concentration detected in the site-specific background samples (for inorganics only) or is less than the ecological screening value, then the analyte is not selected as an ECPC. In addition, calcium, iron, magnesium, potassium, and sodium are excluded as ECPCs because these analytes are considered to be essential nutrients. Further information on the rationale for eliminating essential nutrients as ECPCs is provided in the GIR (HLA, 1998).

Six surface soil samples (02S00101, 02S00201, 02S00301, 02S00401, 02S00501, and 2-SB01[0-2]) were collected at Site 2. Site 2 surface soil sample locations are shown on Figure 3-1. Table 7-2 presents frequency of detection, range of detection limits, range of detected concentrations, average of detected concentrations, background screening concentrations, and ecological screening values. Table 7-2 also identifies chemicals exceeding the screening process and thus selected as ECPCs (i.e., chemicals having maximum detected concentrations greater than background and ecological screening concentrations, and not considered an essential nutrient, are retained as ECPCs and evaluated in the ERA). ECPCs selected for Site 2 surface soil include one VOC (chloroform), one SVOC (bis(2-ethylhexyl)phthalate) and two inorganics (beryllium and vanadium).

**7.4 EXPOSURE ASSESSMENT.** The purpose of the ecological exposure assessment is to estimate or measure the amount of an ECPC to which an ecological receptor may be exposed. The following sections briefly describe how contaminant exposures are estimated or measured for wildlife, terrestrial plants, and invertebrates.

**Table 7-2**  
**Selection of Ecological Chemicals of Potential Concern**  
**in Site 2 Surface Soil**

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Analytes	Frequency of Detection <sup>1</sup>	Reporting Limits Range	Detected Concentration Range <sup>2</sup>	Average of Detected Concentrations <sup>3</sup>	Background Screening Concentration <sup>4</sup>	Ecological Screening Value <sup>5</sup>	Chemicals of Ecological Concern <sup>6</sup>	Average of All Concentrations <sup>7</sup>	Exposure Point Concentrations	
									Maximum <sup>8</sup>	Average <sup>9</sup>
<b>Volatile Organic Compounds (µg/kg)</b>										
Chloroform	1/6	10 to 11	5	5	ND	NA	Yes	5.3	5	5
<b>Semivolatile Organic Compounds (µg/kg)</b>										
bis(2-Ethylhexyl)-phthalate	1/6	350 to 3,600	105*	105	57	NA	Yes	1072	105	105
<b>Pesticides and PCBs (µg/kg)</b>										
4,4-DDT	1/6	3.5 to 18.5	3.65*	3.7	ND	100	No <sup>10</sup>			
Dieldrin	2/6	3.5 to 18	8.15* to 11.5	9.8	29	100	No <sup>10</sup>			
alpha-Chlordane	1/6	1.8 to 9.5	5.35*	5.4	ND	100	No <sup>10</sup>			
gamma-Chlordane	1/6	1.8 to 9.5	3.2*	3.2	ND	100	No <sup>10</sup>			
<b>Inorganic Analytes (mg/kg)</b>										
Aluminum	6/6	40	1,150 to 9,230	6150	13,500	NA	No <sup>11</sup>			
Arsenic	6/6	2	0.82* to 3.95*	2.1	2.6	20	No <sup>10</sup>			
Barium	6/6	40	1.7 to 27.1	14	18.8	200	No <sup>10,11</sup>			
Beryllium	4/6	1	0.11 to 0.45	0.24	0.36	NA	Yes	0.32	0.45	0.32
Calcium	5/6	1,000	981.5* to 12,500	7340	446	NA	No <sup>12</sup>			
Chromium	6/6	2	1.5 to 13.8*	6.2	10	100	No <sup>10</sup>			
Cobalt	2/6	10	0.59 to 2.77*	1.7	2.8	20	No <sup>10,11</sup>			
Copper	3/6	5	3.6 to 4.8	4.1	8	50	No <sup>10,11</sup>			
Cyanide	2/6	0.5 to 1	0.1 to 0.2*	0.15	0.28	1	No <sup>10,11</sup>			
Iron	6/6	20	799 to 3,950*	3030	7,744	NA	No <sup>11</sup>			

See notes at end of table.

**Table 7-2 (Continued)**  
**Selection of Ecological Chemicals of Potential Concern**  
**in Site 2 Surface Soil**

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Analytes	Frequency of Detection <sup>1</sup>	Reporting Limits Range	Detected Concentration Range <sup>2</sup>	Average of Detected Concentrations <sup>3</sup>	Background Screening Concentration <sup>4</sup>	Ecological Screening Value <sup>5</sup>	Chemicals of Ecological Concern <sup>6</sup>	Average of All Concentrations <sup>7</sup>		Exposure Point Concentrations	
								Maximum <sup>8</sup>	Average <sup>9</sup>	Maximum <sup>8</sup>	Average <sup>9</sup>
<b>Inorganic Analytes (mg/kg) (Continued)</b>											
Lead	6/6	0.6	1.4 to 15.8*	9.2	10.2	50	No <sup>10</sup>				
Magnesium	6/6	1,000	11.3 to 1,890	715	244	NA	No <sup>12</sup>				
Manganese	6/6	3	4 to 176*	98.4	324	NA	No <sup>11</sup>				
Mercury	4/6	0.1	0.01 to 0.04*	0.02	0.12	0.5	No <sup>10,11</sup>				
Nickel	4/6	8	2.85* to 4.4	3.8	6.8	50	No <sup>10,11</sup>				
Potassium	3/6	1,000	247 to 567	358	177	NA	No <sup>12</sup>				
Sodium	1/6	1,000	168*	168	382	NA	No <sup>11,12</sup>				
Vanadium	6/6	10	3.2 to 20.3	11.3	19	NA	Yes	11.3	20.3	11.3	
Zinc	5/6	4	6.2 to 12.8*	8.6	15.8	200	No <sup>10,11</sup>				
See notes at end of table.											

**Table 7-2 (Continued)**  
**Selection of Ecological Chemicals of Potential Concern**  
**in Site 2 Surface Soil**

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- <sup>1</sup> Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
- <sup>2</sup> The value indicated by an asterisk is the average of a sample and its duplicate. For duplicate samples having one nondetect value, one-half of the contract required quantification limit/contract required detection limit is used as a surrogate concentration.
- <sup>3</sup> The average of detected concentrations is the arithmetic average of all samples in which the analyte was detected. It does not include those samples with "R", "U", or "UJ" validation qualifiers.
- <sup>4</sup> The background screening value is twice the average of detected concentrations for inorganic analytes in background samples. Organic analyte values are one times the average of detected concentrations. Organic values are included for comparison only.
- <sup>5</sup> The ecological screening values are the Dutch Soil Criteria as reported in the U.S. Fish and Wildlife Service, Biological Report 1990(2), "Evaluating Soil Contamination," (Beyer, 1990).
- <sup>6</sup> Chemicals that exceed the background screening concentration and ecological screening values and are not essential nutrients are retained for further evaluation in the ecological risk assessment.
- <sup>7</sup> The average of all concentrations uses a surrogate value of one-half the detection limit for samples in which no detectable concentration was measured (nondetect value).
- <sup>8</sup> The maximum exposure point concentration is equal to the maximum detected concentration.
- <sup>9</sup> The average exposure point concentration is equal to the lesser of the average of all concentrations or the maximum exposure point concentration.
- <sup>10</sup> The maximum detected concentration is less than the ecological screening value and will not be evaluated further.
- <sup>11</sup> The maximum detected concentration is less than the background screening concentration and will not be evaluated further.
- <sup>12</sup> Analyte is an essential nutrient and not considered toxic. Based on professional judgment, this nutrient will not be evaluated further.

Notes: The average of a sample and its duplicate is used for all table calculations unless otherwise noted.

Samples: 02S00101, 02S00201, 02S00301, 02S00401, 02S00501, and 2-SB01(0-2)

Duplicate sample: 02S00201D

Background samples: BKG-SL-01, BKG-SL-02, BKG-SL-06, BKG-SL-07, BKG-SL-08, BKG-SL-09, BKG-SL-010, BKS00101, BKS00201, BKS00401, BKS00501

Duplicate background samples: BKG-SL-09A, BKS00201D

µg/kg = micrograms per kilogram.

ND = not detected in background samples.

NA = not available.

\* = average of a sample and its duplicate.

PCB = polychlorinated biphenyl.

DDT = dichlorodiphenyltrichloroethane.

mg/kg = milligrams per kilogram.

The contaminant pathway model (Figure 7-1) provides a summary of the potential exposure pathways that exist at Site 2 for each group of receptors. Additional detail regarding the exposure assessment is provided in the GIR (HLA, 1998).

**7.4.1 Calculation of Exposure Point Concentrations** The EPC is a representative concentration used for evaluating risks throughout the ERA. "Maximum" and "average" EPCs are established as representative concentrations for each ECPC in surface soil. The average EPC represents a typical site concentration, whereas the maximum EPC is the highest average concentration that could reasonably be expected to occur.

Because less than 10 surface soil samples were collected at Site 2, the highest detected concentration is used as the maximum EPC (USEPA, 1992d). The average of all concentrations assigns a value of one-half of the CRDL (organics) or contract required quantitation limit (inorganics) to each sample in which the analyte was not detected. The average concentration of all samples is used to represent the average ECPC, unless it exceeds the maximum EPC, in which case the maximum EPC is used for both scenarios. Table 7-2 presents the maximum and average EPCs for selected ECPCs.

**7.4.2 Terrestrial Wildlife** Exposure routes for wildlife receptors include direct and indirect ingestion of soil and ingestion of food containing site-related chemicals. The actual amount of an ECPC taken in by wildlife species (i.e., ingestion dose in milligrams per kilogram per day [mg/kg-day]) depends on a number of factors. A potential dietary exposure (PDE) model was used to estimate exposure to representative wildlife species. The PDE (or body dose) is calculated for each ECPC in each medium using the equations in Table 7-3 and the methodologies described in the GIR (HLA, 1998).

Wildlife species from different trophic guilds present at the site were selected for the PDE model. The model uses species-specific feeding and habitat characteristics to estimate chemical exposures to wildlife species respective to their position in the food chain. Terrestrial receptors chosen represent the trophic levels typically found in southeastern flatwoods and disturbed upland communities. Below is a listing of the representative wildlife species (summarized in Table 7-4) selected for evaluation in the food-chain exposures.

- **Cotton mouse** (*Peromyscus gossypinus*). This species could potentially be exposed to chemicals in soil and in plant tissue (accumulated from the surface soil). Herbivorous small mammals could receive relatively high exposure to inorganics, which may be translocated from the soil into plant tissues and then to the herbivore. The cotton mouse home range is estimated at 0.147 acre and could reside entirely on the site. The cotton mouse represents the small mammal herbivore guild at Site 2.
- **Short-tailed shrew** (*Blarina brevicauda*). The short-tailed shrew finds suitable habitat in forests, fields, marshes, and brush. It primarily feeds on earthworms, snails, centipedes, insects, small vertebrates, and slugs (DeGraaf and Rudis, 1986). Insectivorous species may receive relatively high chemical doses of bioaccumulating compounds as a result of their voracious appetites. The shrew represents small omnivorous mammals found in wooded and old-field portions of Site 2.

**Table 7-3**  
**Estimation of Potential Chemical**  
**Exposures for Representative Wildlife Species**

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**Estimation of Chemical Exposures Related to Surface Soil**

**Scope:** Estimates the amount (dose) of a chemical ingested and accumulated by a species via incidental ingestion of surface soil and food items containing site-related chemicals.

**Soil Chemical Concentration:** The maximum detected concentration of the ecological chemicals of potential concern (ECPCs) when the sample size is  $\leq 9$ , and the lesser of the maximum detected concentration or the 95th percent upper confidence limit (UCL) when the sample size is  $\geq 10$ .

**Soil Exposure Concentration:**

$$\text{Soil Exposure (mg/kg)} = \left( \frac{\% \text{ of Diet as Soil}}{\text{mg/kg}} \times \text{Soil Concentration (mg/kg)} \right)$$

**Primary Prey Item Concentration ( $T_N$ ):**

$$\text{Primary Prey Item Concentration (mg/kg)} = \left( \text{BAF}_{\text{inv or plant}} \times \text{Soil Concentration (mg/kg)} \right)$$

**Secondary Prey Item Concentration ( $T_N$ ):**

$$\text{Secondary Prey Item Concentration (mg/kg)} = \left( \text{BAF}_{\text{mamm or bird}} \times \text{Concentration of Primary Prey Items}^* \right)$$

where BAF = Bioaccumulation Factor or mg/kg fresh weight tissue over mg/kg dry weight soil for invertebrates and plants, and mg/kg fresh weight tissue over mg/kg fresh weight food for small mammals and small birds.

\* For a discussion of the weighted chemical concentration in prey items, see explanation of the PDE term below, and the GIR (HLA, 1998)

**Total Exposure Related to Surface Soil:**

$$\text{PDE (mg/kgBW-day)} = \frac{[P_1 \times T_1 + \dots + P_N \times T_N + \text{soil exposure}] \times \text{IR}_{\text{Diet}} \times \text{SFF} \times \text{ED}}{\text{BW}}$$

where PDE = potential dietary exposure (mg/kg BW-day),  
 $P_N$  = percent of diet composed of food item N,  
 $T_N$  = tissue concentration in food item N (mg/kg),  
 $\text{IR}_{\text{Diet}}$  = food ingestion rate of receptor (kg of food or dietary item per day),  
 BW = body weight (kg) of receptor,  
 SFF = Site Foraging Frequency (site area [acres] divided by home range [acres]), assumed to be equal to 1 for lethal exposure scenario, and  
 ED = Exposure Duration (fraction of year species is expected to occur on site).

See notes at end of table.

**Table 7-3 (Continued)**  
**Estimation of Potential Chemical**  
**Exposures for Representative Wildlife Species**

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Notes:  $\leq$  = less than or equal to.  
 $\geq$  = greater than or equal to.  
mg/kg = milligrams per kilogram.  
% = percent.  
BAF = bioaccumulation factor.  
mg/kg BW-day = milligrams per kilogram of body weight per day.  
inv = invertebrate species.  
mam = mammal species.  
kg = kilograms.  
kg/day = kilograms per day.

**Table 7-4  
Ecological Receptors Evaluated  
for Surface Soil**

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Receptor Evaluated		Method of Evaluation
Common Name	Scientific Name	
Terrestrial Plants	NA	Benchmark comparison
Terrestrial Invertebrates	NA	Benchmark comparison
Cotton mouse	<i>Peromyscus gossypinus</i>	Food-web model
Short-tailed shrew	<i>Blarina brevicauda</i>	Food-web model
Eastern meadowlark	<i>Sturnella magna</i>	Food-web model
Red fox	<i>Vulpes vulpes</i>	Food-web model
Great horned owl	<i>Bubo virginianus</i>	Food-web model

Note: NA = not available.

- **Eastern meadowlark (*Sturnella magna*)**. The eastern meadowlark is most commonly found in open pastures, prairies, farms, and meadows and has a home range of approximately 5 acres. The meadowlark feeds primarily on invertebrates, although its diet is supplemented with plants. The meadowlark represents insectivorous avian receptors found in open areas of Site 2 (DeGraaf and Rudis, 1986).
- **Red fox (*Vulpes vulpes*)**. This omnivorous mammal prefers open woodlands and grassy fields and is most active at night and twilight. It is an opportunistic forager, feeding on small mammals, birds, amphibians, reptiles, and invertebrates, and berries and other fruits (Burt and Grossenheider, 1976). The red fox has an estimated home range of approximately 250 acres. The red fox represents the large predatory mammal guild at Site 2.
- **Great horned owl (*Bubo virginianus*)**. The great horned owl is primarily a nocturnal hunter of small mammals. Its habitat includes deep woods and heavily wooded swamps often near open country where it may hunt for primary prey items consisting of small mammals and birds (DeGraaf and Rudis, 1986). The great horned owl home range is approximately 15 acres. The owl represents the predatory avian carnivores of both the open and forested areas of Site 2.

Parameters for quantitatively evaluating exposures to wildlife include body weights, food ingestion rates, and relative consumption of food items. Exposure assumptions for each of the representative wildlife species for Site 2 are provided in Table 7-5 and in Table 6 of Appendix D. In addition to these parameters, the species foraging habits and bioaccumulation in food items are considered.

The Site Foraging Frequency (SFF) considers the frequency a receptor feeds within the site area by estimating the acreage of the site relative to the receptor's home range, and by considering the fraction of the year the receptor would be

**Table 7-5**  
**Exposure Parameters for Representative Wildlife Species**

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Representative Wildlife Species	Body Weight (kg)	Reported Diet	Assumed Diet for Terrestrial Exposure Assessment (% of diet)	Food Ingestion Rate (kg/day)	Home Range (acres)
Cotton mouse [a] ( <i>Peromyscus gossypinus</i> )	0.021 [b]	Seeds and some insects. [c]	88% Plants 10% Invertebrates 2% Soil [d]	0.0029 [e]	0.147 [f]
Short-tailed shrew ( <i>Blarina brevicauda</i> )	0.017 [g]	Earthworms, slugs and snails, fungi, insects, and vegetation. [c]	78% Invertebrates 12% Plants 10% Soil [c]	0.0024 [e]	0.96 ± 0.09 [c]
	0.087 [h]	Insects, weed seeds and grass seeds, 75% of diet is invertebrates (beetles, grubs, bugs, grasshoppers, crickets, ants, and spiders). [h]	75% Invertebrates 20% Plants 5% Soil [h]	0.0119 [i]	5 [h]
Eastern meadowlark ( <i>Sturnella magna</i> )	0.087 [h]	Insects, weed seeds and grass seeds, 75% of diet is invertebrates (beetles, grubs, bugs, grasshoppers, crickets, ants, and spiders). [h]	75% Invertebrates 20% Plants 5% Soil [h]	0.0119 [i]	5 [h]
X Red fox ( <i>Vulpes vulpes</i> )	4.69 [c]	Small mammals, birds, and invertebrates, as well as berries and other fruits. [c]	57% Small mammals 20% Invertebrates 10% Small birds 10% Plants 3% Soil [c]	0.24 [e]	250 [c]
Great horned owl ( <i>Bubo virginianus</i> )	1.50 [i]	Mostly rabbits, mice, rats, squirrels, birds, bats, snakes, frog, crayfish and grasshoppers. [j]	80% Small mammals 19% Birds 1% Soil [c]	0.078 [j]	15 [k]
See notes at end of table.					

**Table 7-5 (Continued)**  
**Exposure Parameters for Representative Wildlife Species**

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**References:**

- [a] Values for the deer mouse were used for the cotton mouse (U.S. Environmental Protection Agency [USEPA], 1993b).
- [b] Average of adult male and female deer mice in North America (USEPA, 1993b).
- [c] *Wildlife Exposure Factors Handbook* (USEPA, 1993b).
- [d] Deer mouse value used for cotton mouse based on similarities in diet. Other values were based on diet composition (USEPA 1993b).
- [e] Calculated using the mammal equation based on body weight (Wt.) in kg. Food ingestion (kg/day) =  $0.0687 \times \text{Wt}^{0.822}$  (kg) (USEPA, 1993b).
- [f] Average for male and female deer mice, Virginia/mixed deciduous forest (USEPA, 1993b).
- [g] Mean of means reported for male and female shrews in summer and fall (USEPA, 1993b).
- [h] Terres (1980).
- [i] DeGraaf and Rudis (1986).
- [j] Calculated using the bird equation based on body weight (Wt.) in kg. Food ingestion (kg/day) =  $0.0582 \times \text{Wt}^{0.651}$  (kg) (USEPA, 1993b).
- [k] Great horned owl home range taken from low end of range in SE Madison County, N.Y. (Hager, 1957).

Notes: kg = kilograms.  
% = percent.  
± = plus or minus.  
kg/day = kilograms per day.

exposed to site-related chemicals. All representative receptors for Site 2 ERA are assumed to be year-round residents at the site.

By definition, the SFF value cannot exceed 1. The SFF value for the cotton mouse, short-tailed shrew, and eastern meadowlark is 1 because the area of Site 2 (approximately 12 acres) is larger than the receptors' home range and each is expected to actively forage at the site year round.

Bioaccumulation factors (BAFs) were used in the wildlife exposure models to estimate the transfer of chemicals between soil and plants or soil invertebrates, and between these organisms and primary consumer species. To estimate the PDE, tissue concentrations of ECPCs in prey items were estimated using BAFs for surface soil. BAFs for most receptors were extrapolated from literature values or estimated using regression equations from scientific literature. Based on the lack of scientific data for VOC bioaccumulation and evidence provided in several reference materials (Suter, 1993; Maughan, 1993), an assumption was made that VOCs do not bioaccumulate in prey tissue. The general approach used to select BAFs for Site 2 is summarized in Table 7-6.

BAFs for invertebrate and plant prey are defined as the ratio of the ECPC concentration in plant or invertebrate tissue (mg chemical/kg tissue wet-weight) to the ECPC concentration in surface soil (mg chemical/kg dry-weight soil). BAFs reported in the scientific literature for avian and mammalian receptors are the reported ratios of ECPC concentrations in the tissues of these receptors (mg chemical/kg tissue wet-weight) to the concentrations of ECPCs in their food items (mg chemical/kg tissue wet-weight). BAFs for each ECPCs evaluated at Site 2 are included in Table D-1 of Appendix D.

7.4.3 Terrestrial Plants and Invertebrates Terrestrial plants and invertebrates may be exposed to ECPCs via direct contact between soil and root uptake (plants) or ingestion (invertebrates).

For the purpose of the Site 2 ERA, exposures to terrestrial plants and invertebrates are assumed to occur within the top 1-foot interval of surface soil. Exposure of terrestrial plants to groundwater is not evaluated because the depth to the water table is approximately 85 to 90 feet bls (see hydrogeological discussion in Chapter 5.0 of this report).

7.5 ECOLOGICAL EFFECTS ASSESSMENT. The ecological effects assessment describes the potential adverse effects associated with each ECPC. The assessment endpoints of the ERA are the survival and maintenance of ecological receptor populations at Site 2. The measurement endpoints used to gauge the success of the assessment endpoints, as well as the methods used for identifying and characterizing ecological effects for ECPCs in surface soil, are described in the following sections, and in greater detail in the GIR (HLA, 1998).

Wildlife receptors, terrestrial plants, and terrestrial invertebrates are potentially exposed to ECPCs detected in surface soil at Site 2. The measures of adverse ecological effects for these receptors are discussed separately.

Terrestrial Wildlife. Because no long-term wildlife population data are available at NAS Whiting Field, a direct measurement of the survival and maintenance of wildlife populations at Site 2 is not possible. The literature-

**Table 7-6  
Estimation of Bioaccumulation Factors for Site 2**

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Receptor Group	Nature of Approach	General Approach
<b><u>Terrestrial Plants</u></b>		
Unit: mg/kg wet tissue per mg/kg dry soil	Literature Values	When available, literature values were used to estimate plant BAFs.
	Extrapolation and Empirical Data	When literature values were not available, plant BAFs for inorganic compounds were obtained from Baes et al. (1984). <sup>1</sup>
	Assumption	Although evidence suggests that plants may transport organic analytes with log $K_{ow}$ s < 5 (i.e., volatile organic compounds [VOCs]) from the roots into leafy portions (Briggs et al., 1982; Briggs et al., 1983), bioaccumulation data for VOCs are generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log $K_{ow}$ s < 3.5 are not bioaccumulated into animal tissue. Therefore, it was assumed that transfer of VOCs from plant tissue to animal tissue does not occur.
<b><u>Terrestrial Invertebrates</u></b>		
Unit: mg/kg wet tissue per mg/kg dry soil	Literature Values	When no site-specific values were available, literature values were used to estimate BAFs for invertebrates.
	Assumption	Bioaccumulation data for VOCs are generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log $K_{ow}$ s < 3.5 are not bioaccumulated into animal tissue. Therefore, it was assumed that soil invertebrates do not bioaccumulate VOCs.
<b><u>Small Mammals</u></b>		
Unit: mg/kg wet tissue per mg/kg wet food	Literature Values	When available, literature values were used to estimate BAFs for small mammals.
	Extrapolation and Empirical Data	When literature values were not available, BAFs for small mammals for inorganics were derived from ingestion-to-beef biotransfer factors (BTFs) presented in Baes et al. (1984). <sup>2</sup>
	Assumption	Bioaccumulation data for VOCs are generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log $K_{ow}$ s < 3.5 are not bioaccumulated into animal tissue. Therefore, it was assumed that small mammals do not bioaccumulate VOCs.
<b><u>Small Birds</u></b>		
Unit: mg/kg wet tissue per mg/kg wet food	Literature Values	When available, literature values were used to estimate BAFs for small birds.
	No Information	BAFs were not obtained for SVOCs or for inorganic compounds as there is little bioaccumulation data available for birds. It was assumed that small birds do not accumulate VOCs.
See notes at end of table.		

**Table 7-6 (Continued)**  
**Estimation of Bioaccumulation Factors for Site 2**

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<sup>1</sup> BAFs derived from Baes et al. (1984). Values are based on analysis of literature references, correlations with other chemical and physical parameters, or comparisons of observed and predicted elemental concentrations in vegetative and reproductive plant material and soil. Data are based on dry weight and were converted to a fresh weight basis assuming that plants are 80 percent water. This is generally consistent with the water content of berries (82 to 87 percent water) and leafy vegetables (87 to 95 percent water), presented in Suter (1993). Grains contain a much lower percentage of water (approximately 10 percent); therefore, this assumption likely underestimates exposure to graminivores.

<sup>2</sup> BTFs were converted to a BAF (mg/kg tissue divided by mg/kg food) by multiplying by a food ingestion rate of 12 kg (dry weight) per day (average intake for lactating and nonlactating cattle reported in Travis and Arms, 1988).

Notes: mg/kg = milligrams per kilogram.

BAFs = bioaccumulation factors.

Log  $K_{ow}$  = Logarithmic expression of the octanol-water partition coefficient.

< = less than.

SVOC = semivolatile organic compound.

derived results of laboratory toxicity studies that relate the dose of a chemical in an oral exposure with an adverse response to growth, reproduction, or survival of a test population (avian or mammalian species) were used as a measure of the assessment endpoint. The ERA used the lowest reported toxicity value for a taxonomic group to represent the dose-response concentration for an ECPC. This value, termed a toxicity reference value (TRV), is used as a threshold effect concentration. Exposures to concentrations below the TRV are unlikely to result in adverse effects. The TRVs are body-weight normalized values (analyte concentration/body weight).

The endpoints for the toxicity studies were divided into lethal and sublethal effects. Lethal and sublethal TRVs were identified using the process described below. The lethal TRV represents the highest exposure (e.g., ingested dose) shown not to produce an increase in mortality. The lethal TRV is based on a no-observable-adverse-effect-level (NOAEL) study conducted on a species that is closely related to the representative wildlife species. If no NOAEL study was found in the literature, then one-tenth of a lowest-observable-adverse-effect-level (LOAEL) (from studies using mortality as the endpoint) or one-fifth of the lowest reported oral LD<sub>50</sub> (oral dose [in mg/kg-body weight-day] lethal to 50 percent of a test population) is used as a surrogate lethal TRV. One-fifth of the LD<sub>50</sub> is considered to be protective against lethal effects for 99.9 percent of individuals in a test population (USEPA, 1986).

Sublethal TRVs represent a threshold level for adverse effects related to reproduction or growth. The sublethal TRV is representative by the NOAEL from a chronic or subchronic study conducted on a closely related species. If an NOAEL is not available, then one-tenth of an LOAEL (study for reproduction or growth) is used as a surrogate sublethal TRV.

Table D-2 in Appendix D presents the available toxicity studies used to derive the TRVs. A summary of selected lethal and sublethal TRVs is provided in Table D-3 in Appendix D. More details regarding the derivation of TRVs are provided in the GIR (HLA, 1998).

If either the lethal or sublethal toxicity information is not available for a taxonomic group, TRVs are not identified and risks associated with the respective ECPC are not quantitatively evaluated. However, the absence of specific data for a taxonomic group does not imply "no toxicological effect." In the absence of specific dose-response data for a particular taxonomic group, a qualitative discussion of potential for risks is presented in the Risk Characterization (Section 7.6).

Terrestrial Plants and Invertebrates. Site-specific toxicity data for plants and invertebrates are not available for Site 2. A literature search was performed for each ECPC. Toxicity data associated with adverse growth, reproduction, or survival effects to plants and invertebrates were respectively identified and summarized in Tables D-4 and Table D-5 in Appendix D.

7.6 RISK CHARACTERIZATION. Potential risks associated with exposures to ECPCs in surface soil at Site 2 are discussed separately for wildlife, terrestrial plants, and soil invertebrates. Risks to wildlife are characterized by comparing the PDE dose estimates (maximum and average dose) for each surface soil ECPC with the lethal and sublethal TRVs. The potential for adverse effects to terrestrial

plants and to soil invertebrates is evaluated by comparing toxicity benchmark values to the highest detected chemical concentration (maximum EPC) and to the average chemical concentration (average EPC) in surface soil.

Terrestrial Wildlife. An HQ approach was employed to quantify risks for the representative wildlife species associated with ingestion and bioaccumulation of ECPCs in surface soil and prey items. HQs are calculated for each ECPC by dividing the PDE concentration by the selected lethal and sublethal TRV. When the estimated PDE is less than the TRV (i.e., the HQ less than 1), it is assumed that chemical exposures are not associated with adverse effects to receptors and no risks to wildlife populations exist. Conversely, as the HQ increases above 1 (HQ greater than 1), the likelihood that an adverse effect will occur also increases.

A hazard index (HI) is determined for each representative receptor by summing the HQs for all ECPCs. HIs greater than 1 suggest the possibility of adverse effects. As the HI increases, the likelihood that an adverse effect will occur also increases. When an HI is greater than 1, a discussion of the ecological significance of the HQs comprising the HI is completed.

This hazard ranking scheme evaluates potential ecological effects to individual organisms and does not evaluate potential population-wide effects. In many circumstances, lethal or sublethal effects may occur to individual organisms with little population or community-level impacts; however, as the number of individual organisms experiencing toxic effects increases, the probability that population effects will occur also increases. The number of affected individuals in a population presumably increases with increasing HI values; therefore, the likelihood of population-level effects occurring is generally expected to increase with higher HI values.

The lethal and sublethal HQs and HIs are calculated for each ECPC and each representative wildlife species. HQ and HI calculations are presented in Tables D-6 through D-14 in Appendix D. Table 7-7 provides a summary of risks to representative wildlife receptors for both lethal and sublethal endpoints. Risks associated with exposure to the maximum detected concentration of ECPCs in Site 2 surface soil are not predicted for the representative wildlife species because all lethal and sublethal HQs and HIs are less than 1.

Terrestrial Plants. Risks for terrestrial plants were evaluated by comparing the selected phytotoxicity TRVs to the maximum and average EPCs. The maximum and average EPCs of chloroform, bis(2-ethylhexyl)phthalate, and beryllium are less than their respective benchmark values (Table 7-8). Only vanadium exceeded its phytotoxicity benchmark value.

Exposure of plants to vanadium occurs primarily through root sorption. After uptake, most vanadium remains in the root system in an insoluble form with calcium. Toxicity symptoms include chlorosis, dwarfing, and inhibited root growth. Vanadium inhibits various enzyme systems while stimulating others, the overall effect on plant growth being negligible (Will and Suter, 1995).

Vanadium detected in surface soil samples may be from natural or anthropogenic sources. Vanadium is a naturally occurring element often found in clays, crude oil, phosphate deposits, and iron ores (Chemical Rubber Company [CRC], 1972). Vanadium was detected in all six samples ranging from 3.2 to 20.3 mg/kg (average

**Table 7-7  
Summary of Hazardous Indices for Terrestrial Wildlife<sup>1</sup>**

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Ecological Receptors	Lethal Effects from Exposure to Maximum EPCs	Lethal Effects from Exposure to Average EPCs	Sublethal Effects from Exposure to Maximum EPCs	Sublethal Effects from Exposure to Average EPCs
Cotton mouse	0.01	0.0059	0.027	0.018
Eastern meadowlark	0.0073	0.0041	0.13	0.071
Short-tailed shrew	0.051	0.029	0.14	0.093
Red fox	0.0003	0.00017	0.0076	0.00051
Great horned owl	0.0007	0.00039	0.012	0.0068

<sup>1</sup> Hazard indices are presented in Tables D-6 through D-14 in Appendix D.

Note: EPC = exposure point concentration.

**Table 7-8**  
**Ecological Risk for Plants and Invertebrates in Site 2 Surface Soil**

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Analyte	Maximum Exposure Point Concentrations	Average Exposure Point Concentrations	TRV		TRV Exceeded?	
			Plant <sup>1</sup>	Invertebrate <sup>2</sup>	Plant	Invertebrate
<b>Volatile Organic Compounds (mg/kg)</b>						
Chloroform	0.005	0.005	1000	148	No/No	No/No
<b>Semivolatile Organic Compounds (mg/kg)</b>						
bis(2-Ethylhexyl)phthalate	0.105	0.105	1000	478	No/No	No/No
<b>Inorganic Analytes (mg/kg)</b>						
Beryllium	0.45	0.32	10	NA	No/No	NA/NA
Vanadium	20.3	11.3	2	NA	Yes/Yes	NA/NA
<p><sup>1</sup> Plant TRVs are from Table D-3 in Appendix D. Generally, the plant TRVs are the lowest observed effect concentration from plant growth studies on plants in solid media.</p> <p><sup>2</sup> Invertebrate TRVs are presented in Table D-4 of Appendix D. Generally, invertebrate TRVs are the lowest LC<sub>50</sub> (14-day soil test on <i>Eisenia foetida</i>). A conservative factor of 0.2 was applied to invertebrate TRVs; the resultant value should be protective of 99.9 percent of the population from lethal effects (U.S.Environmental Protection Agency, 1986).</p> <p>Notes: TRV = toxicity reference value.  mg/kg = milligrams per kilogram.  NA = not available.  <span style="background-color: #cccccc;"> </span> = shading indicates exceedances.  LC<sub>50</sub> = lethal concentration to 50 percent of the population.</p>						

concentration of 11.3 mg/kg). The background screening concentration for vanadium was 19 mg/kg. Both site-specific concentrations and background concentrations of vanadium exceed the phytotoxicity benchmark value of 2 mg/kg.

The vanadium phytotoxicity benchmark value of 2 mg/kg, was taken from a USEPA report titled, "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals" (USEPA, 1980). This report does not identify how the vanadium value was derived or provide specific vanadium studies used to justify the 2 mg/kg value. Consequently, the confidence level of the vanadium benchmark is "low" (Will and Suter, 1995).

Further evaluation of background surface soil collected from NAS Whiting Field shows that vanadium was detected at concentrations ranging from 6 to 31.9 mg/kg. The Site 2 maximum exposure point concentration of 20.3 mg/kg is less than the maximum background concentration of 31.9 mg/kg. Although both values exceed the phytotoxicity benchmark of 2 mg/kg, it appears that detected concentrations of vanadium at Site 2 may be representative of background conditions.

As previously discussed in Section 7.1, the plant community at Site 2 is predominantly covered with the vine kudzu. The old field community observed at Site 2 is consistent with the type of vegetation expected in an open disposal area. In addition, no areas of stressed vegetation were observed at Site 2 during the site characterization.

Based on the relative low confidence of the vanadium screening value, the detected concentrations of vanadium at Site 2 that are representative of background conditions, and the lack of observable stressed vegetation at Site 2, reductions in plant biomass and/or plant cover are not predicted at Site 2.

Terrestrial Invertebrates. Risks for terrestrial invertebrates are evaluated by comparing invertebrate toxicity benchmark values to maximum and average EPCs. The results of this evaluation are presented in Table 7-8.

Maximum and average EPCs of chloroform and bis(2-ethylhexyl)phthalate are below the invertebrate TRVs. Because invertebrate TRVs are not available for beryllium and vanadium, a qualitative discussion of the toxicity of these analytes is provided below.

Beryllium. Beryllium does not volatilize. The primary exposure route of beryllium to invertebrates is through direct contact and ingestion of soil or affected food items.

Beryllium was detected in four out of six samples at concentrations below the laboratory detection limit of 1 mg/kg. Detected concentrations of beryllium ranged from 0.11 to 0.45 mg/kg (average detected concentration of 0.24 mg/kg). The background screening concentration for beryllium is 0.36 mg/kg. Detected concentrations of beryllium at Site 2 are consistent with concentrations of beryllium detected in background surface soil from NAS Whiting Field. Therefore, it appears that detected concentrations of beryllium at Site 2 may be representative of background conditions.

Vanadium. Vanadium is a naturally occurring element often found in clays, crude oil, phosphate deposits, and iron ores (CRC, 1972). Vanadium is not easily

volatilized. Most of the exposure to invertebrates is through direct contact and ingestion of soil or affected food items.

Vanadium was detected in all six surface soil samples. Detected concentrations of vanadium ranged from 3.2 to 20.3 mg/kg (average concentration of 11.3 mg/kg). The background screening concentration for vanadium is 19 mg/kg. Detected concentrations of vanadium at Site 2 are consistent with concentrations of vanadium detected in background surface soil from NAS Whiting Field. Therefore, it appears that detected concentrations of vanadium at Site 2 may be representative of background conditions.

Although invertebrate benchmark values are not available for beryllium and vanadium, qualitative evaluation of site-specific concentrations to background values suggests that the concentrations are similar. Therefore, it is unlikely that terrestrial invertebrates are at risk from exposure to ECPCs detected in Site 2 surface soil.

**7.7 UNCERTAINTY ANALYSIS.** The objective of the uncertainty analysis is to discuss the assumptions of the ERA process that may influence the risk assessment results and conclusions. Table 2.5 of the GIR presents general uncertainties inherent in the risk assessment process (HLA, 1998).

Specific uncertainties associated with exposure to surface soil at Site 2 include the following:

- Risks to invertebrates may have been underestimated because invertebrate benchmarks for beryllium and vanadium are not available.
- Risks to avian species may have been underestimated because bioaccumulation and toxicity data for this taxonomic group are generally lacking in the literature. As a result, the ERA may have underestimated potential risks to avian species.
- Risks to amphibian and reptile species were not estimated because bioaccumulation and toxicity data for this taxonomic group are generally not available. As a result, potential risks were not evaluated for these species.
- Many of the analytes detected in surface soil samples were inorganics. Inorganics are naturally occurring and thus may be related to either natural conditions or anthropogenic activities. It is possible that the inorganic analytes detected in surface soil samples represent natural conditions and are unlikely to pose additional risks to native plants and animals.
- The chemical forms used to derive toxicity values may not be the same form that is present at the site. Different chemical forms may raise or lower the threshold concentration at which a chemical could adversely affect a species. In addition, organic and inorganic analytes may bond into complexes that prevent the chemical from being available to wildlife, plants, and invertebrates.

- The exposure parameters used to calculate home range, ingestion rates, and bioaccumulation were obtained from the literature. These values may overestimate or underestimate risks to site organisms.
- Because no other toxicity studies were available, a gavage study was used to derive the lethal mammalian TRV for vanadium. Gavage studies usually result in an overestimation of risk.
- Toxicity values were derived from laboratory animals and may overestimate or underestimate toxicity to native or sensitive species.

**7.8 SUMMARY OF ECOLOGICAL RISKS.** Potential risks to ecological receptors were quantitatively and/or qualitatively evaluated for ECPCs identified in surface soil samples collected from Site 2, NAS Whiting Field.

Risks associated with exposure to ECPCs in surface soil were evaluated for terrestrial wildlife based on the food-web model that predicts the amount of contaminant exposure via the diet and incidental ingestion of soil. Comparison of predicted dose for representative wildlife species with thresholds for both lethal and sublethal effects (TRVs) is the basis of risk evaluation. Based on this comparison, exposure to Site 2 surface soil is unlikely to result in adverse effects to wildlife receptors.

Risks for plants and invertebrates were evaluated based on comparison of maximum and average EPCs with literature-reported toxicity values. Based on this comparison, risks were not predicted for invertebrates because all maximum EPCs were below available toxicity values. Although the maximum EPC of vanadium exceeded its respective phytotoxicity benchmark, risks are unlikely because the Site 2 surface soil concentration of vanadium is within the range found in background surface soil from NAS Whiting Field. Therefore, it appears detected concentrations of vanadium at Site 2 may be representative of background conditions. Additionally, stressed vegetation was not apparent at the site. Therefore, risks to terrestrial plants are not predicted.

## 8.0 CONTAMINANT FATE AND TRANSPORT

This chapter discusses the fate and transport of human health and ecological CPCs detected in soil and groundwater samples at Site 2. Fate, in the context of this chapter, refers to the ultimate disposition of a given CPC following its release into the environment. Transport refers to the mechanism(s) by which a given chemical released into the environment will arrive at its fate. Explanation of the fate and transport of chemicals in the environment can be very complicated or very simple, depending on the physical, chemical, and biological characteristics of the compound or metal considered and the environment into which that compound is released.

Several organic compounds and inorganics were detected in soil and groundwater sampled at Site 2. Because of the number of potential chemicals detected and the myriad fate and transport scenarios possible for those chemicals in the media, this discussion will focus only on those chemicals that may pose adverse risk to human or ecological receptors, as identified by the HHRA (Chapter 6.0) and the ERA (Chapter 7.0) in this report.

The following discussion of contaminant fate and transport is divided into two sections. Section 8.1 discusses potential migration routes of a chemical(s) in the media evaluated and does not focus specifically on media found to be of concern at Site 2. The site-specific persistence, fate, and transport of those compounds and elements found to pose a potential risk to human health or the environment are discussed in Section 8.2.

8.1 POTENTIAL ROUTES OF MIGRATION. Several routes of migration are possible for a contaminant in the various media: air, soil, surface water, groundwater, and biota. These routes are summarized below.

Air. Gases and particulate material can be transported in the atmosphere. Organic compounds, metals, and metal complexes that exist as gases at surface temperature and pressure may disperse or diffuse into the air and particulates may become entrained in air and thereby migrate. The extent to which gaseous constituents and particulate material remain airborne is a function of the level of excitation of the air (wind and temperature) and fate processes acting on the constituent and, for particulates, their density. Particulate material as discussed herein consists of organic compounds and inorganic material that would otherwise not be present in a gaseous medium under atmospheric conditions.

Soil. The primary agents of migration acting on soil include wind, rainwater, running water, biological activity, and human activity. Wind commonly transports soil in the form of particulate material. Rainwater may cause soil to migrate either by washing soil particles downward into the subsurface or by carrying soil particles overland to surface water bodies or other areas of deposition. The amount and type of vegetative cover and surface disturbance affects the degree to which wind and water cause soil to migrate.

Surface Water. The mechanisms for migration of constituents in surface water are dissolution and suspension. Several organic compounds and metals are soluble in water and can be transported in the aqueous phase. Other organic compounds and elements are not soluble in water, but may be transported by surface water via

suspension. The amount of suspended particulate material in surface water is largely a function of the water's energy; as that energy decreases, suspended material will settle and become part of the soil or sediment. Colloidal material may remain in suspension (by electrochemical forces) in water of very low energy (e.g., standing water).

Sediment. Saltation, traction, suspension, biological action, and human action are the primary mechanisms of migration for sediment. Physical, chemical, and biological processes affecting a constituent will determine where and how migration from sediment will occur.

Groundwater. Groundwater is a liquid medium capable of transporting constituents as colloidal forms, as complexes, as pure-phase liquids, or as dissolved-phase liquids. Organic compounds and elements generally reach groundwater either by being placed directly into the water table (e.g., disposal pits) or by being leached from soil or solid waste to the water table by physical or chemical processes. Groundwater may discharge to the land surface, surface water bodies, other aquifers, or pumping wells. The migration of constituents from groundwater upon discharge depends on the chemical and/or physical processes acting upon that individual constituent in the medium to which it is discharged.

Biota. Biota may be considered a medium for migration of certain organic compounds and inorganics. Several compounds and elements are known to accumulate in the tissues of organisms at various levels in the food chain. As these organisms are consumed by other organisms, compounds and elements are accumulated in their tissue and passed on to organisms higher in the food chain. In this manner, contaminants may be transported by biota. Additionally, some organisms disturb bed sediments in streams and rivers. This disturbance can cause organic compounds and elements to be transported downstream as suspended material in surface water.

**8.2 CONTAMINANT PERSISTENCE AND FATE**. The discussion of contaminant persistence and fate in the environment is divided into three subsections. Subsection 8.2.1 discusses the processes that control the persistence and fate of organic compounds and inorganics in the environment. Subsection 8.2.2 discusses the primary persistence and fate characteristics of the constituents detected at Site 2. Subsection 8.2.3 discusses contaminant transport for Site 2.

**8.2.1 Processes** The persistence and fate of chemical constituents in the environment depend on various chemical, physical, and biological processes. The predominant processes affecting the environmental persistence and fate of chemical constituents include solubility, photolysis, volatilization, hydrolysis, oxidation, chemical speciation, complexation, precipitation or coprecipitation, cationic exchange, sorption, biodegradation or biotransformation, and bioaccumulation. These processes are briefly summarized below.

Solubility. The solubility of chemical constituents in water is important in assessing their mobility in the environment. This is particularly important for the transport and ultimate fate of chemicals from soil and sediment to water (i.e., groundwater and/or surface water). Generally for organic compounds, aqueous solubility is a function of molecular size, molecular polarity, temperature, and the presence of other dissolved organic cosolvents. For metals and other inorganic parameters, solubility is generally controlled by chemical

speciation, pH, redox potential (Eh), oxygen content, and the presence of dissolved and/or colloidal organic compounds (e.g., humic and fulvic acids) or other inorganic ion species (e.g., hydroxides and sulfates) (USEPA, 1979). Increased solubility is usually directly related to increased environmental mobility with groundwater and/or surface water being the principal transport medium. Therefore, solubility is a significant factor affecting the fate of a compound or element in the water environment.

Photolysis. Many chemical constituents, particularly organic compounds, are susceptible to photolytic degradation either directly or indirectly. Direct photolysis involves a splitting of the chemical compound by light, whereas indirect photolysis occurs when another compound is transformed by light into a reactive species (i.e., usually an hydroxyl radical) that reacts with and modifies the original compound. In general, photolysis primarily occurs within the atmosphere, although it may also occur to a limited extent in surface water and/or soil under certain environmental conditions (USEPA, 1979).

Volatilization. Volatilization of organic chemicals from soil or water to the atmosphere is an important pathway for chemicals with high vapor pressures. For organic compounds, volatilization is a function of partial pressure gradients, temperature, and molecular size and is more likely to occur for compounds with low molecular weights. In addition, certain metals such as mercury, arsenic, and lead are capable of undergoing biologically mediated transformation (i.e., alkylation) that forms volatile end products. Volatilization is important for the transport of certain chemical constituents from surface soil (i.e., vadose zone), sediment, and surface water and is evaluated using Henry's law and other associated chemical-specific rate constants.

Hydrolysis. Hydrolysis involves the decomposition of a chemical compound by its reaction with water. The rate of reaction may be promoted by acid (hydronium ion,  $[H_3O^+]$ ) and/or base (hydroxyl ion,  $[OH^-]$ ) compounds. In general, most organic compounds are resistant to hydrolytic reactions unless they contain a functional group (or groups) capable of reacting with water. Metallic compounds, however, generally dissociate readily in water depending upon the aqueous environmental conditions (e.g., pH and ionic strength). For metals, hydrolytic dissociation is an indirect process that affects the primary fate and transport mechanism of aqueous solubility.

Oxidation. The direct oxidation of organic compounds in natural environmental matrices may occur, but this is generally a slow, insignificant transformation mechanism of minimal importance (USEPA, 1979). However, some inorganic compounds may be rapidly oxidized under naturally occurring environmental conditions when the surrounding environment changes from anaerobic to aerobic conditions.

Chemical Speciation. Chemical speciation is important primarily for metals that may exist in multiple forms in the environment, particularly within aqueous matrices. In general, the aqueous speciation of metals depends primarily upon the relative stabilities of individual valence states (which are element specific), oxygen content, pH and Eh condition, and the presence of available complexing agents and/or other cations and anions (USEPA, 1979). Because various metallic species exhibit differential aqueous solubilities and differential mobilities within soils and/or sediments (USEPA, 1979), the particular speciation of an individual metal will greatly affect its environmental mobility.

Complexation. For metals, complexation with various ligands is an important process because these complexes may be highly soluble in water. Complexation may, therefore, greatly enhance mobility within environmental matrices, particularly in groundwater and surface water, depending upon the aqueous solubility of the resulting complex. Complexation depends upon numerous factors such as pH, Eh, type and concentration of complexing ligands, and other ions present (USEPA, 1979).

Most metals are capable of forming numerous organic and/or inorganic complexes in the natural environment (USEPA, 1979). Metals may form organo-metallic complexes, especially with naturally occurring organic acids (i.e., humic and fulvic acids). In some cases, these metallic species may exhibit varying affinities for different organic ligands (i.e., mercury and arsenic for amino acids and their derivatives) (USEPA, 1979). Metals may also form metallo-inorganic complexes with inorganic ligands such as carbonate, halogens (usually chlorine), hydroxyl, and sulfate (USEPA, 1979). However, organo-metallic complex formation is usually favored over metallo-inorganic complexes.

Precipitation and Coprecipitation. Both chemical precipitation and coprecipitation are important removal mechanisms, particularly for metals and metallo-cyanides in the environment. Precipitation and/or coprecipitation reactions depend on numerous aqueous environmental conditions such as pH, Eh, organic ligands present, oxygen content, and cationic and anionic species present (USEPA, 1979). Depending on the specific conditions, the removal of aqueous metallic species and metallo-cyanides from groundwater and/or surface water can greatly affect a metal's environmental mobility and, hence, its ultimate fate and transport.

Cation Exchange. Cation exchange is important primarily for metals and other ions that may substitute with other cations of similar charge and size within the lattice structure of clay minerals in soil and/or sediment (USEPA, 1979). This process, therefore, can significantly affect the mobility of an aqueous metal cation by removing it from solution under certain environmental conditions.

Sorption. The sorption of chemical constituents by inorganic particulate matter (i.e., soil or sediment) and organic compounds is an important process that affects mobility in the environment. This process is particularly important for the fate and transport of chemicals from soil or sediment to water (i.e., groundwater and surface water). In general, most metals exhibit a potential for adsorption to inorganic particulate matter and organic compounds (USEPA, 1979). Organic compounds also exhibit sorptive capability, but show greater variability in their ability to sorb to particulate or organic matter. The tendency for organic compounds to sorb to soils or sediment is reflected in their organic carbon partitioning coefficients ( $K_{oc}$ ).  $K_{oc}$  is a measure of relative adsorption potential. The normal range of  $K_{oc}$  values is from 1 to  $10^7$  with higher values indicating greater sorption potential. Actual adsorption is chemical specific and is largely dependent on the organic content of the soil. The fraction of organic carbon,  $f_{oc}$ , in soil times the  $K_{oc}$  is defined as the distribution coefficient,  $K_d$ . The  $K_d$  is a ratio of the concentration adsorbed to the concentration partitioned to water.

Regardless of chemical class, sorption is a reversible process whereby desorption can be favored over sorption under certain environmental conditions (e.g., low pH for metals). For organic compounds in general, as the molecular weight

increases and the aqueous solubility decreases (i.e., low polarity and high hydrophobicity), the sorptive binding affinity increases (i.e.,  $K_{oc}$  increases). The tendency for chemical constituents to adsorb to inorganic particulate and/or organic compounds is a particularly important process because sorption to soils and/or sediments can effectively reduce a chemical constituent's mobility.

Biodegradation or Biotransformation. Biodegradation is a result of the enzyme-catalyzed transformation of chemicals. Organisms require energy, carbon, and essential nutrients from the environment for their growth and maintenance. In the process, chemicals from the environment will be transformed by enzymes into a form that can be used by the organism. The biodegradation rate is the rate by which contaminants will be degraded. The rate is a function of microbial biomass and a chemical's concentration under given environmental conditions. When a pollutant is introduced into the environment, there is often a lag time before biodegradation begins as the organism generates an enzyme capable of digesting the chemical. Co-metabolism occurs when a pollutant can be biotransformed only in the presence of another compound that serves as a carbon and energy source (USEPA, 1979).

Bioaccumulation. Bioconcentration and bioaccumulation data are important when evaluating the impact of chemicals in the aquatic environment. The process is characterized by hydrophobic chemicals that can be partitioned into fat and lipid tissues and inorganic chemicals that can be partitioned into bone marrow. The bioconcentration factor is a measure of the concentration of a chemical in tissue (on a dry-weight basis) divided by the concentration in water and is a commonly used parameter to quantify bioconcentration (USEPA, 1979). The process is significant because bioaccumulation magnifies up through the food chain.

8.2.2 Persistence and Fate of Site 2 CPCs This section discusses the persistence and fate characteristics for CPCs detected at Site 2. To focus the discussion of persistence and fate characteristics, only those constituents that were (1) identified by the human health or ecological risk assessments (presented in Chapters 6.0 and 7.0, respectively) as CPCs and (2) present above relevant standards will be addressed. These constituents are summarized below by medium for Site 2.

#### Human Health Assessment Constituents

- Surface soil: arsenic
- Groundwater: iron

#### Ecological Assessment Constituents

- Surface soil: chloroform, bis(2-ethylhexyl)phthalate, beryllium, and vanadium

The fate and persistence characteristics of these constituents is summarized below by analytical fraction.

VOCs. Chloroform has been widely used in refrigerants, solvents, adhesives, dry-cleaning spot removers, fire extinguishers, in manufacturing of dyes and pesticides, and as a fumigant. Chloroform was previously used as an anesthetic (Agency for Toxic Substances and Disease Registry [ATSDR], 1991a).

Most chloroform released into the environment will eventually end up in the atmosphere, and a much smaller amount will enter the groundwater. Chloroform in the atmosphere is degraded by indirect photochemical reactions (ATSDR, 1991a).

Chloroform is released to soil by improperly disposed of wastes. It can be released to water during manufacture; however, most releases to groundwater at sites occur by leaching. Chloroform will readily leach from soil into the groundwater because of low soil adsorption and significant water solubility (ATSDR, 1991a).

Chemical hydrolysis and biodegradation are not a significant removal process in soil or water. Chloroform is expected to persist for a long time in groundwater (ATSDR, 1991a).

SVOCs. Bis(2-ethylhexyl)phthalate (also known as di(2-ethylhexyl)phthalate) ( $C_{24}H_{38}O_4$ ) is principally used as a plasticizer in the production of polyvinyl chloride (PVC) and vinyl chloride resins. PVC is used in many common household items such as toys, vinyl upholstery, shower curtains, adhesives, and as a component of paper and paperboard. Bis(2-ethylhexyl)phthalate has also been used as a solvent, an acaricide in orchards, and as an inert ingredient in pesticide products (ATSDR, 1991b).

Bis(2-ethylhexyl)phthalate is a widely used chemical that enters the environment primarily through the disposal of industrial and municipal wastes in landfills. Bis(2-ethylhexyl)phthalate tends to adsorb strongly to soil and sediments and to bioconcentrate in aquatic organisms. Sorption, bioaccumulation, and biodegradation are likely to be competing processes, with the dominant fate being determined by local environmental conditions (ATSDR, 1991b).

Bis(2-ethylhexyl)phthalate has a strong tendency to be adsorbed to atmospheric particulate matter, soils, and sediments. Bis(2-ethylhexyl)phthalate biodegradation in soil is slow since strong adsorption reduces the availability for degradation. Biodegradation is expected to occur under aerobic conditions. Bis(2-ethylhexyl)phthalate may slowly volatilize into air. In air, direct photolysis and photooxidation are not likely (ATSDR, 1991b).

Bis(2-ethylhexyl)phthalate is relatively insoluble; however, it may leach to the groundwater in the presence of common organic solvents such as alcohols and ketones. Bis(2-ethylhexyl)phthalate in the water will undergo biodegradation under aerobic conditions. Chemical hydrolysis occurs too slowly to be important (ATSDR, 1991b).

It should be noted that, since bis(2-ethylhexyl)phthalate is a ubiquitous laboratory contaminant, it is very difficult to accurately determine the low levels of this compound that are usually present in the environment. Laboratory contamination often undermines the credibility of the data, and reported concentrations of bis(2-ethylhexyl)phthalate in environmental samples must be viewed with caution (ATSDR, 1991b).

Inorganics. Arsenic has two stable forms in solution in groundwater, arsenate ( $As^{5+}$ ) and arsenite ( $As^{3+}$ ). In groundwater with pH ranging from 3 to 7, the monovalent arsenate anion  $H_2AsO_4^-$  is the dominant form. Upon entering surface water, via groundwater discharge, arsenic may partition to sediment from solution by hydrous iron oxide adsorption and/or coprecipitation (or a combination of

both) with sulfides in the sediment. The Eh and pH conditions of the surface water and sediment govern the effectiveness of these mechanisms (adsorption and coprecipitation) as a sink for arsenic. These mechanisms appear to be the major inorganic factors controlling arsenic concentrations in surface water (Hem, 1992).

Arsenic may be very mobile in the aquatic environment, cycling through the water column, sediment, biota, and air. Most arsenic released into the environment (on the earth's surface) eventually ends up in either sediments (in stream beds or lakes) or in the oceans. Eh and pH conditions largely govern the fate of arsenic (USEPA, 1979).

Iron is the second most abundant element in the environment though dissolved concentrations present in groundwater are generally low. The chemical behavior of iron and its solubility depend upon the oxidation intensity and pH of the environmental system in which it is found. Iron exists in two valence states  $Fe^{2+}$  and  $Fe^{3+}$ , with the  $Fe^{2+}$  or ferrous form the most common form of iron found in solution in the reducing conditions within the groundwater environment. Dissolved iron generally sorbs to sediment and may precipitate as iron hydroxide or may oxidize to form iron oxides and iron oxyhydroxides (USEPA, 1979). Iron also may complex with organic molecules, especially fluvic and humic acids. Aerated or flowing water with a pH in the range of 6.5 to 8.5 should contain little dissolved iron.

Vanadium commonly exists in the  $V^{3+}$ ,  $V^{4+}$ , and  $V^{5+}$  valence states. Its aqueous chemistry is quite complex, but overall concentrations seem to be controlled more by availability of a vanadium source, rather than equilibrium considerations. Bioconcentration of vanadium by vegetation has been reported by several researchers.

**8.2.3 Transport of Contaminants** This section discusses the transport of chemicals in various media at Site 2. All media, surface soil, subsurface soil, surface water, sediment, and groundwater will be discussed.

Surface Soil. Transport of the CPCs in soil is dependent on several factors, as discussed in Section 8.1. The primary agents of migration acting on soil include wind, water, and human activity. Soil can also act as a source medium from which the CPCs are transported to other media. Transport of the CPCs from soil via wind is not expected to be a major transport mechanism because of the heavy vegetation present at Site 2. Vegetative cover is an effective means of limiting wind erosion of soil. Humans are effective at moving soil and can greatly affect the transport of soil-bound chemicals at hazardous waste sites. Under the current use of Site 2, human activity is not a major transport mechanism for the CPCs in soils. This condition may change based on the future use of Site 2.

Water can cause the transport of soil, and therefore the CPCs in soil, via the mechanisms of physical transport of soil or the leaching of constituents from the soil to groundwater. Soil erosion, the physical transport of soil via surface water runoff, is currently not considered a major mechanism for the transport of the CPCs in soil at Site 2 because of (1) the low grade (slope) of the land surface at the site, (2) the heavy vegetation at the site, and (3) the nature of the constituents remaining in the soil at the site.

During the period of reported active disposal (1976 to 1984) at the Site 2, the potential for physical transport of both soil and CPCs via runoff does not appear to be a significant mechanism for transport. The site has a central depression, which prevents surface water runoff.

The majority of the inorganic analytes detected in the soil at Site 2 are likely to remain attached to the soil because most metal analytes adsorb readily to or are natural constituents of clays and other minerals.

Surface Water. There are no permanent surface water bodies associated with Site 2. Infiltration directly into the soil in the central depression area of the site is presumed to occur during all rain events.

Currently, transport of the CPCs at Site 2 via runoff is not considered possible because of (1) the low depression of the land surface at the site, (2) high infiltration capacity of soil at the site, (3) the heavy vegetation at Site 2, and (4) the tendency of the surface soil contaminants at the sites to remain attached to clays in the soil.

Sediment. The transport of sediment at Site 2 by the action of humans is not currently a significant transport mechanism, as very little human activity occurs on the site. Transport of sediment in water (by saltation, traction, and suspension) are unlikely means of sediment transport at Site 2.

Groundwater. As discussed in Subsection 5.5.2, the observed concentrations of the inorganics in unfiltered groundwater at Site 2 was affected by turbidity in the groundwater samples at the time of collection. The groundwater samples collected in 1996 (during Phase IIB) are thought to be more representative of groundwater conditions at the site. It is probable that particulate material of larger than colloidal size does not easily move through the matrix of the aquifer. Colloid-sized material may be transported through the aquifer matrix at flow rates present in the surficial aquifer system at Site 2.

Hydrogeology at Site 2 is discussed in Section 5.2 of this report. The aquifer present at the site is the surficial (sand and gravel) aquifer. The CPCs identified for groundwater are associated with the surficial aquifer system. Recharge of the surficial aquifer at Site 2 occurs primarily by rainfall on the site and in the area north of the site. Groundwater flow direction in the surficial aquifer at Site 2 is primarily to the south-southwest. Clear Creek acts as a point of discharge approximately 4,000 feet south of the site.

Hydraulic data from a well cluster (WHF-1-1 and WHF-1-1S) completed 800 feet north of Site 2 indicate that vertical gradient in this area is downward. The upper (approximately) 99 feet of material is a sand with varying amounts of silt and clay and should probably act as a single hydraulic unit.

Horizontal hydraulic gradient estimates have been developed for the Site 2 area. The gradient was calculated for the period between September 1993 and November 1996 and averaged (Table 5-2). The average hydraulic gradient in the surficial aquifer is 0.0039 ft/ft in a south-southwest direction.

Hydraulic conductivity testing was completed on monitoring well WHF-2-1 at Site 2. The average hydraulic conductivity value for the site is 0.0133 ft/min or 19.14 ft/day (Table 5-4).

Horizontal groundwater seepage velocity calculations have been completed for the surficial aquifer system at Site 2 using available hydraulic information (Section 5.2). A seepage velocity of 62 ft/yr was calculated using the average hydraulic conductivity from monitoring wells WHF1-2 and WHF1-1S at Site 1 (0.17 ft/day), an average horizontal gradient of 0.0039 ft/ft for these monitoring wells, and an estimated effective porosity of 0.35. Disposal activities at Site 2 may have begun releasing contaminants to the aquifer approximately 21 years ago. Using the seepage velocity calculated above and a 21-year timeframe, the total distance of potential contaminant migration was estimated to be approximately 1,302 feet.

Using the seepage velocity or the calculated distance presented above would most likely overestimate the transport of potential contaminants from the site because it does not account for dilution, advection, dispersion, or adsorption. Dividing either the seepage velocity or the distance by a correction factor of 1.4 (USEPA, 1988b) may provide a more accurate estimate for potential contaminant migration of 930 feet.

The calculated estimate of 1,302 feet of migration relies on hydraulic conductivity values derived from slug test data. Slug tests provide a rough estimate of hydraulic conductivity that can be more accurately measured using pumping tests. Slug data may differ by up to a factor of 10 (Bouwer, 1989). If the hydraulic conductivity value used in the calculation were decreased by an order of magnitude, a total migration of only 130 feet would be expected for the 21-year history of the site.

Clear Creek is likely the final point of discharge for groundwater from the surficial aquifer at Site 2. Clear Creek is located approximately 4,000 feet southwest of Site 2. Surface water and sediment samples collected during Phase I of the RI from sampling locations located upstream and downstream of the expected groundwater discharge points from Site 2 do not conclusively support any impact to surface water quality of Clear Creek from past Site 2 activities (ABB-ES, 1992b). The results of surface water and sediment sampling are presented in Technical Memorandum No. 4, Surface Water and Sediments, May 1992 (ABB-ES, 1992b) and will also be presented in the concurrent Remedial Investigation Report for Site 39, Clear Creek Flood Plain.

## 9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS. The following is a summary based on the RI at Site 2, Northwest Open Disposal Area, NAS Whiting Field.

- One VOC (chloroform) and one SVOC (bis(2-ethylhexyl)phthalate) were detected in surface soil samples collected at the site. Four pesticide compounds (dieldrin, 4,4'-DDT, alpha-chlordane, and gamma-chlordane) were also detected in surface soil samples collected at the site. Nineteen inorganic analytes were detected in the surface soil samples. Nine of the inorganic analytes exceeded the site-specific background screening values. None of the analytes detected in surface soil samples exceeded the industrial-use values of the USEPA Region III RBCs or Chapter 62-785, FAC, SCTLs. Four analytes (aluminum, arsenic, iron, and manganese) detected in surface soil samples exceeded the residential values for either USEPA Region III RBCs or the Chapter 62-785, FAC, SCTLs.
- No VOCs were detected in subsurface soil samples collected during the site assessment. Two SVOCs (methylnaphthalene and phenanthrene) and three pesticide compounds (dieldrin, alpha-chlordane, and gamma-chlordane) were detected in subsurface soil samples. One PCB compound (Aroclor-1260) was detected in two subsurface soil samples. Seventeen inorganic analytes were detected in the subsurface soil samples. Four inorganic analytes (calcium, manganese, potassium, and sodium) exceeded the background screening values. The analytes and compounds detected in subsurface soil samples did not exceed industrial-use values of its Chapter 62-785, FAC, SCTLs or USEPA Region III RBCs.
- The groundwater flow direction is to the south-southwest and likely discharges at Clear Creek, located approximately 4,000 feet southwest of the site.
- The pH values of groundwater samples collected from monitoring wells were below the lower range for Federal and State secondary MCLs; however, these values were within the range observed in facility-specific background groundwater samples collected at NAS Whiting Field (HLA, 1998).
- Groundwater samples collected from onsite monitoring wells contained one VOC (carbon disulfide) and one SVOC (bis(2-ethylhexyl)phthalate) at concentrations less than FDEP guidance concentrations. No pesticide or PCB compounds were detected in groundwater samples.
- Two inorganic analytes, aluminum and iron, were detected at concentrations exceeding Federal MCLs and Chapter 62-785, FAC, GCTLs in the monitoring well groundwater samples collected by low-flow methods.
- The HHRA determined carcinogenic risks associated with groundwater did not exceed the FDEP target level ( $1 \times 10^{-6}$ ) for a current or hypothetical future resident at the site.

- The total ELGR associated with surface soil for a potential future resident ( $2 \times 10^{-5}$ ), current and future trespasser ( $2 \times 10^{-6}$ ), and occupational worker ( $3 \times 10^{-6}$ ) exceeded Florida's target risk ( $1 \times 10^{-6}$ ) due to arsenic and beryllium. However, it is likely the natural background concentrations of arsenic contribute to exceeding the FDEP target level. It could not be determined whether or not arsenic concentrations were related to the disposal of waste at Site 2.
- The ERA determined exposures to Site 2 surface soil are unlikely to result in adverse effects to wildlife receptors because all maximum EPCs were well below toxicity values.
- The maximum EPC for vanadium exceeded its phytotoxicity benchmark; however, except for one sample, vanadium concentrations detected in surface soil were generally within the range found in background surface soil collected from NAS Whiting Field. Additionally, stressed vegetation was not apparent at the site; therefore, risks to terrestrial plants are not predicted.
- Chloroform and arsenic are CPCs identified in the risk assessments as soluble and may be transported in groundwater. Leaching of chemicals to groundwater is the most likely mechanism of transport from Site 2.
- Based on a 21-year site history and an evaluation of hydrogeologic data, a potential migration distance for CPCs is estimated to be approximately 930 feet; however, there is no evidence that any chemical is migrating from the site.

**9.2 RECOMMENDATIONS.** Based on the interpretation of findings from the remedial investigation activities, a focused feasibility study is proposed for soil at Site 2, Northwest Open Disposal Area. A comprehensive basewide groundwater investigation that will characterize the Site 2 groundwater is currently being conducted at NAS Whiting Field. The results of the NAS Whiting Field basewide groundwater investigation will be reported in the Site 40 Remedial Investigation Report.

10.0 PROFESSIONAL REVIEW CERTIFICATION

The work and professional opinions rendered in this report were conducted or developed in accordance with commonly accepted procedures and protocols consistent with applied standards of practice. This report is based on the geologic investigation and associated information detailed in the text and appended to this report. If conditions are discovered or determined to exist that differ from those described, the undersigned geologist should be notified to evaluate the effects of any additional information on the assessment described in this report. The remedial investigation for Site 2, Northwest Open Disposal Area, was developed for NAS Whiting Field in Milton, Florida, and should not be construed to apply for any other purpose to any other site.



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**APPENDIX A**  
**SOIL ANALYTICAL DATA**

NAS WHITING FIELD -- SITE 2  
 SURFACE SOIL -- SEMIVOLATILES -- REPORT NO. 10457

Lab Sample Number:	G8876002	G8876003	G8876004	G8864007					
Site	WHITING	WHITING	WHITING	WHITING					
Locator	02S00101	02S00201	02S00301	02S00401					
Collect Date:	06-DEC-95	06-DEC-95	06-DEC-95	05-DEC-95					
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP SEMIVOLATILES 90-SQW

Phenol	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
bis(2-Chloroethyl) ether	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2-Chlorophenol	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
1,3-Dichlorobenzene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
1,4-Dichlorobenzene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
1,2-Dichlorobenzene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2-Methylphenol	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2,2-oxybis(1-Chloropropane)	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
4-Methylphenol	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
N-Nitroso-di-n-propylamine	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Hexachloroethane	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Nitrobenzene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Isophorone	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2-Nitrophenol	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2,4-Dimethylphenol	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
bis(2-Chloroethoxy) methane	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2,4-Dichlorophenol	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
1,2,4-Trichlorobenzene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Naphthalene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
4-Chloroaniline	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Hexachlorobutadiene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
4-Chloro-3-methylphenol	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2-Methylnaphthalene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Hexachlorocyclopentadiene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2,4,6-Trichlorophenol	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2,4,5-Trichlorophenol	9000 U	ug/kg	9000	880 U	ug/kg	880	9000 U	ug/kg	9000	3700 U	ug/kg	3700
2-Chloronaphthalene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2-Nitroaniline	9000 U	ug/kg	9000	880 U	ug/kg	880	9000 U	ug/kg	9000	3700 U	ug/kg	3700
Dimethylphthalate	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Acenaphthylene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2,6-Dinitrotoluene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
3-Nitroaniline	9000 U	ug/kg	9000	880 U	ug/kg	880	9000 U	ug/kg	9000	3700 U	ug/kg	3700
Acenaphthene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2,4-Dinitrophenol	9000 U	ug/kg	9000	880 U	ug/kg	880	9000 U	ug/kg	9000	3700 U	ug/kg	3700
4-Nitrophenol	9000 U	ug/kg	9000	880 U	ug/kg	880	9000 U	ug/kg	9000	3700 U	ug/kg	3700
Dibenzofuran	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
2,4-Dinitrotoluene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Diethylphthalate	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
4-Chlorophenyl-phenylether	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Fluorene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
4-Nitroaniline	9000 U	ug/kg	9000	880 U	ug/kg	880	9000 U	ug/kg	9000	3700 U	ug/kg	3700
4,6-Dinitro-2-methylphenol	9000 U	ug/kg	9000	880 U	ug/kg	880	9000 U	ug/kg	9000	3700 U	ug/kg	3700
N-Nitrosodiphenylamine	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
4-Bromophenyl-phenylether	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Hexachlorobenzene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Pentachlorophenol	9000 U	ug/kg	9000	880 U	ug/kg	880	9000 U	ug/kg	9000	3700 U	ug/kg	3700
Phenanthrene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Anthracene	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Carbazole	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500
Di-n-butylphthalate	3600 U	ug/kg	3600	350 U	ug/kg	350	3600 U	ug/kg	3600	1500 U	ug/kg	1500

NAS WHITING FIELD -- SITE 2  
 SURFACE SOIL -- SEMIVOLATILES -- REPORT NO. 10457

Lab Sample Number:	G8876002	G8876003	G8876004	G8864007								
Site	WHITING	WHITING	WHITING	WHITING								
Locator	02S00101	02S00201	02S00301	02S00401								
Collect Date:	06-DEC-95	06-DEC-95	06-DEC-95	05-DEC-95								
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL				
Fluoranthene	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Pyrene	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Butylbenzylphthalate	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
3,3-Dichlorobenzidine	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Benzo (a) anthracene	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Chrysene	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
bis(2-Ethylhexyl) phthalate	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Di-n-octylphthalate	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Benzo (b) fluoranthene	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Benzo (k) fluoranthene	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Benzo (a) pyrene	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Indeno (1,2,3-cd) pyrene	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Dibenzo (a,h) anthracene	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500
Benzo (g,h,i) perylene	3600	U	ug/kg	3600	350	U	ug/kg	350	3600	U	ug/kg	3600	1500	U	ug/kg	1500

U= NOT DETECTED J=ESTIMATED VALUE  
 UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
 R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
 SURFACE SOIL -- SEMIVOLATILES -- REPORT NO. 10457

Lab Sample Number:	G8864008	G8876005			
Site	WHITING	WHITING			
Locator	02S00401D	02S00501			
Collect Date:	05-DEC-95	06-DEC-95			
VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP SEMIVOLATILES 90-SOW

Phenol	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
bis(2-Chloroethyl) ether	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2-Chlorophenol	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
1,3-Dichlorobenzene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
1,4-Dichlorobenzene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
1,2-Dichlorobenzene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2-Methylphenol	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2,2-oxybis(1-Chloropropane)	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
4-Methylphenol	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
N-Nitroso-di-n-propylamine	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
Hexachloroethane	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
Nitrobenzene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
Isophorone	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2-Nitrophenol	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2,4-Dimethylphenol	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
bis(2-Chloroethoxy) methane	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2,4-Dichlorophenol	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
1,2,4-Trichlorobenzene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
Naphthalene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
4-Chloroaniline	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
Hexachlorobutadiene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
4-Chloro-3-methylphenol	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2-Methylnaphthalene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
Hexachlorocyclopentadiene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2,4,6-Trichlorophenol	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2,4,5-Trichlorophenol	3700 UJ	ug/kg	3700	9000 U	ug/kg	9000
2-Chloronaphthalene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2-Nitroaniline	3700 UJ	ug/kg	3700	9000 U	ug/kg	9000
Dimethylphthalate	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
Acenaphthylene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2,6-Dinitrotoluene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
3-Nitroaniline	3700 UJ	ug/kg	3700	9000 U	ug/kg	9000
Acenaphthene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2,4-Dinitrophenol	3700 UJ	ug/kg	3700	9000 U	ug/kg	9000
4-Nitrophenol	3700 UJ	ug/kg	3700	9000 U	ug/kg	9000
Dibenzofuran	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
2,4-Dinitrotoluene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
Diethylphthalate	1500 UJ	ug/kg	1500	3600 UJ	ug/kg	3600
4-Chlorophenyl-phenylether	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600
Fluorene	1500 UJ	ug/kg	1500	3600 U	ug/kg	3600

NAS WHITING FIELD -- SITE 2  
 SURFACE SOIL -- SEMIVOLATILES -- REPORT NO. 10457

Lab Sample Number:	G8864008	G8876005
Site	WHITING	WHITING
Locator	02S00401D	02S00501
Collect Date:	05-DEC-95	06-DEC-95

	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL
4-Nitroaniline	3700	UJ	ug/kg	3700	9000	U	ug/kg	9000
4,6-Dinitro-2-methylphenol	3700	UJ	ug/kg	3700	9000	U	ug/kg	9000
N-Nitrosodiphenylamine	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
4-Bromophenyl-phenylether	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Hexachlorobenzene	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Pentachlorophenol	3700	UJ	ug/kg	3700	9000	U	ug/kg	9000
Phenanthrene	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Anthracene	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Carbazole	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Di-n-butylphthalate	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Fluoranthene	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Pyrene	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Butylbenzylphthalate	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
3,3-Dichlorobenzidine	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Benzo (a) anthracene	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Chrysene	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
bis(2-Ethylhexyl) phthalate	1500	UJ	ug/kg	1500	3600	U	ug/kg	3600
Di-n-octylphthalate	1500	U	ug/kg	1500	3600	U	ug/kg	3600
Benzo (b) fluoranthene	1500	U	ug/kg	1500	3600	U	ug/kg	3600
Benzo (k) fluoranthene	1500	U	ug/kg	1500	3600	U	ug/kg	3600
Benzo (a) pyrene	1500	U	ug/kg	1500	3600	U	ug/kg	3600
Indeno (1,2,3-cd) pyrene	1500	U	ug/kg	1500	3600	U	ug/kg	3600
Dibenzo (a,h) anthracene	1500	U	ug/kg	1500	3600	U	ug/kg	3600
Benzo (g,h,i) perylene	1500	U	ug/kg	1500	3600	U	ug/kg	3600

U= NOT DETECTED J=ESTIMATED VALUE  
 UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
 R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
 SURFACE SOIL -- PESTICIDES AND PCBs -- REPORT NO. 10458

Lab Sample Number:	G8876002	G8876003R	G8876004	G8864007							
Site	WHITING	WHITING	WHITING	WHITING							
Locator	02S00101	02S00201	02S00301	02S00401							
Collect Date:	06-DEC-95	06-DEC-95	06-DEC-95	05-DEC-95							
VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP PESTICIDES/PCBS 90-SOW

alpha-BHC	8.9 UJ	ug/kg	8.9	1.8 UJ	ug/kg	1.8	9 UJ	ug/kg	9	9.6 UJ	ug/kg	9.6
beta-BHC	8.9 U	ug/kg	8.9	1.8 U	ug/kg	1.8	9 U	ug/kg	9	9.6 U	ug/kg	9.6
delta-BHC	8.9 U	ug/kg	8.9	1.8 U	ug/kg	1.8	9 U	ug/kg	9	9.6 U	ug/kg	9.6
gamma-BHC (Lindane)	8.9 U	ug/kg	8.9	1.8 U	ug/kg	1.8	9 U	ug/kg	9	9.6 U	ug/kg	9.6
Heptachlor	8.9 U	ug/kg	8.9	1.8 U	ug/kg	1.8	9 U	ug/kg	9	9.6 U	ug/kg	9.6
Aldrin	8.9 U	ug/kg	8.9	1.8 U	ug/kg	1.8	9 U	ug/kg	9	9.6 U	ug/kg	9.6
Heptachlor epoxide	8.9 U	ug/kg	8.9	1.8 U	ug/kg	1.8	9 U	ug/kg	9	9.6 U	ug/kg	9.6
Endosulfan I	8.9 U	ug/kg	8.9	1.8 U	ug/kg	1.8	9 U	ug/kg	9	9.6 U	ug/kg	9.6
Dieldrin	17 U	ug/kg	17	3.5 U	ug/kg	3.5	18 U	ug/kg	18	8.3 J	ug/kg	18
4,4-DDE	17 U	ug/kg	17	3.5 U	ug/kg	3.5	18 U	ug/kg	18	19 U	ug/kg	19
Endrin	17 U	ug/kg	17	3.5 U	ug/kg	3.5	18 U	ug/kg	18	19 U	ug/kg	19
Endosulfan II	17 U	ug/kg	17	3.5 U	ug/kg	3.5	18 U	ug/kg	18	19 U	ug/kg	19
4,4-DDD	17 U	ug/kg	17	3.5 U	ug/kg	3.5	18 U	ug/kg	18	19 U	ug/kg	19
Endosulfan sulfate	17 U	ug/kg	17	3.5 U	ug/kg	3.5	18 U	ug/kg	18	19 U	ug/kg	19
4,4-DDT	17 U	ug/kg	17	3.5 U	ug/kg	3.5	18 U	ug/kg	18	19 U	ug/kg	19
Methoxychlor	89 U	ug/kg	89	18 U	ug/kg	18	90 U	ug/kg	90	96 U	ug/kg	96
Endrin ketone	17 U	ug/kg	17	3.5 U	ug/kg	3.5	18 U	ug/kg	18	19 U	ug/kg	19
Endrin aldehyde	17 U	ug/kg	17	3.5 U	ug/kg	3.5	18 U	ug/kg	18	19 U	ug/kg	19
alpha-Chlordane	8.9 U	ug/kg	8.9	1.8 U	ug/kg	1.8	9 U	ug/kg	9	5.6	ug/kg	10
gamma-Chlordane	8.9 U	ug/kg	8.9	1.8 U	ug/kg	1.8	9 U	ug/kg	9	3.5 J	ug/kg	10
Toxaphene	890 U	ug/kg	890	180 U	ug/kg	180	900 U	ug/kg	900	960 U	ug/kg	960
Aroclor-1016	170 U	ug/kg	170	35 U	ug/kg	35	180 U	ug/kg	180	190 U	ug/kg	190
Aroclor-1221	350 U	ug/kg	350	71 U	ug/kg	71	360 U	ug/kg	360	380 U	ug/kg	380
Aroclor-1232	170 U	ug/kg	170	35 U	ug/kg	35	180 U	ug/kg	180	190 U	ug/kg	190
Aroclor-1242	170 U	ug/kg	170	35 U	ug/kg	35	180 U	ug/kg	180	190 U	ug/kg	190
Aroclor-1248	170 U	ug/kg	170	35 U	ug/kg	35	180 U	ug/kg	180	190 U	ug/kg	190
Aroclor-1254	170 U	ug/kg	170	35 U	ug/kg	35	180 U	ug/kg	180	190 U	ug/kg	190
Aroclor-1260	170 U	ug/kg	170	35 U	ug/kg	35	180 U	ug/kg	180	190 U	ug/kg	190

U= NOT DETECTED J=ESTIMATED VALUE  
 UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
 R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
 SURFACE SOIL -- PESTICIDES AND PCBs -- REPORT NO. 10458

Lab Sample Number:	G8864008	G8876005
Site	WHITING	WHITING
Locator	02S00401D	02S00501
Collect Date:	05-DEC-95	06-DEC-95
	VALUE QUAL UNITS DL	VALUE QUAL UNITS DL

CLP PESTICIDES/PCBS 90-SOW

alpha-BHC	9.4 UJ	ug/kg	9.4	9.4 UJ	ug/kg	9.4
beta-BHC	9.4 U	ug/kg	9.4	9.4 U	ug/kg	9.4
delta-BHC	9.4 U	ug/kg	9.4	9.4 U	ug/kg	9.4
gamma-BHC (Lindane)	9.4 U	ug/kg	9.4	9.4 U	ug/kg	9.4
Heptachlor	9.4 U	ug/kg	9.4	9.4 U	ug/kg	9.4
Aldrin	9.4 U	ug/kg	9.4	9.4 U	ug/kg	9.4
Heptachlor epoxide	9.4 U	ug/kg	9.4	9.4 U	ug/kg	9.4
Endosulfan I	9.4 U	ug/kg	9.4	9.4 U	ug/kg	9.4
Dieldrin	8	ug/kg	18	18 U	ug/kg	18
4,4-DDE	18 U	ug/kg	18	18 U	ug/kg	18
Endrin	18 U	ug/kg	18	18 U	ug/kg	18
Endosulfan II	18 U	ug/kg	18	18 U	ug/kg	18
4,4-DDD	18 U	ug/kg	18	18 U	ug/kg	18
Endosulfan sulfate	18 U	ug/kg	18	18 U	ug/kg	18
4,4-DDT	18 U	ug/kg	18	18 U	ug/kg	18
Methoxychlor	94 U	ug/kg	94	94 U	ug/kg	94
Endrin ketone	18 U	ug/kg	18	18 U	ug/kg	18
Endrin aldehyde	18 U	ug/kg	18	18 U	ug/kg	18
alpha-Chlordane	5.1 J	ug/kg	9	9.4 U	ug/kg	9.4
gamma-Chlordane	2.9 J	ug/kg	9	9.4 U	ug/kg	9.4
Toxaphene	940 U	ug/kg	940	940 U	ug/kg	940
Aroclor-1016	180 U	ug/kg	180	180 U	ug/kg	180
Aroclor-1221	370 U	ug/kg	370	370 U	ug/kg	370
Aroclor-1232	180 U	ug/kg	180	180 U	ug/kg	180
Aroclor-1242	180 U	ug/kg	180	180 U	ug/kg	180
Aroclor-1248	180 U	ug/kg	180	180 U	ug/kg	180
Aroclor-1254	180 U	ug/kg	180	180 U	ug/kg	180
Aroclor-1260	180 U	ug/kg	180	180 U	ug/kg	180

U= NOT DETECTED J=ESTIMATED VALUE  
 UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
 R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
SURFACE SOIL -- INORGANICS -- REPORT NO. 10459

Lab Sample Number:	G8876002	G8876003	G8876004	G8864007					
Site	WHITING	WHITING	WHITING	WHITING					
Locator	02S00101	02S00201	02S00301	02S00401					
Collect Date:	06-DEC-95	06-DEC-95	06-DEC-95	05-DEC-95					
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP METALS AND CYANIDE

Aluminum	9230	mg/kg	40	1150	mg/kg	40	7160	mg/kg	40	9580	mg/kg	40
Antimony	12 UJ	mg/kg	12									
Arsenic	1.9 J	mg/kg	2	.95 J	mg/kg	2	2.1 J	mg/kg	2	3.9	mg/kg	2
Barium	27.1 J	mg/kg	40	1.7 J	mg/kg	40	10.4 J	mg/kg	40	27.7 J	mg/kg	40
Beryllium	.45 J	mg/kg	1	1 U	mg/kg	1	.11 J	mg/kg	1	.31 J	mg/kg	1
Cadmium	1 UJ	mg/kg	1									
Calcium	12500	mg/kg	1000	1000 UJ	mg/kg	1000	4200	mg/kg	1000	14900	mg/kg	1000
Chromium	6.4	mg/kg	2	1.5 J	mg/kg	2	5.3	mg/kg	2	13.6	mg/kg	2
Cobalt	.59 J	mg/kg	10	10 U	mg/kg	10	10 U	mg/kg	10	.53 J	mg/kg	10
Copper	3.6 J	mg/kg	5	5 UJ	mg/kg	5	5 UJ	mg/kg	5	4.3 J	mg/kg	5
Iron	3880	mg/kg	20	799	mg/kg	20	3750	mg/kg	20	4010	mg/kg	20
Lead	7.4	mg/kg	.6	1.4	mg/kg	.6	10	mg/kg	.6	10.9	mg/kg	.6
Magnesium	1890	mg/kg	1000	11.3 J	mg/kg	1000	286 J	mg/kg	1000	926 J	mg/kg	1000
Manganese	172 J	mg/kg	3	4 J	mg/kg	3	80 J	mg/kg	3	188 J	mg/kg	3
Mercury	.01 J	mg/kg	.1	.1 U	mg/kg	.1	.01 J	mg/kg	.1	.03 J	mg/kg	.1
Nickel	4.4 J	mg/kg	8	8 UJ	mg/kg	8	8 UJ	mg/kg	8	3.9 J	mg/kg	8
Potassium	567 J	mg/kg	1000	1000 U	mg/kg	1000	1000 U	mg/kg	1000	377 J	mg/kg	1000
Selenium	1 UJ	mg/kg	1	1 UJ	mg/kg	1	1 UJ	mg/kg	1	1 U	mg/kg	1
Silver	2 U	mg/kg	2									
Sodium	1000 UJ	mg/kg	1000	1000 U	mg/kg	1000	1000 UJ	mg/kg	1000	1000 UJ	mg/kg	1000
Thallium	2 U	mg/kg	2									
Vanadium	20.3	mg/kg	10	3.2 J	mg/kg	10	11.9	mg/kg	10	12.9	mg/kg	10
Zinc	6.2	mg/kg	4	4 UJ	mg/kg	4	7.5	mg/kg	4	13.1	mg/kg	4
Cyanide	.5 U	mg/kg	.5	.5 U	mg/kg	.5	.5 U	mg/kg	.5	.15 J	mg/kg	.5

U= NOT DETECTED J=ESTIMATED VALUE  
UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
 SURFACE SOIL -- INORGANICS -- REPORT NO. 10459

Lab Sample Number:	G8864008		G8876005	
Site	WHITING		WHITING	
Locator	02S00401D		02S00501	
Collect Date:	05-DEC-95		06-DEC-95	
	VALUE	QUAL UNITS	DL	VALUE
				QUAL UNITS
				DL

CLP METALS AND CYANIDE

Aluminum	7580	mg/kg	40	5310	mg/kg	40
Antimony	12 UJ	mg/kg	12	12 UJ	mg/kg	12
Arsenic	4	mg/kg	2	2.6	mg/kg	2
Barium	15.9 J	mg/kg	40	14.7 J	mg/kg	40
Beryllium	.13 J	mg/kg	1	.16 J	mg/kg	1
Cadmium	1 UJ	mg/kg	1	1 UJ	mg/kg	1
Calcium	9900	mg/kg	1000	6620	mg/kg	1000
Chromium	14	mg/kg	2	4.7	mg/kg	2
Cobalt	10 U	mg/kg	10	10 U	mg/kg	10
Copper	3.8 J	mg/kg	5	4.8 J	mg/kg	5
Iron	3880	mg/kg	20	2560	mg/kg	20
Lead	11.6	mg/kg	.6	9.3	mg/kg	.6
Magnesium	403 J	mg/kg	1000	1310	mg/kg	1000
Manganese	164 J	mg/kg	3	99.4 J	mg/kg	3
Mercury	.05	mg/kg	.1	.01 J	mg/kg	.1
Nickel	3.8 J	mg/kg	8	4.2 J	mg/kg	8
Potassium	142 J	mg/kg	1000	247 J	mg/kg	1000
Selenium	1 U	mg/kg	1	1 UJ	mg/kg	1
Silver	2 U	mg/kg	2	2 U	mg/kg	2
Sodium	1000 UJ	mg/kg	1000	1000 UJ	mg/kg	1000
Thallium	2 U	mg/kg	2	2 U	mg/kg	2
Vanadium	11.7	mg/kg	10	10.4 J	mg/kg	10
Zinc	12.5	mg/kg	4	9.7	mg/kg	4
Cyanide	.5 U	mg/kg	.5	.1 J	mg/kg	.5

U= NOT DETECTED J=ESTIMATED VALUE  
 UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
 R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
 SURFACE SOIL -- VOLATILES -- REPORT NO. 10456

Lab Sample Number:	G8876002		G8876003		G8876004		G8864007		
Site	WHITING		WHITING		WHITING		WHITING		
Locator	02S00101		02S00201		02S00301		02S00401		
Collect Date:	06-DEC-95		06-DEC-95		06-DEC-95		05-DEC-95		
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP VOLATILES 90-SOW

Chloromethane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 UJ	ug/Kg	11
Bromomethane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Vinyl chloride	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Chloroethane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Methylene chloride	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Acetone	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Carbon disulfide	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
1,1-Dichloroethene	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
1,1-Dichloroethane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
1,2-Dichloroethene (total)	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Chloroform	5 J	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
1,2-Dichloroethane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
2-Butanone	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
1,1,1-Trichloroethane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Carbon tetrachloride	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Bromodichloromethane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
1,2-Dichloropropane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
cis-1,3-Dichloropropene	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Trichloroethene	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Dibromochloromethane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
1,1,2-Trichloroethane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Benzene	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
trans-1,3-Dichloropropene	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Bromoform	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
4-Methyl-2-pentanone	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
2-Hexanone	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Tetrachloroethene	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Toluene	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
1,1,2,2-Tetrachloroethane	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Chlorobenzene	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Ethylbenzene	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Styrene	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11
Xylenes (total)	10 U	ug/Kg	10	10 U	ug/Kg	10	11 U	ug/Kg	11	11 U	ug/Kg	11

U= NOT DETECTED J=ESTIMATED VALUE  
 UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
 R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
 SURFACE SOIL -- VOLATILES -- REPORT NO. 10456

Lab Sample Number:	G8864008		G8876005	
Site	WHITING		WHITING	
Locator	02S00401D		02S00501	
Collect Date:	05-DEC-95		06-DEC-95	
	VALUE	QUAL UNITS	DL	VALUE
				QUAL UNITS
				DL

CLP VOLATILES 90-SOW

Chloromethane	11 UJ	ug/Kg	11	11 U	ug/Kg	11
Bromomethane	11 U	ug/Kg	11	11 U	ug/Kg	11
Vinyl chloride	11 U	ug/Kg	11	11 U	ug/Kg	11
Chloroethane	11 U	ug/Kg	11	11 U	ug/Kg	11
Methylene chloride	11 U	ug/Kg	11	11 U	ug/Kg	11
Acetone	11 U	ug/Kg	11	11 U	ug/Kg	11
Carbon disulfide	11 U	ug/Kg	11	11 U	ug/Kg	11
1,1-Dichloroethene	11 U	ug/Kg	11	11 U	ug/Kg	11
1,1-Dichloroethane	11 U	ug/Kg	11	11 U	ug/Kg	11
1,2-Dichloroethene (total)	11 U	ug/Kg	11	11 U	ug/Kg	11
Chloroform	11 U	ug/Kg	11	11 U	ug/Kg	11
1,2-Dichloroethane	11 U	ug/Kg	11	11 U	ug/Kg	11
2-Butanone	11 U	ug/Kg	11	11 U	ug/Kg	11
1,1,1-Trichloroethane	11 U	ug/Kg	11	11 U	ug/Kg	11
Carbon tetrachloride	11 U	ug/Kg	11	11 U	ug/Kg	11
Bromodichloromethane	11 U	ug/Kg	11	11 U	ug/Kg	11
1,2-Dichloropropane	11 U	ug/Kg	11	11 U	ug/Kg	11
cis-1,3-Dichloropropene	11 U	ug/Kg	11	11 U	ug/Kg	11
Trichloroethene	11 U	ug/Kg	11	11 U	ug/Kg	11
Dibromochloromethane	11 U	ug/Kg	11	11 U	ug/Kg	11
1,1,2-Trichloroethane	11 U	ug/Kg	11	11 U	ug/Kg	11
Benzene	11 U	ug/Kg	11	11 U	ug/Kg	11
trans-1,3-Dichloropropene	11 U	ug/Kg	11	11 U	ug/Kg	11
Bromoform	11 U	ug/Kg	11	11 U	ug/Kg	11
4-Methyl-2-pentanone	11 U	ug/Kg	11	11 U	ug/Kg	11
2-Hexanone	11 U	ug/Kg	11	11 U	ug/Kg	11
Tetrachloroethene	11 U	ug/Kg	11	11 U	ug/Kg	11
Toluene	11 U	ug/Kg	11	11 U	ug/Kg	11
1,1,2,2-Tetrachloroethane	11 U	ug/Kg	11	11 U	ug/Kg	11
Chlorobenzene	11 U	ug/Kg	11	11 U	ug/Kg	11
Ethylbenzene	11 U	ug/Kg	11	11 U	ug/Kg	11
Styrene	11 U	ug/Kg	11	11 U	ug/Kg	11
Xylenes (total)	11 U	ug/Kg	11	11 U	ug/Kg	11

U= NOT DETECTED J=ESTIMATED VALUE  
 UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
 R= RESULT IS REJECTED AND UNUSABLE

**APPENDIX B**

**GROUNDWATER ANALYTICAL DATA**

NAS WHITING FIELD -- SITE 2  
GROUNDWATER -- VOLATILES -- REPORT NO. 10461

Lab Sample Number:	90178002		90178004		RB887009		RB887008	
Site	WHITING		WHITING		WHITING		WHITING	
Locator	WHF2-1		WHF2-1A		02G00101		02G00201	
Collect Date:	19-OCT-93		19-OCT-93		23-JUL-96		23-JUL-96	
VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP VOLATILES 90-SOW

Chloromethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Bromomethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Vinyl chloride	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Chloroethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Methylene chloride	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Acetone	10 U	ug/l	10	10 U	ug/l	10	10 UJ	ug/l	10	10 UJ	ug/l	10
Carbon disulfide	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,1-Dichloroethene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,1-Dichloroethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,2-Dichloroethene (total)	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Chloroform	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,2-Dichloroethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2-Butanone	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,1,1-Trichloroethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Carbon tetrachloride	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Bromodichloromethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,2-Dichloropropane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
cis-1,3-Dichloropropene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Trichloroethene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Dibromochloromethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,1,2-Trichloroethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Benzene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
trans-1,3-Dichloropropene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Bromoform	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
4-Methyl-2-pentanone	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2-Hexanone	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Tetrachloroethene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Toluene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,1,2,2-Tetrachloroethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Chlorobenzene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Ethylbenzene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Styrene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Xylenes (total)	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10

U= NOT DETECTED J=ESTIMATED VALUE  
UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
GROUNDWATER -- VOLATILES -- REPORT NO. 10461

Lab Sample Number:	RB887012		RB887013			
Site	WHITING		WHITING			
Locator	02G00301		02G00301D			
Collect Date:	24-JUL-96		24-JUL-96			
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP VOLATILES 90-SOW

Chloromethane	10 U	ug/l	10	10 U	ug/l	10
Bromomethane	10 U	ug/l	10	10 U	ug/l	10
Vinyl chloride	10 U	ug/l	10	10 U	ug/l	10
Chloroethane	10 U	ug/l	10	10 U	ug/l	10
Methylene chloride	10 U	ug/l	10	10 U	ug/l	10
Acetone	10 UJ	ug/l	10	10 UJ	ug/l	10
Carbon disulfide	1 J	ug/l	10	10 U	ug/l	10
1,1-Dichloroethene	10 U	ug/l	10	10 U	ug/l	10
1,1-Dichloroethane	10 U	ug/l	10	10 U	ug/l	10
1,2-Dichloroethene (total)	10 U	ug/l	10	10 U	ug/l	10
Chloroform	10 U	ug/l	10	10 U	ug/l	10
1,2-Dichloroethane	10 U	ug/l	10	10 U	ug/l	10
2-Butanone	10 U	ug/l	10	10 U	ug/l	10
1,1,1-Trichloroethane	10 U	ug/l	10	10 U	ug/l	10
Carbon tetrachloride	10 U	ug/l	10	10 U	ug/l	10
Bromodichloromethane	10 U	ug/l	10	10 U	ug/l	10
1,2-Dichloropropane	10 U	ug/l	10	10 U	ug/l	10
cis-1,3-Dichloropropene	10 U	ug/l	10	10 U	ug/l	10
Trichloroethene	10 U	ug/l	10	10 U	ug/l	10
Dibromochloromethane	10 U	ug/l	10	10 U	ug/l	10
1,1,2-Trichloroethane	10 U	ug/l	10	10 U	ug/l	10
Benzene	10 U	ug/l	10	10 U	ug/l	10
trans-1,3-Dichloropropene	10 U	ug/l	10	10 U	ug/l	10
Bromoform	10 U	ug/l	10	10 U	ug/l	10
4-Methyl-2-pentanone	10 U	ug/l	10	10 U	ug/l	10
2-Hexanone	10 U	ug/l	10	10 U	ug/l	10
Tetrachloroethene	10 U	ug/l	10	10 U	ug/l	10
Toluene	10 U	ug/l	10	10 U	ug/l	10
1,1,2,2-Tetrachloroethane	10 U	ug/l	10	10 U	ug/l	10
Chlorobenzene	10 U	ug/l	10	10 U	ug/l	10
Ethylbenzene	10 U	ug/l	10	10 U	ug/l	10
Styrene	10 U	ug/l	10	10 U	ug/l	10
Xylenes (total)	10 U	ug/l	10	10 U	ug/l	10

U= NOT DETECTED J=ESTIMATED VALUE  
UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
GROUNDWATER -- SEMIVOLATILES -- REPORT NO. 10462

Lab Sample Number:	90178002		90178004		RB887009		RB887008		
Site	WHITING		WHITING		WHITING		WHITING		
Locator	WHF2-1		WHF2-1A		02G00101		02G00201		
Collect Date:	19-OCT-93		19-OCT-93		23-JUL-96		23-JUL-96		
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP SEMIVOLATILES 90-SQW

Phenol	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
bis(2-Chloroethyl) ether	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2-Chlorophenol	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,3-Dichlorobenzene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,4-Dichlorobenzene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,2-Dichlorobenzene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2-Methylphenol	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2,2-oxybis(1-Chloropropane)	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
4-Methylphenol	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
N-Nitroso-di-n-propylamine	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Hexachloroethane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Nitrobenzene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Isophorone	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2-Nitrophenol	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2,4-Dimethylphenol	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
bis(2-Chloroethoxy) methane	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2,4-Dichlorophenol	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
1,2,4-Trichlorobenzene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Naphthalene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
4-Chloroaniline	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Hexachlorobutadiene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
4-Chloro-3-methylphenol	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2-Methylnaphthalene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Hexachlorocyclopentadiene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2,4,6-Trichlorophenol	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2,4,5-Trichlorophenol	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25
2-Chloronaphthalene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2-Nitroaniline	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25
Dimethylphthalate	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Acenaphthylene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2,6-Dinitrotoluene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
3-Nitroaniline	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25
Acenaphthene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2,4-Dinitrophenol	25 UJ	ug/l	25	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25
4-Nitrophenol	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25
Dibenzofuran	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
2,4-Dinitrotoluene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Diethylphthalate	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
4-Chlorophenyl-phenylether	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Fluorene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
4-Nitroaniline	25 U	ug/l	25	25 U	ug/l	25	25 UJ	ug/l	25	25 UJ	ug/l	25
4,6-Dinitro-2-methylphenol	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25
N-Nitrosodiphenylamine	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
4-Bromophenyl-phenylether	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Hexachlorobenzene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Pentachlorophenol	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25	25 U	ug/l	25
Phenanthrene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Anthracene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Carbazole	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Di-n-butylphthalate	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10

NAS WHITING FIELD -- SITE 2  
GROUNDWATER -- SEMIVOLATILES -- REPORT NO. 10462

Lab Sample Number:	90178002		90178004		RB887009		RB887008		
Site	WHITING		WHITING		WHITING		WHITING		
Locator	WHF2-1		WHF2-1A		02G00101		02G00201		
Collect Date:	19-OCT-93		19-OCT-93		23-JUL-96		23-JUL-96		
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

Fluoranthene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Pyrene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Butylbenzylphthalate	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
3,3-Dichlorobenzidine	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Benzo (a) anthracene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Chrysene	10 U	ug/l	10	10 U	ug/l	10	10 UJ	ug/l	10	10 UJ	ug/l	10
bis(2-Ethylhexyl) phthalate	10 U	ug/l	10	7 J	ug/l	10	1 J	ug/l	10	10 U	ug/l	10
Di-n-octylphthalate	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Benzo (b) fluoranthene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Benzo (k) fluoranthene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Benzo (a) pyrene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Indeno (1,2,3-cd) pyrene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Dibenzo (a,h) anthracene	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10	10 U	ug/l	10
Benzo (g,h,i) perylene	10 U	ug/l	10	10 U	ug/l	10	10 UJ	ug/l	10	10 UJ	ug/l	10

U= NOT DETECTED J=ESTIMATED VALUE  
UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
GROUNDWATER -- SEMIVOLATILES -- REPORT NO. 10462

Lab Sample Number:	RB887012		RB887013	
Site	WHITING		WHITING	
Locator	02G00301		02G00301D	
Collect Date:	24-JUL-96		24-JUL-96	
	VALUE	DL	VALUE	DL

CLP SEMIVOLATILES 90-SOW

Phenol	10 U	ug/l	10	10 U	ug/l	10
bis(2-Chloroethyl) ether	10 U	ug/l	10	10 U	ug/l	10
2-Chlorophenol	10 U	ug/l	10	10 U	ug/l	10
1,3-Dichlorobenzene	10 U	ug/l	10	10 U	ug/l	10
1,4-Dichlorobenzene	10 U	ug/l	10	10 U	ug/l	10
1,2-Dichlorobenzene	10 U	ug/l	10	10 U	ug/l	10
2-Methylphenol	10 U	ug/l	10	10 U	ug/l	10
2,2-oxybis(1-Chloropropane)	10 U	ug/l	10	10 U	ug/l	10
4-Methylphenol	10 U	ug/l	10	10 U	ug/l	10
N-Nitroso-di-n-propylamine	10 U	ug/l	10	10 U	ug/l	10
Hexachloroethane	10 U	ug/l	10	10 U	ug/l	10
Nitrobenzene	10 U	ug/l	10	10 U	ug/l	10
Isophorone	10 U	ug/l	10	10 U	ug/l	10
2-Nitrophenol	10 U	ug/l	10	10 U	ug/l	10
2,4-Dimethylphenol	10 U	ug/l	10	10 U	ug/l	10
bis(2-Chloroethoxy) methane	10 U	ug/l	10	10 U	ug/l	10
2,4-Dichlorophenol	10 U	ug/l	10	10 U	ug/l	10
1,2,4-Trichlorobenzene	10 U	ug/l	10	10 U	ug/l	10
Naphthalene	10 U	ug/l	10	10 U	ug/l	10
4-Chloroaniline	10 U	ug/l	10	10 U	ug/l	10
Hexachlorobutadiene	10 U	ug/l	10	10 U	ug/l	10
4-Chloro-3-methylphenol	10 U	ug/l	10	10 U	ug/l	10
2-Methylnaphthalene	10 U	ug/l	10	10 U	ug/l	10
Hexachlorocyclopentadiene	10 U	ug/l	10	10 U	ug/l	10
2,4,6-Trichlorophenol	10 U	ug/l	10	10 U	ug/l	10
2,4,5-Trichlorophenol	25 U	ug/l	25	25 U	ug/l	25
2-Chloronaphthalene	10 U	ug/l	10	10 U	ug/l	10
2-Nitroaniline	25 U	ug/l	25	25 U	ug/l	25
Dimethylphthalate	10 U	ug/l	10	10 U	ug/l	10
Acenaphthylene	10 U	ug/l	10	10 U	ug/l	10
2,6-Dinitrotoluene	10 U	ug/l	10	10 U	ug/l	10
3-Nitroaniline	25 U	ug/l	25	25 U	ug/l	25
Acenaphthene	10 U	ug/l	10	10 U	ug/l	10
2,4-Dinitrophenol	25 U	ug/l	25	25 U	ug/l	25
4-Nitrophenol	25 U	ug/l	25	25 U	ug/l	25
Dibenzofuran	10 U	ug/l	10	10 U	ug/l	10
2,4-Dinitrotoluene	10 U	ug/l	10	10 U	ug/l	10
Diethylphthalate	10 U	ug/l	10	10 U	ug/l	10
4-Chlorophenyl-phenylether	10 U	ug/l	10	10 U	ug/l	10
Fluorene	10 U	ug/l	10	10 U	ug/l	10

NAS WHITING FIELD -- SITE 2  
 GROUNDWATER -- SEMIVOLATILES -- REPORT NO. 10462

Lab Sample Number:	RB887012		RB887013			
Site	WHITING		WHITING			
Locator	02G00301		02G00301D			
Collect Date:	24-JUL-96		24-JUL-96			
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

4-Nitroaniline	25 UJ	ug/l	25	25 UJ	ug/l	25
4,6-Dinitro-2-methylphenol	25 U	ug/l	25	25 U	ug/l	25
N-Nitrosodiphenylamine	10 U	ug/l	10	10 U	ug/l	10
4-Bromophenyl-phenylether	10 U	ug/l	10	10 U	ug/l	10
Hexachlorobenzene	10 U	ug/l	10	10 U	ug/l	10
Pentachlorophenol	25 U	ug/l	25	25 U	ug/l	25
Phenanthrene	10 U	ug/l	10	10 U	ug/l	10
Anthracene	10 U	ug/l	10	10 U	ug/l	10
Carbazole	10 U	ug/l	10	10 U	ug/l	10
Di-n-butylphthalate	10 U	ug/l	10	10 U	ug/l	10
Fluoranthene	10 U	ug/l	10	10 U	ug/l	10
Pyrene	10 U	ug/l	10	10 U	ug/l	10
Butylbenzylphthalate	10 U	ug/l	10	10 U	ug/l	10
3,3-Dichlorobenzidine	10 U	ug/l	10	10 U	ug/l	10
Benzo (a) anthracene	10 U	ug/l	10	10 U	ug/l	10
Chrysene	10 UJ	ug/l	10	10 UJ	ug/l	10
bis(2-Ethylhexyl) phthalate	10 U	ug/l	10	10 U	ug/l	10
Di-n-octylphthalate	10 U	ug/l	10	10 U	ug/l	10
Benzo (b) fluoranthene	10 U	ug/l	10	10 U	ug/l	10
Benzo (k) fluoranthene	10 U	ug/l	10	10 U	ug/l	10
Benzo (a) pyrene	10 U	ug/l	10	10 U	ug/l	10
Indeno (1,2,3-cd) pyrene	10 U	ug/l	10	10 U	ug/l	10
Dibenzo (a,h) anthracene	10 U	ug/l	10	10 U	ug/l	10
Benzo (g,h,i) perylene	10 UJ	ug/l	10	10 UJ	ug/l	10

U= NOT DETECTED J=ESTIMATED VALUE  
 UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
 R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
GROUNDWATER -- PESTICIDES AND PCBs -- REPORT NO. 10463

Lab Sample Number:	90178002			90178004			RB887009			RB887008		
Site	WHITING			WHITING			WHITING			WHITING		
Locator	WHF2-1			WHF2-1A			02G00101			02G00201		
Collect Date:	19-OCT-93			19-OCT-93			23-JUL-96			23-JUL-96		
	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL	VALUE	QUAL	UNITS	DL

CLP PESTICIDES/PCBS 90-SOW

alpha-BHC	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	U	ug/l	.05
beta-BHC	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	U	ug/l	.05
delta-BHC	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	U	ug/l	.05
gamma-BHC (Lindane)	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	U	ug/l	.05
Heptachlor	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	U	ug/l	.05
Aldrin	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	U	ug/l	.05
Heptachlor epoxide	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	U	ug/l	.05
Endosulfan I	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	U	ug/l	.05
Dieldrin	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	U	ug/l	.1
4,4-DDE	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	U	ug/l	.1
Endrin	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	U	ug/l	.1
Endosulfan II	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	U	ug/l	.1
4,4-DDD	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	U	ug/l	.1
Endosulfan sulfate	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	U	ug/l	.1
4,4-DDT	.1	UJ	ug/l	.1												
Methoxychlor	.5	UJ	ug/l	.5	.5	UJ	ug/l	.5	.5	UJ	ug/l	.5	.5	U	ug/l	.5
Endrin ketone	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	U	ug/l	.1
Endrin aldehyde	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	UJ	ug/l	.1	.1	U	ug/l	.1
alpha-Chlordane	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	U	ug/l	.05
gamma-Chlordane	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	UJ	ug/l	.05	.05	U	ug/l	.05
Toxaphene	5	UJ	ug/l	5	5	UJ	ug/l	5	5	UJ	ug/l	5	5	U	ug/l	5
Aroclor-1016	1	UJ	ug/l	1	1	UJ	ug/l	1	1	UJ	ug/l	1	1	U	ug/l	1
Aroclor-1221	2	UJ	ug/l	2	2	UJ	ug/l	2	2	UJ	ug/l	2	2	U	ug/l	2
Aroclor-1232	1	UJ	ug/l	1	1	UJ	ug/l	1	1	UJ	ug/l	1	1	U	ug/l	1
Aroclor-1242	1	UJ	ug/l	1	1	UJ	ug/l	1	1	UJ	ug/l	1	1	U	ug/l	1
Aroclor-1248	1	UJ	ug/l	1	1	UJ	ug/l	1	1	UJ	ug/l	1	1	U	ug/l	1
Aroclor-1254	1	UJ	ug/l	1	1	UJ	ug/l	1	1	UJ	ug/l	1	1	U	ug/l	1
Aroclor-1260	1	UJ	ug/l	1	1	UJ	ug/l	1	1	UJ	ug/l	1	1	U	ug/l	1

U= NOT DETECTED J=ESTIMATED VALUE  
UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
GROUNDWATER -- PESTICIDES AND PCBs -- REPORT NO. 10463

Lab Sample Number:	RB887012		RB887013		
Site	WHITING		WHITING		
Locator	02G00301		02G00301D		
Collect Date:	24-JUL-96		24-JUL-96		
VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP PESTICIDES/PCBS 90-SOW

alpha-BHC	.05 U	ug/l	.05	.05 U	ug/l	.05
beta-BHC	.05 U	ug/l	.05	.05 U	ug/l	.05
delta-BHC	.05 U	ug/l	.05	.05 U	ug/l	.05
gamma-BHC (Lindane)	.05 U	ug/l	.05	.05 U	ug/l	.05
Heptachlor	.05 U	ug/l	.05	.05 U	ug/l	.05
Aldrin	.05 U	ug/l	.05	.05 U	ug/l	.05
Heptachlor epoxide	.05 U	ug/l	.05	.05 U	ug/l	.05
Endosulfan I	.05 U	ug/l	.05	.05 U	ug/l	.05
Dieldrin	.1 U	ug/l	.1	.1 U	ug/l	.1
4,4-DDE	.1 U	ug/l	.1	.1 U	ug/l	.1
Endrin	.1 U	ug/l	.1	.1 U	ug/l	.1
Endosulfan II	.1 U	ug/l	.1	.1 U	ug/l	.1
4,4-DDD	.1 U	ug/l	.1	.1 U	ug/l	.1
Endosulfan sulfate	.1 U	ug/l	.1	.1 U	ug/l	.1
4,4-DDT	.1 UJ	ug/l	.1	.1 UJ	ug/l	.1
Methoxychlor	.5 U	ug/l	.5	.5 U	ug/l	.5
Endrin ketone	.1 U	ug/l	.1	.1 U	ug/l	.1
Endrin aldehyde	.1 U	ug/l	.1	.1 U	ug/l	.1
alpha-Chlordane	.05 U	ug/l	.05	.05 U	ug/l	.05
gamma-Chlordane	.05 U	ug/l	.05	.05 U	ug/l	.05
Toxaphene	5 U	ug/l	5	5 U	ug/l	5
Aroclor-1016	1 U	ug/l	1	1 U	ug/l	1
Aroclor-1221	2 U	ug/l	2	2 U	ug/l	2
Aroclor-1232	1 U	ug/l	1	1 U	ug/l	1
Aroclor-1242	1 U	ug/l	1	1 U	ug/l	1
Aroclor-1248	1 U	ug/l	1	1 U	ug/l	1
Aroclor-1254	1 U	ug/l	1	1 U	ug/l	1
Aroclor-1260	1 U	ug/l	1	1 U	ug/l	1

U= NOT DETECTED J=ESTIMATED VALUE  
UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
GROUNDWATER -- INORGANICS -- REPORT NO. 10464

Lab Sample Number:	90178002		90178004		RB887009		RB887010		
Site	WHITING		WHITING		WHITING		WHITING		
Locator	WHF2-1		WHF2-1A		02G00101		02G00101F		
Collect Date:	19-OCT-93		19-OCT-93		23-JUL-96		23-JUL-96		
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP METALS AND CYANIDE

Aluminum	12700	ug/l	200	11200	ug/l	200	248	ug/l	33.7	U	ug/l
Antimony	20.7	U	60	20.7	U	60	8.6	U	8.6	U	ug/l
Arsenic	1.6	U	10	1.6	U	10	.5	U	.5	U	ug/l
Barium	60.9	J	200	57	J	200	42.3	J	38.7	J	ug/l
Beryllium	1.4	J	5	1.3	J	5	.52	J	.3	U	ug/l
Cadmium	3.2	U	5	3.2	U	5	1.2	U	1.2	U	ug/l
Calcium	1320	J	5000	1290	J	5000	1360	J	2080	J	ug/l
Chromium	163	ug/l	10	144	ug/l	10	4.1	J	2	U	ug/l
Cobalt	4.1	U	50	4.1	U	50	2.3	U	2.3	U	ug/l
Copper	39.2	ug/l	25	34.1	ug/l	25	2.4	J	1.6	J	ug/l
Iron	74200	ug/l	100	66500	ug/l	100	1280	ug/l	44.6	U	ug/l
Lead	5.8	ug/l	3	4.8	ug/l	5	1.7	U	.6	U	ug/l
Magnesium	1390	J	5000	1380	J	5000	1030	J	982	J	ug/l
Manganese	46	ug/l	15	42.4	ug/l	15	5	J	4	J	ug/l
Mercury	.15	U	.2	.15	U	.2	.1	U	.1	U	ug/l
Nickel	9	UJ	40	9	UJ	40	7.3	U	7.3	U	ug/l
Potassium	954	J	5000	996	J	5000	650	J	316	U	ug/l
Selenium	2	U	5	2	U	5	.6	U	.6	U	ug/l
Silver	4.6	J	10	2.7	U	10	2.5	U	2.5	U	ug/l
Sodium	1280	J	5000	1310	J	5000	1110	J	1150	J	ug/l
Thallium	.88	U	10	.88	U	10	.6	U	.6	U	ug/l
Vanadium	169	ug/l	50	153	ug/l	50	4.2	J	1.9	J	ug/l
Zinc	21.8	ug/l	20	20.2	ug/l	20	19.3	J	5.5	U	ug/l
Cyanide	1.7	U	10	1.7	U	10	3.9	U	-		ug/l

U= NOT DETECTED, J=ESTIMATED VALUE  
UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
R= RESULT IS REJECTED AND UNUSABLE

NAS WHITING FIELD -- SITE 2  
GROUNDWATER -- INORGANICS -- REPORT NO. 10464

Lab Sample Number:	RB887008		RB887012		RB887013	
Site	WHITING		WHITING		WHITING	
Locator	02G00201		02G00301		02G00301D	
Collect Date:	23-JUL-96		24-JUL-96		24-JUL-96	
	VALUE	QUAL UNITS	DL	VALUE	QUAL UNITS	DL

CLP METALS AND CYANIDE

Aluminum	58.8 U	ug/l		79.3 J	ug/l		84.6 J	ug/l
Antimony	8.6 U	ug/l		8.6 U	ug/l		8.6 U	ug/l
Arsenic	.5 U	ug/l		.5 U	ug/l		.5 U	ug/l
Barium	92.2 J	ug/l		128 J	ug/l		129 J	ug/l
Beryllium	.3 U	ug/l		.39 J	ug/l		.3 U	ug/l
Cadmium	1.2 U	ug/l		1.2 U	ug/l		1.2 U	ug/l
Calcium	64800	ug/l		113000	ug/l		113000	ug/l
Chromium	2 U	ug/l		2 U	ug/l		2 U	ug/l
Cobalt	2.3 U	ug/l		2.3 U	ug/l		2.3 U	ug/l
Copper	1.1 U	ug/l		1.1 U	ug/l		1.1 U	ug/l
Iron	59.7 J	ug/l		36.2 U	ug/l		38.7 U	ug/l
Lead	.7 U	ug/l		1.4 U	ug/l		1.3 U	ug/l
Magnesium	8650	ug/l		9560	ug/l		9590	ug/l
Manganese	3.4 J	ug/l		13.5 J	ug/l		13.7 J	ug/l
Mercury	.1 U	ug/l		.1 U	ug/l		.1 U	ug/l
Nickel	7.3 U	ug/l		7.8 J	ug/l		9.6 J	ug/l
Potassium	6850	ug/l		4610 J	ug/l		4580 J	ug/l
Selenium	.6 U	ug/l		1.2 J	ug/l		.66 J	ug/l
Silver	2.5 U	ug/l		2.5 U	ug/l		2.5 U	ug/l
Sodium	1980 J	ug/l		2200 J	ug/l		2240 J	ug/l
Thallium	.6 U	ug/l		.6 U	ug/l		.6 J	ug/l
Vanadium	1.2 U	ug/l		3 J	ug/l		2.8 U	ug/l
Zinc	2 U	ug/l		1.8 U	ug/l		2 U	ug/l
Cyanide	4.5 U	ug/l		4.5 U	ug/l		2 U	ug/l

U= NOT DETECTED J=ESTIMATED VALUE  
UJ= REPORTED QUANTITATION LIMIT IS QUALIFIED AS ESTIMATED  
R= RESULT IS REJECTED AND UNUSABLE

**APPENDIX C**

**HUMAN HEALTH RISK DATA**

**Table C-1  
Screening Concentrations for Surface Soil  
for Selection of Chemicals of Potential Concern for Site 1**

Remedial Investigation Report  
Site 2, Northwest Disposal Area  
Naval Air Station, Whiting Field  
Milton, Florida

Chemical	Risk Based Screening Concentration <sup>1</sup>	Florida Cleanup Goal <sup>2</sup>	Florida Cleanup Goal Leaching Value <sup>3</sup>	Selected Screening Concentration <sup>4</sup>
<b><u>Volatile Organic Compounds (µg/kg)</u></b>				
Xylenes (total)	100,000	400	NA	400
<b><u>Semivolatile Organic Compounds (µg/l)</u></b>				
bis(2-Ethylhexyl)phthalate	46,000	48,000	NA	46,000
<b><u>Pesticides (µg/kg)</u></b>				
Dieldrin	40	70	NA	40
alpha-Chlordane	1,800	3,000	NA	1,800
gamma-Chlordane	1,800	3,000	NA	1,800
4,4'-DDT	1,900	3,200	NA	1,900
<b><u>Inorganic Analytes (mg/kg)</u></b>				
Aluminum	7,800	72,000	NA	7,800
Arsenic	<sup>5</sup> 0.43	<sup>5</sup> 0.8	NA	0.43
Barium	550	105	NA	105
Beryllium	16	12	NA	16
Calcium	<sup>6</sup> 1,000,000	-	-	1,000,000
Chromium	<sup>7</sup> 23	<sup>7</sup> 290	NA	23
Cobalt	470	4,700	NA	470
Copper	310	105	NA	105
Cyanide	<sup>8</sup> 160	30	NA	30
Iron	2,300	23,000	SPLP <sup>9</sup>	2,300
Lead	<sup>10</sup> 400	500	NA	400

See notes at end of table.

**Table C-1 (Continued)**  
**Screening Concentrations for Surface Soil**  
**for Selection of Chemicals of Potential Concern for Site 1**

Remedial Investigation Report  
 Site 2, Northwest Disposal Area  
 Naval Air Station, Whiting Field  
 Milton, Florida

Chemical	Risk Based Screening Concentration <sup>1</sup>	Florida Cleanup Goal <sup>2</sup>	Florida Cleanup Goal Leaching Value <sup>3</sup>	Selected Screening Concentration <sup>4</sup>
<b><u>Inorganic Analytes (mg/kg) (Continued)</u></b>				
Magnesium	460,468 <sup>7</sup>	-	-	460,468
Manganese	160	1,600	NA	160
Mercury	2.3	3.7	NA	2.3
Nickel	160	105	NA	105
Potassium	1,000,000 <sup>7</sup>	-	-	1,000,000
Sodium	1,000,000 <sup>7</sup>	-	-	1,000,000
Vanadium	55	15	NA	15
Zinc	2,300	23,000	NA	2,300

<sup>1</sup> For all chemicals except the essential nutrients, the U.S. Environmental Protection Agency Region III Risk Based Concentration Table for residential soil (October 1, 1998) has been used, unless otherwise noted. Screening values are based on a cancer risk of 10<sup>-6</sup> or a hazard quotient of 1.0. Noncarcinogenic RBCs have been adjusted to reflect a target hazard quotient of 0.1.

<sup>2</sup> Chapter 62-785, Florida Administrative Code (FAC), residential soil cleanup target level (SCTL).

<sup>3</sup> Chapter 62-785, FAC, leachability SCTL.

<sup>4</sup> The selected screening concentration for the human health risk assessment is the lowest value of the RBC and the Chapter 62-785, FAC, SCTL. The leaching SCTL is used if an analyte is selected as an HHCP in groundwater.

<sup>5</sup> RBC value is based on arsenic's as a carcinogen.

<sup>6</sup> Essential nutrient screening value (see GIR Report).

<sup>7</sup> RBC and Florida Cleanup Goal values are based on Chromium IV.

<sup>8</sup> Value for hydrogen cyanide used as a surrogate.

<sup>9</sup> RBC is not available for lead; value is from Revised Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OSWER Directive 9355.4-12). Leachability values may be derived using the SPLP Test to calculate site-specific SCTLs or may be determined using TCLP in the event oily wastes are present.

Notes:  $\mu\text{g}/\text{kg}$  = micrograms per kilogram.

NA = not applicable.

DDT = dichlorodiphenyltrichloroethane.

mg/kg = milligrams per kilogram.

-- = criteria not available.

**Table C-2**  
**Screening Concentrations for Subsurface Soil**  
**for Selection of Chemicals of Potential Concern**

Remedial Investigation Report  
 Site 2, Northwest Disposal Area  
 Naval Air Station, Whiting Field  
 Milton, Florida

Chemical	Risk-Based Screening Concentration <sup>1</sup>	Florida Industrial Cleanup Goal <sup>2</sup>	Florida Cleanup Goal Leaching Value <sup>3</sup>	Selected Screening Concentration <sup>4</sup>
<b>Semivolatile Organic Compounds <math>\mu\text{g}/\text{kg}</math></b>				
2-Methylnaphthalene	4,100,000	15,000,000	NA	4,100,000
Phenanthrene	--	29,000,000	NA	29,000,000
<b>Pesticides and PCBs <math>\mu\text{g}/\text{kg}</math></b>				
Aroclor-1260	2,900	3,500,000	NA	2,900
Dieldrin	360	300	NA	300
alpha-Chlordane	16,000	11,00	NA	3,000
gamma-Chlordane	16,000	11,00	NA	3,000
<b>Metals <math>\mu\text{g}/\text{l}</math></b>				
Aluminum	200,000	1,000,000	NA	<sup>2</sup> 100,000
Arsenic	<sup>5</sup> 3.8	3.7	NA	3.7
Barium	14,000	87,000	NA	14,000
Beryllium	410	700	NA	410
Cadmium	100	1,300	NA	100
Calcium	<sup>6</sup> 1,000,000	--	--	1,000,00
Chromium	<sup>7</sup> 610	<sup>7</sup> 430	NA	430
Copper	8,200	140,000	NA	8,200
Iron	61,100	490,000	SPLP <sup>8</sup>	61,000
Lead	<sup>9</sup> 400	920	NA	400
Magnesium	<sup>6</sup> 460,468	--	--	460,468
Manganese	4,100	20,000	NA	4,700
Potassium	<sup>6</sup> 1,000,000	--	--	1,000,000
Silver	1,000	9,100	NA	1,000
Sodium	<sup>6</sup> 1,000,000	--	--	1,00,000
Vanadium	1,400	7,700	NA	1,400
Zinc	61,000	560,000	NA	61,000
See notes at end of table.				

**Table C-2 (Continued)**  
**Screening Concentrations for Subsurface Soil**  
**for Selection of Chemicals of Potential Concern**

Remedial Investigation Report  
Site 2, Northwest Disposal Area  
Naval Air Station, Whiting Field  
Milton, Florida

<sup>1</sup> For all chemicals except the essential nutrients, the U.S. Environmental Protection Agency Region III Risk Based Concentration Table for residential soil (October 1, 1998) has been used, unless otherwise noted. Screening values are based on a cancer risk of  $10^{-6}$  or a hazard quotient of 1.0. Noncarcinogenic RBCs have been adjusted to reflect a target hazard quotient of 0.1.

<sup>2</sup> Chapter 62-785, Florida Administrative Code (FAC), residential soil cleanup target level (SCTL).

<sup>3</sup> Chapter 62-785, FAC leachability SCTL.

<sup>4</sup> The selected screening concentration for the human health risk assessment is the lowest value of the RBC and the Chapter 62-784, FAC, leaching SCTL is used if an analyte is selected as an HHCP in groundwater.

<sup>5</sup> RBC value is based on arsenic's as a carcinogen.

<sup>6</sup> Essential nutrient screening value (see GIR Report).

<sup>7</sup> RBC and Florida Cleanup Goal values are based on Chromium IV.

<sup>8</sup> Value for hydrogen cyanide used as a surrogate.

<sup>9</sup> RBC is not available for lead; value is from Revised Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OSWER Directive 9355.4-12). Leachability values may be derived using the SPLP Test to calculate site-specific SCTLs or may be determined using TCLP in the event oily wastes are present.

Notes: MCL = maximum contaminant level.

$\mu\text{g}/\text{l}$  = micrograms per liter.

-- = criteria not available.

**Table C-3  
Screening Concentrations for Groundwater  
for Selection of Chemicals of Potential Concern**

Remedial Investigation Report  
Site 2, Northwest Disposal Area  
Naval Air Station, Whiting Field  
Milton, Florida

Chemical	Risk-Based Screening Concentration <sup>1</sup>	Federal MCL <sup>2</sup>	Florida Groundwater Guidance Concentration <sup>3</sup>	Selected Screening Concentration <sup>4</sup>
<b><u>Volatile Organic Compounds (µg/l)</u></b>				
Carbon disulfide	100	—	700	100
<b><u>Semivolatile Organic Compounds (µg/l)</u></b>				
bis(2-Ethylhexyl)phthalate	4.8	6	6	4.8
<b><u>Inorganic Analytes (µg/l)</u></b>				
Aluminum	3,700	200	200	50
Barium	260	2,000	2,000	260
Beryllium	7.3	4	4	4
Calcium	<sup>5</sup> 1,055,398	—	—	1,055,398
Chromium	<sup>6</sup> 11	<sup>6</sup> 100	<sup>6</sup> 1,000	11
Copper	150	(1,000)	1,000	150
Iron	1,100	(300)	300	300
Lead	—	15	15	15
Magnesium	<sup>6</sup> 118,807	—	—	118,807
Manganese	73	(50)	50	50
Nickel	73	100	100	73
Potassium	<sup>5</sup> 297,016	—	—	297,016
Selenium	18	50	50	18
Sodium	<sup>5</sup> 396,022	—	160,000	160,000
Thallium	<sup>9</sup> 0.26	2 [0.5]	2	0.26
Vanadium	26	—	49	26
Zinc	1,100	(5,000)	5,000	1,100
See notes at end of table.				

**Table C-3 (Continued)**  
**Screening Concentrations for Groundwater**  
**for Selection of Chemicals of Potential Concern**

Remedial Investigation Report  
Site 2, Northwest Disposal Area  
Naval Air Station, Whiting Field  
Milton, Florida

<sup>1</sup> For all chemicals except the essential nutrients, the U.S. Environmental Protection Agency (USEPA) Region III Risked Based Concentration Table for tap water (October 1, 1998) has been used. Screening values are based on a cancer risk of  $10^{-6}$  and a hazard quotient of 1. Per USEPA Region IV Guidance (USEPA, 1995), the noncarcinogenic RBCs have been adjusted to reflect a target hazard quotient of 0.1.

<sup>2</sup> Federal MCLs are taken from USEPA Drinking Water Regulations and Health Advisories from October 1996. Primary MCLs have no marks, Secondary MCLs are indicated by parentheses ( ), and Federal maximum contaminant level goals (MCLGs) are indicated by brackets [ ]. The lowest of these nonzero values is presented.

<sup>3</sup> Chapter 62-785, Florida Administrative Code (FAC), Groundwater Cleanup Target Levels (GCTLs).

<sup>4</sup> The selected screening concentration for the human health risk assessment is the lowest value of the RBC, Federal MCL value, Chapter 62-785, FAC, GCTLs.

<sup>5</sup> Essential nutrient screening value (see GIR Report).

<sup>6</sup> Value is for hexavalent chromium.

Notes: MCL = maximum contaminant level.

$\mu\text{g}/\text{l}$  = micrograms per liter.

- = criteria not available.

TABLE C.4

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL  
 ADULT TRESPASSER  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

EXPOSURE PARAMETERS

EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical specific	chemical specific	
INGESTION RATE	IR	100	mg/day	USEPA, 1991
FRACTION INGESTED	FI	100%	unitless	USEPA, 1995
ADHERENCE FACTOR	AF	1	mg/cm <sup>2</sup> -event	USEPA, 1995
ABSORPTION FRACTION	ABS <sub>d</sub>	chemical specific	unitless	USEPA, 1995
SURFACE AREA EXPOSED	SA	5,750	cm <sup>2</sup>	USEPA, 1992
DOSE ABSORBED PER EVENT	DA <sub>event</sub>	chemical specific	mg/cm <sup>2</sup> -event	USEPA, 1992
CONVERSION FACTOR	CF	1.00E-06	kg/mg	inorganics
	CF	1.00E-09	kg/ug	organics
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	45	days/year [1]	Assumption
EXPOSURE DURATION	ED	20	years	Assumption
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	20	years	Assumption

**CANCER RISK =** INTAKE (mg/kg day) x CANCER SLOPE FACTOR (mg/kg day)<sup>-1</sup>

**HAZARD QUOTIENT =** INTAKE (mg/kg day) / REFERENCE DOSE (mg/kg day)

**INTAKE<sub>INGESTION</sub> =**  $\frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$

**INTAKE<sub>DERMAL</sub> =**  $\frac{DA_{event} \times SA \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$

**Where:**  
 DA<sub>event</sub> = AF x ABS<sub>d</sub> x CF

**Note:** For noncarcinogenic effects: AT = ED

[1] Units for exposure frequency are events/year in the calculation of the dermally absorbed dose  
 USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors"; OSWER Directive 9285 6-03  
 USEPA, 1992. Dermal Exposure Assessment. Principles and Applications, EPA/600/8-91/011B, 1/92  
 USEPA, 1995. Supplemental Guidance to RAGS: Region IV, Human Health Risk Assessment Bulletin No. 3

TABLE C.5

INHALATION OF PARTICULATES - SURFACE SOIL  
 ADULT TRESPASSER  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

EXPOSURE PARAMETERS

EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m <sup>3</sup> /kg	default [1]
CONCENTRATION AIR	CA	chemical-specific	mg/m <sup>3</sup>	
INHALATION RATE	IR	0.833	m <sup>3</sup> /hour	USEPA, 1995
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE TIME	ET	4	hours/day	Assumption
EXPOSURE FREQUENCY	EF	45	days/year	Assumption
EXPOSURE DURATION	ED	20	years	Assumption
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	20	years	USEPA, 1991

**CANCER RISK** = INTAKE (mg/kg-day) x INHALATION CANCER SLOPE FACTOR (mg/kg-day)<sup>-1</sup>

**HAZARD QUOTIENT** = INTAKE (mg/kg-day) / INHALATION REFERENCE DOSE (mg/kg-day)

**INTAKE** =  $\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$

Where:

**CA** =  $C \times CF \times (1/PEF)$

Note: For noncarcinogenic effects, AT = ED

[1] Florida Soil Clean-Up Goal Variable FDEP, 1995  
 USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors", OSWER Directive 9285-6-03  
 USEPA, 1995. Supplemental Guidance to RAGS: Region IV, Human Health Risk Assessment Bulletin No. 3

TABLE C.6

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL  
 ADOLESCENT TRESPASSER  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

## EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	100	mg/day	USEPA, 1991
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm <sup>2</sup> -event	USEPA, 1995
AGE SPECIFIC SURFACE AREA	SA <sub>i</sub>	age-specific	cm <sup>2</sup>	USEPA, 1989
ABSORPTION FRACTION	ABS <sub>i</sub>	chemical-specific	unitless	USEPA, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganics
	CF	1.00E-09	kg/mg	Organics
BODY WEIGHT	BW	45	kg	USEPA, 1995
AGE SPECIFIC BODY WEIGHT	BW <sub>i</sub>	age-specific	kg	USEPA, 1989
EXPOSURE FREQUENCY	EF	45	days/year [1]	Assumption
EXPOSURE DURATION	ED	10	years	USEPA, 1995
AGE SPECIFIC EXPOSURE DURATION	ED <sub>i</sub>	age-specific	years	Assumption
AGE WEIGHTED SURFACE AREA [2]	SA <sub>totadj</sub>	1013	cm <sup>2</sup> -year/kg	Per USEPA, 1992
DOSE ABSORBED PER EVENT	DA <sub>event</sub>	chemical-specific	mg/cm <sup>2</sup> -event	Per USEPA, 1992
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	10	years	USEPA, 1995

[1] Units for exposure frequency are in events/year in the calculation of the dermally absorbed dose

[2] In estimating the dermally absorbed dose for children age 7 through 16, the time-weighted, bodyweight normalized surface area exposed is calculated from surface area, exposure duration, and body weight for each of 10 age periods, age 7 through 16, per USEPA, 1992

USEPA, 1989 Exposure Factors Handbook: EPA/600/8-89/043, May 1989

USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors", OSWER Directive 9285.6-01

USEPA, 1992. Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B, January 1992

USEPA, 1995. Supplemental Guidance to RAGS Region 4 Bulletin, Bulletin No. 3, November 1995

## EQUATIONS

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CANCER SLOPE FACTOR (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg-day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{\text{CS} \times \text{IR} \times \text{FI} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = \text{AT} \times 365 \text{ days/year} \times \text{SA}_{\text{totadj}}$$

Where:

$$\text{SA}_{\text{totadj}} = \text{SUM} (\text{SA}_i \times \text{ED}_i) / \text{BW}_i$$

$$\text{DA}_{\text{event}} = \text{CS} \times \text{AF} \times \text{ABS}_i \times \text{CF}$$

Note: For noncarcinogenic effects: AT = ED.

TABLE C.7

INHALATION OF PARTICULATES - SURFACE SOIL  
 ADOLESCENT TRESPASSER  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m <sup>3</sup> /kg	default [1]
CONCENTRATION AIR	CA	chemical-specific	mg/m <sup>3</sup>	
INHALATION RATE	IR	0.625	m <sup>3</sup> /hour	USEPA, 1995
BODY WEIGHT	BW	45	kg	USEPA, 1995
EXPOSURE TIME	ET	4	hours/day	Assumption
EXPOSURE FREQUENCY	EF	45	days/year	Assumption
EXPOSURE DURATION	ED	10	years	USEPA, 1995
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	10	years	USEPA, 1995

[1] Florida Soil Clean-Up Goal Variable. FDEP, 1995

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors", OSWER Directive 9285.6-03

USEPA 1995. Supplemental Guidance to RAGS, Region 4 Bulletins, Bulletin No. 3, November 1995

CANCER RISK = INTAKE (mg/kg day) x INHALATION CANCER SLOPE FACTOR (mg/kg day)<sup>-1</sup>

HAZARD QUOTIENT = INTAKE (mg/kg day) / INHALATION REFERENCE DOSE (mg/kg day)

INTAKE =  $\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$

Where:

CA =  $C \times CF \times (1/PEF)$

Note: For noncarcinogenic effects: AT = ED

TABLE C.8

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL.  
ADULT RESIDENT  
NAS WHITING FIELD  
MILTON, FLORIDA  
SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	100	mg/day	USEPA, 1995
FRACTION INGESTED	FI	100%	unitless	USEPA, 1995
ADHERENCE FACTOR	AF	1	mg/cm <sup>2</sup> -event	USEPA, 1995
ABSORPTION FRACTION	ABS <sub>d</sub>	chemical-specific	unitless	USEPA, 1995
SURFACE AREA EXPOSED	SA	5,750	cm <sup>2</sup>	USEPA, 1992
DOSE ABSORBED PER EVENT	DA <sub>event</sub>	chemical-specific	mg/cm <sup>2</sup> -event	USEPA, 1992
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	350	days/year [1]	Assumption
EXPOSURE DURATION	ED	24	years	USEPA, 1995
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	24	years	USEPA, 1995

[1] Units for exposure frequency are events/year in the calculation of the dermally absorbed dose  
USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors",  
OSWER Directive 9285.6-03.  
USEPA, 1992. Dermal Exposure Assessment Principles and Applications, EPA/600/8-91/011B, January 1992  
USEPA, 1995 Supplemental Guidance to RAGS: Region IV, Human Health Risk Assessment Bulletin No. 3

$$\text{CANCER RISK} = \text{INTAKE (mg/kg day)} \times \text{CANCER SLOPE FACTOR (mg/kg day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{\text{CS} \times \text{IR} \times \text{FI} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = \frac{\text{DA}_{\text{event}} \times \text{SA} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

Where:

$$\text{DA}_{\text{event}} = \text{CS} \times \text{AF} \times \text{ABS}_d \times \text{CF}$$

Note: For noncarcinogenic effects, AT = ED.

TABLE C.9

INHALATION OF PARTICULATES - SURFACE SOIL  
 ADULT RESIDENT  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	µ³/kg	default [1]
CONCENTRATION AIR	CA	chemical-specific	mg/m³	
INHALATION RATE	IR	0.833	m³/hour	USEPA, 1995
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE TIME	ET	16	hours/day	Assumption
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1995
EXPOSURE DURATION	ED	24	years	USEPA, 1995
CONVERSION FACTOR	CF	0.001	mg/µg	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	24	years	USEPA, 1995

CANCER RISK = INTAKE (mg/kg.day) x INHALATION CANCER SLOPE FACTOR (mg/kg.day)<sup>-1</sup>

HAZARD QUOTIENT = INTAKE (mg/kg.day) / INHALATION REFERENCE DOSE (mg/kg.day)

$$\text{INTAKE} = \frac{\text{CA} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

Where:

$$\text{CA} = \text{C} \times \text{CF} \times (1/\text{PEF})$$

Note:

For noncarcinogenic effects: AT = ED

[1] Florida Soil Clean-Up Goal Variable FDEP, 1995.  
 USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors", OSWER Directive 9285 6-03  
 USEPA, 1995. Supplemental Guidance to RAGS - Region IV, Human Health Risk Assessment Bulletin No. 3

TABLE C.10

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL.  
CHILD RESIDENT  
NAS WHITING FIELD  
MILTON, FLORIDA  
SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	200	mg/day	USEPA, 1995
FRACTION INGESTED	FI	100%	unitless	USEPA, 1995
ADHERENCE FACTOR	AF	1	mg/cm <sup>2</sup> -event	USEPA, 1995
AGE-SPECIFIC SURFACE AREA	SA	age-specific	cm <sup>2</sup>	USEPA, 1989
ABSORPTION FRACTION	ABS	chemical-specific	unitless	USEPA, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
BODY WEIGHT	BW	15	kg	USEPA, 1991
AGE-SPECIFIC BODY WEIGHT	BW	age-specific	kg	USEPA, 1989
EXPOSURE FREQUENCY	EF	350	days/year [1]	USEPA, 1995
EXPOSURE DURATION	ED	6	years	USEPA, 1995
AGE-SPECIFIC EXPOSURE DURATION	ED	age-specific	years	Assumption
AGE-WEIGHTED SURFACE AREA [2]	SA <sub>adj</sub>	766	cm <sup>2</sup> -year/kg	USEPA, 1992
DOSE ABSORBED PER EVENT	DA <sub>event</sub>	chemical-specific	mg/cm <sup>2</sup> -event	USEPA, 1992
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	6	years	USEPA, 1995

[1] Units for exposure frequency are in events/year in the calculation of the dermally absorbed dose

[2] In estimating the dermally absorbed dose for children age 1 through 6, the time-weighted, bodyweight normalized surface area exposed is calculated from surface area, exposure duration, and body weight for each of 6 age periods, age 1 through 6, per USEPA, 1992

USEPA, 1989 Exposure Factors Handbook, EPA/600/8-89/043, May 1989

USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors", OSWER Directive 9285.6-03

USEPA, 1992 Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B, January 1992

USEPA, 1995. Supplemental Guidance to RAGS: Region IV, Human Health Risk Assessment Bulletin No. 3

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CANCER SLOPE FACTOR (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg-day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{\text{CS} \times \text{IR} \times \text{FI} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = (\text{DA}_{\text{event}} \times \text{EF} / \text{AT} \times 365 \text{ days/year}) \times \text{SA}_{\text{adj}}$$

Where:

$$\text{SA}_{\text{adj}} = \text{SUM}(\text{SA} \times \text{ED}) / \text{BW}$$

$$\text{DA}_{\text{event}} = \text{CS} \times \text{AF} \times \text{ABS} \times \text{CF}$$

Note: For noncarcinogenic effects, AT = ED.

TABLE C.11

INHALATION OF PARTICULATES - SURFACE SOIL  
CHILD RESIDENT  
NAS WHITING FIELD  
MILTON, FLORIDA  
SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m <sup>3</sup> /kg	default [1]
CONCENTRATION IN AIR	CA	chemical-specific	mg/m <sup>3</sup>	
INHALATION RATE	IR	0.625	m <sup>3</sup> /hour	USEPA, 1995
BODY WEIGHT	BW	15	kg	USEPA, 1991
EXPOSURE TIME	ET	24	hours/day	Assumption
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1991
EXPOSURE DURATION	ED	6	years	USEPA, 1991
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	6	years	USEPA, 1991

[1] Florida Soil Clean-Up Goal Variable. FDEP, 1995.  
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.  
USEPA, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins, Bulletin No. 3, November 1995

CANCER RISK = INTAKE (mg/kg-day) x INHALATION CANCER SLOPE FACTOR (mg/kg day)<sup>-1</sup>

HAZARD QUOTIENT = INTAKE (mg/kg-day) / INHALATION REFERENCE DOSE (mg/kg day)

INTAKE =  $\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$

Where:

CA = C x CF x (1/PEF)

Note:

For noncarcinogenic effects: AT = ED

TABLE C.12

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL.  
 SITE MAINTENANCE WORKER  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	50	mg/day	USEPA, 1995
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm <sup>2</sup> -event	USEPA, 1995
ABSORPTION FRACTION	ABS	chemical-specific	unitless	Assumption
SURFACE AREA EXPOSED	SA	5,750	cm <sup>2</sup>	USEPA, 1992
DOSE ABSORBED PER EVENT	DA <sub>event</sub>	chemical-specific	mg/cm <sup>2</sup> -event	USEPA, 1992
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	30	days/year [1]	Assumption
EXPOSURE DURATION	ED	25	years	USEPA, 1995
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	25	years	USEPA, 1995

[1] Units for exposure frequency are events/year in the calculation of the dermally absorbed dose  
 USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors".  
 OSWER Directive 9285 6-03  
 USEPA, 1992 Dermal Exposure Assessment Principles and Applications, EPA/600/8-91/011B, 1/92  
 USEPA, 1995 Supplemental Guidance to RAGS: Region IV, Human Health Risk Assessment Bulletin No. 3

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CANCER SLOPE FACTOR (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg-day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{\text{CS} \times \text{IR} \times \text{FI} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = \frac{\text{DA}_{\text{event}} \times \text{SA} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

Where:

$$\text{DA}_{\text{event}} = \text{CS} \times \text{AF} \times \text{ABS} \times \text{CF}$$

Note: For noncarcinogenic effects, AT = ED

TABLE C.13

INHALATION OF PARTICULATES - SURFACE SOIL  
 SITE MAINTENANCE WORKER  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m <sup>3</sup> /kg	default [1]
CONCENTRATION AIR	CA	chemical-specific	mg/m <sup>3</sup>	
INHALATION RATE	IR	2.5	m <sup>3</sup> /hour	USEPA, 1995
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE TIME	ET	8	hours/day	Assumption
EXPOSURE FREQUENCY	EF	30	days/year	Assumption
EXPOSURE DURATION	ED	25	years	USEPA, 1995
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	25	years	USEPA, 1995

CANCER RISK = INTAKE (mg/kg day) x INHALATION CANCER SLOPE FACTOR (mg/kg day)<sup>-1</sup>

HAZARD QUOTIENT = INTAKE (mg/kg day) / INHALATION REFERENCE DOSE (mg/kg day)

INTAKE =  $\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$

Where:

CA = C x CF x (1/PEF)

Note: For noncarcinogenic effects, AT = ED

[1] Florida Soil Clean-Up Goal Variable. FDEP, 1995.  
 USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance  
 "Standard Default Exposure Factors"; OSWER Directive 9285 6-03  
 USEPA, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins, Bulletin No. 3, November 1995

TABLE C.14

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL.  
 OCCUPATIONAL WORKER  
 NAS WHITTING FIELD  
 MILTON, FLORIDA  
 SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	50	mg/day	USEPA, 1995
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm <sup>2</sup> -event	USEPA, 1992
ABSORPTION FRACTION	ABS	chemical-specific	unitless	Assumption
SURFACE AREA EXPOSED	SA	2,300	cm <sup>2</sup>	USEPA, 1992
DOSE ABSORBED PER EVENT	DA <sub>DERMAL</sub>	chemical-specific	mg/cm <sup>2</sup> -event	USEPA, 1995
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	250	days/year [1]	USEPA, 1995
EXPOSURE DURATION	ED	25	years	USEPA, 1995
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	25	years	USEPA, 1995

[1] Units for exposure frequency are events/year in the calculation of the dermally absorbed dose  
 USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors".  
 OSWER Directive 9285.6-03.  
 USEPA, 1992. Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B, 1/92  
 USEPA, 1995. Supplemental Guidance to RAOS: Region IV, Human Health Risk Assessment Bulletin No. 3

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CANCER SLOPE FACTOR (mg/kg day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{\text{CS} \times \text{IR} \times \text{FI} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = \frac{\text{DA}_{\text{DERMAL}} \times \text{SA} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

Where:

$$\text{DA}_{\text{DERMAL}} = \text{CS} \times \text{AF} \times \text{ABS} \times \text{CF}$$

Note: For noncarcinogenic effects, AT = ED

TABLE C.15

INHALATION OF PARTICULATES - SURFACE SOIL  
 OCCUPATIONAL WORKER  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

EXPOSURE PARAMETERS

EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m <sup>3</sup> /kg	default [1]
CONCENTRATION AIR	CA	chemical-specific	mg/m <sup>3</sup>	
INHALATION RATE	IR	0.833	m <sup>3</sup> /hour	USEPA, 1995
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE TIME	ET	8	hours/day	Assumption
EXPOSURE FREQUENCY	EF	250	days/year	Assumption
EXPOSURE DURATION	ED	25	years	USEPA, 1995
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	25	years	USEPA, 1995

[1] Florida Soil Clean-Up Goal Variable. FDEP, 1995  
 USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance  
 \*Standard Default Exposure Factors\*; OSWER Directive 9285.6-03  
 USEPA, 1995. Supplemental Guidance to RAGS. Region 4 Bulletins, Bulletin No. 3, November 1995

CANCER RISK = INTAKE (mg/kg day) x INHALATION CANCER SLOPE FACTOR (mg/kg day)<sup>-1</sup>

HAZARD QUOTIENT = INTAKE (mg/kg day) / INHALATION REFERENCE DOSE (mg/kg day)

INTAKE =  $\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$

Where:

CA =  $C \times CF \times (H/PEF)$

Note: For noncarcinogenic effects, AT = ED.

TABLE C.16

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL.  
EXCAVATION WORKER  
NAS WHITING FIELD  
MILTON, FLORIDA  
SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	480	mg/day	USEPA, 1995
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm <sup>2</sup> -event	USEPA, 1995
ABSORPTION FRACTION	ABS	chemical-specific	unitless	USEPA, 1995
SURFACE AREA EXPOSED	SA	5,750	cm <sup>2</sup>	USEPA, 1992
DOSE ABSORBED PER EVENT	DA <sub>event</sub>	chemical-specific	mg/cm <sup>2</sup> -event	USEPA, 1992
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	30	days/year [1]	Assumption
EXPOSURE DURATION	ED	1	years	USEPA, 1991
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	1	years	USEPA, 1991

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg day)<sup>-1</sup>

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

INTAKE<sub>INGESTION</sub> =  $\frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$

INTAKE<sub>DERMAL</sub> =  $\frac{DA_{event} \times SA \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$

Where:

DA<sub>event</sub> = CS x AF x ABS x CF

Note: For noncarcinogenic effects, AT = ED

[1] Units for exposure frequency are events/year in the calculation of the dermally absorbed dose  
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors";  
OSWER Directive 9285 6-03.  
USEPA, 1992. Dermal Exposure Assessment Principles and Applications, EPA/600/8-91/011B, 1/92  
USEPA, 1995. Supplemental Guidance to RAGS Region IV, Human Health Risk Assessment Bulletin No. 3

TABLE C.17

INHALATION OF PARTICULATES - SURFACE SOIL  
 EXCAVATION WORKER  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

EXPOSURE PARAMETERS

EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	1.24E+09	m <sup>3</sup> /kg	default [1]
CONCENTRATION AIR	CA	chemical-specific	mg/m <sup>3</sup>	
INHALATION RATE	IR	2.5	m <sup>3</sup> /hour	USEPA, 1995
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE TIME	ET	8	hours/day	Assumption
EXPOSURE FREQUENCY	EF	30	days/year	Assumption
EXPOSURE DURATION	ED	1	years	Assumption
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	1	years	USEPA, 1991

[1] Florida Soil Clean-Up Goal Variable. FDEP, 1995  
 USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance  
 Standard Default Exposure Factors; OSWER Directive 9285.6-03  
 USEPA, 1995. Supplemental Guidance to RAGS Region IV, Human Health Risk Assessment Bulletin No. 3

$$\text{CANCER RISK} = \text{INTAKE (mg/kg day)} \times \text{INHALATION CANCER SLOPE FACTOR (mg/kg day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg day)} / \text{INHALATION REFERENCE DOSE (mg/kg day)}$$

$$\text{INTAKE} = \frac{\text{CA} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

Where:

$$\text{CA} = \text{C} \times \text{CF} \times (1/\text{PEF})$$

Note:

For noncarcinogens, AT = ED.

TABLE C.18

INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES)  
 ADULT RESIDENT  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION WATER	CW	chemical-specific	ug/liter	
INGESTION RATE	IR	2	liters/day	USEPA, 1995
BODY WEIGHT	BW	70	kg	USEPA, 1991
CONVERSION FACTOR	CF	0.001	mg/ug	
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1995
EXPOSURE DURATION	ED	24	years	USEPA, 1995
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	24	years	USEPA, 1991

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance:  
 \*Standard Default Exposure Factors\*; OSWER Directive 9285 6-03  
 USEPA, 1995. Region IV Supplemental Guidance to RAGS, Bulletin No. 3, November

CANCER RISK = INTAKE (mg/kg day) x CANCER SLOPE FACTOR (mg/kg day)<sup>-1</sup>  
 HAZARD QUOTIENT = INTAKE (mg/kg day) / REFERENCE DOSE (mg/kg day)  
 INTAKE =  $\frac{CW \times IR \times EF \times ED \times CF}{BW \times AT \times 365 \text{ days/year}}$   
 Note: For noncarcinogenic effects, AT = ED.

TABLE C.19

INGESTION OF GROUNDWATER AS DRINKING WATER (UNFILTERED SAMPLES)  
 CHILD RESIDENT  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

## EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION WATER	CW	chemical-specific	ug/liter	
INGESTION RATE	IR	1	liters/day	USEPA, 1995
BODY WEIGHT	BW	15	kg	USEPA, 1991
CONVERSION FACTOR	CF	0.001	mg/ug	
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1995
EXPOSURE DURATION	ED	6	years	USEPA, 1995
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	6	years	USEPA, 1991

<p>USEPA, 1991 Human Health Evaluation Manual, Supplemental Guidance  "Standard Default Exposure Factors", OSWER Directive 9285 6-03</p> <p>USEPA, 1995 Region IV Supplemental Guidance to RAGS, Bulletin No. 3, November</p>	<p>CANCER RISK = INTAKE (mg/kg day) x CANCER SLOPE FACTOR (mg/kg day)<sup>-1</sup></p> <p>HAZARD QUOTIENT = INTAKE (mg/kg day) / REFERENCE DOSE (mg/kg day)</p> <p>INTAKE = <math>\frac{CW \times IR \times EF \times ED \times CF}{BW \times AT \times 365 \text{ days/year}}</math></p> <p>Note: For noncarcinogenic effects, AT = ED.</p>
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TABLE C.20

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY  
 ADULT RESIDENT  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

EXPOSURE PARAMETERS

EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	100	mg/day	USEPA, 1992
FRACTION INGESTED	FI	100%	unitless	USEPA, 1995
ADHERENCE FACTOR	AF	0.2	mg/cm <sup>2</sup> -event	USEPA, 1992
ABSORPTION FRACTION	ABS <sub>d</sub>	chemical-specific	unitless	USEPA, 1995
SURFACE AREA EXPOSED	SA	5,000	cm <sup>2</sup>	USEPA, 1989
DOSE ABSORBED PER EVENT	DA <sub>event</sub>	chemical-specific	mg/cm <sup>2</sup> -event	USEPA, 1992
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	350	days/year	USEPA, 1992
EXPOSURE DURATION	ED	7	years	USEPA, 1992
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	7	years	USEPA, 1992

USEPA, 1989. Exposure Factors Handbook, May 1989.  
 USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.  
 USEPA, 1992. Region 6 Memorandum: Central Tendency and RME Exposure Parameters.  
 USEPA, 1995. Supplemental Guidance to RAGS: Region IV, Human Health Risk Assessment Bulletin No. 3.

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CANCER SLOPE FACTOR (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg-day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{\text{CS} \times \text{IR} \times \text{FI} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = \frac{\text{DA}_{\text{event}} \times \text{SA} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

Where:

$$\text{DA}_{\text{event}} = \text{CS} \times \text{AF} \times \text{ABS}_d \times \text{CF}$$

Note: For noncarcinogenic effects, AT = ED.

TABLE C.21

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY  
CHILD RESIDENT  
NAS WHITING FIELD  
MILTON, FLORIDA  
SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	200	mg/day	USEPA, 1992
FRACTION INGESTED	FI	100 %	unitless	USEPA, 1995
ADHERENCE FACTOR	AF	0.2	mg/cm <sup>2</sup> -event	USEPA, 1992
AGE-SPECIFIC SURFACE AREA	SA	age-specific	cm <sup>2</sup>	USEPA, 1989
ABSORPTION FRACTION	ABS	chemical-specific	unitless	USEPA, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
BODY WEIGHT	BW	15	kg	USEPA, 1991
AGE-SPECIFIC BODY WEIGHT	BW	age-specific	kg	USEPA, 1989
EXPOSURE FREQUENCY	EF	350	days/year [1]	USEPA, 1992
EXPOSURE DURATION	ED	2	years	USEPA, 1992
AGE-SPECIFIC EXPOSURE DURATION	ED	age-specific	years	Assumption
AGE-WEIGHTED SURFACE AREA [2]	SA <sub>adj</sub>	662.8	cm <sup>2</sup> -year/kg	GIR -Table C-5-5; USEPA, 1989
DOSE ABSORBED PER EVENT	DA <sub>event</sub>	chemical-specific	mg/cm <sup>2</sup> -event	USEPA, 1992
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	2	years	USEPA, 1992

[1] Air Force meteorological data summary for Eglin AFB (close proximity to Milton) states that there is 0.01 inches of rain for 110 days per year. Exposure frequency assumes half of the rainy days require indoor restriction.

[2] In estimating the dermally absorbed dose for children age 1 through 6, the time-weighted, bodyweight normalized surface area exposed is calculated from surface area, exposure duration, and body weight for each of 6 age periods, age 1 through 6, per USEPA, 1992.

USEPA, 1989. Exposure Factors Handbook; EPA/600/8-89/043; May 1989.

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.

USEPA, 1992. Region 6 Memorandum: Central Tendency and RME Exposure Parameters.

USEPA, 1995. Supplemental Guidance to RAGS: Region IV, Human Health Risk Assessment Bulletin No. 3.

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CANCER SLOPE FACTOR (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg-day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{\text{CS} \times \text{IR} \times \text{FI} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = (\text{DA}_{\text{event}} \times \text{EF} / \text{AT} \times 365 \text{ days/year}) \times \text{SA}_{\text{adj}}$$

Where:

$$\text{SA}_{\text{adj}} = \text{SUM} (\text{SA} \times \text{ED} / \text{BW})$$

$$\text{DA}_{\text{event}} = \text{CS} \times \text{AF} \times \text{ABS} \times \text{CF}$$

Note: For noncarcinogenic effects, AT = ED.



TABLE C.13

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY  
 ADOLESCENT TRESPASSER  
 NAB WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

## EXPOSURE PARAMETERS

## EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	200	mg/day	USEPA, 1992
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	0.2	mg/cm <sup>2</sup> -event	USEPA, 1992
AGE-SPECIFIC SURFACE AREA	SA <sub>a</sub>	age-specific	cm <sup>2</sup>	USEPA, 1989
ABSORPTION FRACTION	ABS <sub>a</sub>	chemical-specific	unitless	USEPA, 1995
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganics
	CF	1.00E-09	kg/mg	Organics
BODY WEIGHT	BW	45	kg	USEPA, 1995
AGE-SPECIFIC BODY WEIGHT	BW <sub>a</sub>	age-specific	kg	USEPA, 1989
EXPOSURE FREQUENCY	EF	350	days/year [1]	USEPA, 1992
EXPOSURE DURATION	ED	3	years	USEPA, 1992
AGE-SPECIFIC EXPOSURE DURATION	ED <sub>a</sub>	age-specific	years	Assumption
AGE-WEIGHTED SURFACE AREA [2]	SA <sub>awt</sub>	821	cm <sup>2</sup> -year/kg	USEPA, 1996
DOSE ABSORBED PER EVENT	DA <sub>event</sub>	chemical specific	mg/cm <sup>2</sup> -event	Per USEPA, 1992
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	3	years	USEPA, 1992

[1] Units for exposure frequency are in events/year in the calculation of the dermally absorbed dose.

[2] In estimating the dermally absorbed dose for children age 7 through 16, the time-weighted, bodyweight normalized surface area exposed is calculated from surface area, exposure duration, and body weight for each of 10 age periods, age 7 through 16, per USEPA, 1992.

USEPA, 1989. Exposure Factors Handbook; EPA/600/3-89/043; May 1989.

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.

USEPA, 1992. Region 6 Memorandum: Central Tendency and RME Exposure Parameters.

USEPA, 1995. Supplemental Guidance to RAGS: Region 4 Bulletin, Bulletin No. 3, November 1995.

USEPA, 1996. Exposure Factors Handbook, 1996.

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CANCER SLOPE FACTOR (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg-day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{\text{CS} \times \text{IR} \times \text{FI} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = \text{AT} \times 365 \text{ days/year} \times \text{SA}_{\text{awt}}$$

Where:

$$\text{SA}_{\text{awt}} = \text{SUM} (\text{SA}_a \times \text{EF}_a) / \text{BW}$$

$$\text{DA}_{\text{event}} = \text{CS} \times \text{AF} \times \text{ABS}_a \times \text{CF}$$

Note: For noncarcinogenic effects: AT = ED.

TABLE C.24

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE SOIL - CENTRAL TENDENCY  
 OCCUPATIONAL WORKER  
 NAS WHITING FIELD  
 MILTON, FLORIDA  
 SITE 2

EXPOSURE PARAMETERS

EQUATIONS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	50	mg/day	USEPA, 1995
FRACTION INGESTED	FI	50%	unitless	Assumption
ADHERENCE FACTOR	AF	0.2	mg/cm <sup>2</sup> -event	USEPA, 1992
ABSORPTION FRACTION	ABS	chemical-specific	unitless	Assumption
SURFACE AREA EXPOSED	SA	2,000	cm <sup>2</sup>	USEPA, 1996
DOSE ABSORBED PER EVENT	DA <sub>event</sub>	chemical-specific	mg/cm <sup>2</sup> -event	USEPA, 1995
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	250	days/year [1]	USEPA, 1992
EXPOSURE DURATION	ED	9	years	USEPA, 1992
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	9	years	USEPA, 1992

$$\text{CANCER RISK} = \text{INTAKE (mg/kg-day)} \times \text{CANCER SLOPE FACTOR (mg/kg-day)}^{-1}$$

$$\text{HAZARD QUOTIENT} = \text{INTAKE (mg/kg-day)} / \text{REFERENCE DOSE (mg/kg-day)}$$

$$\text{INTAKE}_{\text{INGESTION}} = \frac{\text{CS} \times \text{IR} \times \text{FI} \times \text{CF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

$$\text{INTAKE}_{\text{DERMAL}} = \frac{\text{DA}_{\text{event}} \times \text{SA} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

Where:

$$\text{DA}_{\text{event}} = \text{CS} \times \text{AF} \times \text{ABS} \times \text{CF}$$

Note: For noncarcinogenic effects, AT = ED

[1] Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.  
 USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.  
 USEPA, 1992. Region 6 Memorandum: Central Tendency and RME Exposure Parameters.  
 USEPA, 1995. Supplemental Guidance to RAOS: Region IV, Human Health Risk Assessment Bulletin No. 3.  
 USEPA, 1996. Exposure Factors Handbook, 1996.

**Table C.25  
Oral Dose-Response Data  
for Carcinogenic Effects**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
NAS, Whiting Field, Milton, Florida

Chemical	Weight of Evidence	Oral Slope Factor (mg/kg/day) <sup>(-1)</sup>	Source	Test Species	Exposure Route	Tumor Type	Study Source
<b>INORGANICS</b>							
Arsenic	A	1.5e + 00	IRIS	Human	Oral-drinking water	Skin	IRIS
Beryllium	B2	4.3e + 00	IRIS	Rat	Oral-drinking water	Total	IRIS
Iron	D	NE					
Thallium	D	NE					
<p>Notes:            ND = No Data            NE = Not Evaluated            Integrated Risk Information System (IRIS) on-line database search, current as of April 1997.            Health Effects Assessment Summary Tables (HEAST), current as of November 1995.            (1) The values for chlordane have been used as surrogates for alpha- and gamma-chlordane.</p> <p>Weight of Evidence (route-specific):            A = Human carcinogen            B = Probable human carcinogen (B1 = limited human evidence; B2 = sufficient human evidence)            C = Possible human carcinogen            D = Not classifiable as to human carcinogenicity</p>							

**Table C.26  
Inhalation Dose-Response Data  
for Carcinogenic Effects**

**Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
NAS, Whiting Field, Milton Florida**

Chemical	Weight of Evidence	Inhalation Slope Factor (mg/kg/day) <sup>(-1)</sup>	Source	Inhalation Unit Risk (µg/m <sup>3</sup> ) <sup>(-1)</sup>	Source	Test Species	Exposure Route	Tumor Type	Study Source
<b>INORGANICS</b>									
Arsenic	A	1.5e+01	HEAST	4.3e-03	IRIS	Human	Inhalation	Lung	IRIS
Beryllium	B2	8.4e+00	HEAST	2.4e-03	IRIS	Human	Inhalation	Lung	IRIS
Iron	D	NE		NE					
Thallium	D	NE		NE					

**Notes:**

**NE = Not Evaluated**

Integrated Risk Information System (IRIS) on-line database search, current as of April 1997.

Health Effects Assessment Summary Tables (HEAST), current as of November 1995.

**Weight of Evidence (route-specific):**

**A = Human carcinogen**

**B = Probable human carcinogen (B1 = limited human evidence; B2 = sufficient human evidence)**

**C = Possible human carcinogen**

**D = Not classifiable as to human carcinogenicity**

**Table C.27  
Oral Dose-Response Data  
for Noncarcinogenic Effects**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
NAS, Whiting Field, Milton Florida

Chemical	Chronic		Subchronic		Study Type	Confidence Level	Critical Effect	Test Animal	Uncertainty Factor	Study Source
	Oral RfD (mg/kg-day)	Source	Oral RfD (mg/kg-day)	Source						
<b>INORGANICS</b>										
Arsenic	3.0e-04	IRIS	3.0e-04	HEAST	Oral-drinking water	Medium	Hyperpigmentation, keratosis	Human	3 D	IRIS
Beryllium	5.0e-03	IRIS	5.0e-03	HEAST	Oral-drinking water	Low	No effects observed	Rat	100 H,A	IRIS
Iron	3.0e-01	(3)	ND							
Thallium	8.0e-05	IRIS (18)	8.0e-04	HEAST (18)	Oral-gavage	Low	No effects observed	Rat	3000 H,A,S,D	IRIS

**Notes:**

ND = No Data

NA = Not Applicable

Integrated Risk Information System (IRIS) on-line database search, current as of April 1997.

Health Effects Assessment Summary Tables (HEAST), current as of November 1995.

Environmental Criteria and Assessment Office (ECAO) of the USEPA in response to a specific request.

**Uncertainty factors:**

H = Variation in human sensitivity

A = Animal to human extrapolation

S = Extrapolation from subchronic to chronic NOAEL

L = Extrapolation from LOAEL to NOAEL

D = Inadequate data

M = Modifying factor

**Table C.28  
Inhalation Dose-Response Data  
for Noncarcinogenic Effects**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
NAS, Whiting Field, Milton Florida

Chemical	Chronic		Subchronic		Study Type	Confidence Level	Critical Effect	Test Animal	Uncertainty Factor	Study Source
	RfC ( $\mu\text{g}/\text{m}^3$ )	Source	RfC ( $\mu\text{g}/\text{m}^3$ )	Source						
<b>INORGANICS</b>										
Arsenic	ND		ND							
Beryllium	ND		ND							
Iron	ND		ND							
Thallium	ND		ND							
<p>Notes:</p> <p>ND = No Data            NA = Not Applicable            Integrated Risk Information System (IRIS) on-line database search, current as of April 1997.            Health Effects Assessment Summary Tables (HEAST), current as November 1995.</p> <p>Uncertainty factors:</p> <p>A = Animal to human extrapolation            H = Variation in human sensitivity            S = Extrapolation from subchronic to chronic NOAEL            L = Extrapolation from LOAEL to NOAEL            D = Inadequate data            M = Modifying factor</p>										

**Table C.29**  
**Dermal Dose-Response Data for Carcinogenic Effects**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 NAS, Whiting Field, Milton Field

Compound	Weight of Evidence	Oral Slope Factor (mg/kg-day) <sup>-1</sup>	Oral Absorption Efficiency	Reference	Dermal Slope Factor (mg/kg-day) <sup>-1</sup>
<b>INORGANICS</b>					
Arsenic	A	1.5e + 00	98%	Vahter, 1983	1.5e + 00
Beryllium	B2	4.3e + 00	1%	Owen, 1990	4.3e + 02
Iron	D	NE			NE
Thallium	D	NE			NE

**Notes:**

NE = Not Evaluated

For documentation concerning oral slope factors, refer to Table 1.

Integrated Risk Information System (IRIS) on-line database search, current as of April 1997.

Health Effects Assessment Summary Tables (HEAST), current as of November 1995.

**Weight of Evidence (route-specific):**

A = Human carcinogen

B = Probable human carcinogen (B1 = limited human evidence; B2 = sufficient human evidence)

C = Possible human carcinogen

D = Not classifiable as to human carcinogenicity

**Table C.30**  
**Dermal Dose-Response Data for Noncarcinogenic Effects**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 NAS, Whiting Field, Milton Florida

Chemical	Chronic Oral RfD (mg/kg-day)	Subchronic Oral RfD (mg/kg-day)	Oral Absorption Efficiency	Reference	Dermal Chronic RfD (mg/kg-day)	Dermal Subchronic RfD (mg/kg-day)
<b>INORGANICS</b>						
Arsenic	3.0e-04	3.0e-04	98%	Vahter, 1983	2.9e-04	2.9e-04
Beryllium	5.0e-03	5.0e-03	1%	Owen, 1990	5.0e-05	5.0e-05
Iron	3.0e-01	ND	2%	Goyer, 1991	6.0e-03	ND
Thallium	8.0e-05	8.0e-04	100%	Lie et al, 1960	8.0e-05	8.0e-04

**Notes:**

ND = No Data

For documentation concerning chronic and subchronic oral RfDs, refer to Table 3.  
 Integrated Risk Information System (IRIS) on-line database search, current as of April 1997.  
 Health Effects Assessment Summary Tables (HEAST), current as of November 1995.

**Arsenic.** Arsenic has been used in pesticide formulations and has industrial uses in tanneries, as well as the glass and wine making industries. Toxicity depends on its chemical form. Arsenic is an irritant of the skin, mucous membranes, and gastrointestinal tract. Symptoms of acute toxicity include vomiting, diarrhea, convulsions, and a severe drop in blood pressure. Subchronic effects include hyperpigmentation, sensory-motor polyneuropathy, persistent headache, and lethargy. Chronic oral exposure has caused skin lesions, peripheral vascular disease, and peripheral neuropathy. The U.S. Environmental Protection Agency (USEPA) has classified arsenic as Group A, human carcinogen, based on increased incidence of lung cancer in occupational studies.

References:

Agency for Toxic Substances and Disease Registry (ATSDR), 1992. "Toxicological Profile for Arsenic"; Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, February 1992.

**Beryllium.** Beryllium is a trace element that is obtained by extraction from mineral ores. Most beryllium is contributed to the environment by the burning of fossil fuels, which contain beryllium ore. Beryllium is generally incorporated into alloy metals that are used in jet engine parts and electrical components. Pure beryllium metal is used in parts for aircraft brakes, nuclear weapons, nuclear reactors, and precision instruments.

Available data on beryllium suggest that it is most toxic to the lungs. Acute inhalation exposures to high concentrations of beryllium in the air can cause chemical pneumonitis, the symptoms of which include cough, shortness of breath, and fatigue. These symptoms can persist and even worsen after exposure to beryllium has been discontinued. Chronic inhalation exposures to low concentrations of beryllium can produce chronic beryllium disease, which results in inhibited breathing efficiency. Inhalation of beryllium has been shown to produce lung cancer in animals, and an increased incidence of lung cancer has been demonstrated in workers who are exposed to beryllium in the air. Therefore, beryllium has been classified by the USEPA as B2, probable human carcinogen.

References:

ATSDR. 1991. "Toxicological Profile for Beryllium." U.S. Public Health Service, (February).

**Iron.** Iron is a metal required for a variety of physiological functions such as heme biosynthesis, oxidative phosphorylation, and mixed-function oxidase-mediated metabolic reactions. Only divalent forms of iron are absorbed. As absorption occurs, divalent iron is biochemically converted to trivalent iron, the biologically active form. Under normal conditions, absorbed dietary iron is complexed to hemoglobin and transported to the liver for storage until needed for physiological reactions. The balance of iron is regulated only by the amount of dietary intake and the degree of intestinal absorption. Intestinal absorption tends to be low (2 to 15 percent) except during periods of increased iron need when absorption efficiency increases dramatically.

Acute iron toxicity has been well characterized following the accidental ingestion of iron-containing preparations by children. Shortly after ingestion, the corrosive effects of iron cause vomiting and diarrhea, often bloody. Later signs include shock, metabolic acidosis, seizures, liver and/or kidney failure,

coma, and death. Chronic iron overload manifests as disturbances in liver function, diabetes mellitus, and endocrine and cardiovascular effects.

Inhalation of iron containing dust or fumes in occupational settings may result in deposition of iron particles in the lungs leading to interstitial fibrosis.

References:

Aisen, P., G. Cohen, and J.O. Kang. 1990. "Iron Toxicosis." *Int. Rev. Exp. Pathol.* 31:1-46.

Goyer, R.A. 1991. "Toxic Effects of Metals." In *Casarett and Doull's Toxicology: The Basic Science of Poisons*. 3rd edition. Eds. C.D. Klaassen, M.O. Amdur, and J. Doull. New York: Macmillan Publishing Co.

Thallium. Thallium is a naturally occurring soft metal that is minor constituent in a variety of ores and is obtained as a by-product of the refining of iron, cadmium, and zinc. It is used as a catalyst, in certain alloys, jewelry, thermometers, semiconductors, dyes and pigments, and optical lenses. It has been used medically as a depilatory agent. Additionally, it is used as a rodenticide and insecticide. Thallium is efficiently absorbed from the gastrointestinal tract. Excretion occurs primarily through urine and feces. Following absorption, distribution occurs to kidney tissue to a large extent, with lesser distribution to thyroid, intestines, testes, pancreas, skin, bone, and spleen.

Thallium is one of the more toxic metals. Acute toxicity results in gastrointestinal irritation, shock, ascending paralysis, seizures, and psychic disturbances. Signs of subacute or chronic thallium poisoning include hair loss, nail dystrophy, cataracts, peripheral muscular weakness and atrophy, chorea, peripheral neuropathy, and kidney damage. Loss of vision has been related to industrial thallium exposures. No information is available that addresses the carcinogenic potential of thallium.

References:

Goyer, R.A. 1991. Toxic Effects of Metals. In: *Casarett and Doull's Toxicology: The Basic Science of Poisons*, 3rd edition. Eds. C.D. Klaassen, M.O. Amdur, and J. Doull. Macmillan Publishing Co. N.Y.

Tweig, M. 1990. Thallium. In: *Poisoning and Drug Overdose*. Ed. K.R. Olson. Appleton & Lange, CT. pps. 276-7.

**APPENDIX D**  
**ECOLOGICAL RISK DATA**

**Table D-1  
Summary of Bioaccumulation and Biomagnification Data**

Remedial Investigation/Feasibility Study  
Site 2 - Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Bioaccumulation Factor [a]				
	Log K <sub>ow</sub> [b]	Invertebrate [c]	Plant [d]	Mammal [e]	Bird
<u>Volatile Organic Compounds</u>					
Chloroform	1.97	NA	NA	NA	NA
<u>Semivolatile Organic Compounds</u>					
bis(2-Ethylhexyl)phthalate	5.1    5.1	5.0E-02	8.7E-03	1.9E-01	NA
<u>Inorganic Analytes</u>					
Beryllium	NA	5.0E-02 [g]	2.0E-03 [h]	5.0E-02 [i]	NA
Vanadium	NA	NA	1.1E-03 [h]	1.20E-01 [j]	NA

NOTES:

- [a] Units for bioaccumulation factors (BAFs) are mg/kg (fresh) tissue weight over mg/kg (dry) soil weight for invertebrates and plants. The BAF units for small mammals and small birds are mg/kg (fresh) tissue weight over mg/kg (fresh) food weight. No BAFs were calculated for volatile organic compounds because available evidence suggests that these analytes do not bioaccumulate (Suter, 1993, Maughan, 1993).
- [b] Log K<sub>ow</sub> values are from the Superfund Chemical Data Matrix (USEPA, 1993), unless otherwise noted. Average Log K<sub>ow</sub> for classes of semivolatiles are presented in the second log K<sub>ow</sub> column. When available, chemical class log K<sub>ow</sub> averages are used instead of chemical specific log K<sub>ow</sub> to calculate BAF values.
- [c] The value is an average BAF for semivolatiles measured in earthworms (Beyer, 1990), unless otherwise noted. Dry weight values were converted to wet weight assuming earthworm are 80% water ( $BAF_{\text{wet weight}} = BAF_{\text{dry weight}} / 0.2$ ).
- [d] Plant BAF were calculated using the following equation presented by Travis and Arms (1988) unless otherwise noted:  
 $\log(\text{Plant Bioaccumulation Factor}) = 1.588 - 0.578(\log K_{ow})$ . The calculated plant BAF value was converted from dry weight to wet weight by dividing the BAF by a factor of 0.2 (assuming 80% water content of plants) ( $BAF_{\text{wet weight}} = BAF_{\text{dry weight}} / 0.2$ ).
- [e] Mammalian BAFs were calculated using the following equation from Travis and Arms (1988), unless otherwise noted:  
 $\log \text{BTF (biotransfer factor)} = \log K_{ow} - 7.6$ .  
 To convert from BTF to BAF, the calculated log BTF is first transformed to base 10 than multiplied by the average ingestion rates for nonlactating and lactating test animals (12 kg/day). BAFs are convert from dry to wet feed weight by divided the BAF by a factor of 0.2 ( $BAF_{\text{wet weight}} = \text{BTF} * 12 \text{ mg/day} / 0.2$ ). There is an uncertainty involved in using this equation for phthalates

**Table D-1**  
**Summary of Bioaccumulation and Biomagnification Data**

**Remedial Investigation/Feasibility Study**  
**Site 2 - Northwest Open Disposal Area**  
**Naval Air Station Whiting Field**  
**Milton, Florida**

- because the study by Travis and Arms (1988) did not use phthalates in the regression analysis.
- [ g ] Prey-specific value not available; value shown is small mammal BAF for this chemical.
- [ h ] Value from Baes et al. (1984) for leafy portions of plants multiplied by 0.2 to represent 80% water composition of plants.
- [ i ] Mean of values reported for *Sorex araneus* in MacFadyne (1980).
- [ j ] Value derived from biotransfer factors (BTFs), presented in Baes et al. (1984) for uptake into cattle.  
BTF converted to BAF by multiplying by food ingestion rate of 50 kg/day wet weight.

Notes:

Log  $K_{ow}$  = log of the octanol/water partition coefficient.  
NA = not available.

References:

- Baes, C.F. III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. "A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture." ORNL-5786. U.S. Department of Energy, Environmental Sciences Division Oak Ridge, Tennessee: Oak Ridge National Laboratory (September).
- MacFadyen, A. 1980. *Advances in Ecological Research*. Vol. II. New York: Academic Press.
- Maughan, J.T. 1993. *Ecological Assessment of Hazardous Waste Sites*. New York: Van Nostrand Reinhold.
- Suter, G. W. 1993. "Ecological Risk Assessment." Chelsea Michigan: Lewis Publishers.
- Travis, C.C., and A.D. Arms. 1988. "Bioconcentration of Organics in Beef, Milk, and Vegetation." *Environ. Sci. Tech.* 22:271-274.
- U.S. Environmental Protection Agency (USEPA). 1993. *Superfund Chemical Data Matrix (SCDM)*. Washington, D.C.

**Table D -2  
Ingestion Toxicity Information for Wildlife**

Remedial Investigation/Feasibility Study  
Site 2 - Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Test Species	Test Type	Duration	Effect	Lethal TRV mg/kg-BW-day		Sublethal TRV mg/kg-BW-day			References
					Oral LD <sub>50</sub>	TRV <sup>1</sup>	LOAEL	NOAEL	TRV <sup>2</sup>	
<b><u>Volatile Organic Compounds</u></b>										
Chloroform	Rat	Oral	NR	Mortality	908					RTECS, 1994
	Rat	Oral	NR	Reproductive effects			1,260			RTECS, 1994
	Rat	Oral	NR	Reproductive effects			4,000			RTECS, 1994
	Mouse	Oral	NR	Reproductive effects			2,177			RTECS, 1994
	Mouse	Oral	NR	Reproductive effects			2,115			RTECS, 1994
	Guinea pig	Oral	NR	Mortality	820	164				RTECS, 1994
	Rabbit	Oral	NR	Reproductive effects			260		26	RTECS, 1994
<b><u>Semivolatile Organic Compounds</u></b>										
bis(2-Ethylhexyl)phthalate	Rat	Oral LD <sub>50</sub>	NR	Mortality	30,600					RTECS, 1993
	Rat	Oral	NR	Reproductive effects			7,140			RTECS, 1993
	Rat	Oral	NR	Reproductive effects			35		3.5	RTECS, 1993
	Rat	Oral	NR	Reproductive effects			6,000			RTECS, 1993
	Rat	Oral	NR	Reproductive effects			17,200			RTECS, 1993
	Rat	Oral	NR	Reproductive effects			10,000			RTECS, 1993
	Rat	Oral	NR	Reproductive effects			9,766			RTECS, 1993
	Mouse	Oral LD <sub>50</sub>	NR	Mortality	30,000					RTECS, 1993
	Mouse	Oral	NR	Reproductive effects			78,880			RTECS, 1993
	Mouse	Oral	NR	Reproductive effects			4,200			RTECS, 1993
	Mouse	Oral	NR	Reproductive effects			50			RTECS, 1993
	Mouse	Oral	NR	Reproductive effects			1,000			RTECS, 1993
	Mouse	Oral	NR	Reproductive effects			2,040			RTECS, 1993
	Rabbit	Oral LD <sub>50</sub>	NR	Mortality	34,000					RTECS, 1993
	Guinea pig	Oral LD <sub>50</sub>	NR	Mortality	26,000					RTECS, 1993
	Guinea pig	Oral	NR	Reproductive effects			20,000			RTECS, 1993
	Mammal	Oral	NR	Reproductive effects			20,000			RTECS, 1993
	Mammal	Oral	NR	Reproductive effects			509,000			RTECS, 1993
	Mouse	Oral LD <sub>50</sub>		Mortality	800	160				RTECS, 1993
	Mouse	Oral (subchronic)	13 weeks	Renal effects				125		RTECS, 1993
<b><u>Inorganic Analytes</u></b>										
Beryllium	Rat	Oral LD <sub>50</sub>	NR	Mortality	10	2				USEPA, 1985a
	Rat	Oral (chronic)	NR	Increase in lung sacromas			0.22			USEPA, 1985a
	Rat	Oral (chronic)	3.2 years	Respiratory, cardiopulmonary, hematological, and hepatic effects			0.85		0.085	ATSDR, 1991
Vanadium	Japanese quail	Oral LD <sub>50</sub>	5 days	Mortality	96	19.2				Hill, E.F., et al., 1986
	Chicken	Oral (subchronic)	6 weeks	Decrease in egg-laying			11		1.1	Berg, L.R., et al., 1963
	Mouse	Gavage LD <sub>50</sub>	One time	Mortality	31	6.2				RTECS, 1993
	Rat	Oral (subchronic)	2 months	Hypertension			15			Susic, D., et al., 1986
	Rat	Oral (subchronic)	35 days	Development effects				8.4	8.4	Domingo, J.L., et al., 1986

**Table D -2**  
**Ingestion Toxicity Information for Wildlife**

Remedial Investigation/Feasibility Study  
Site 2 - Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

- <sup>1</sup> Selected lethal TRVs are boxed. The lethal TRVs corresponds to the NOAEL when available. If there is not an NOAEL or LOAEL studies available, then the TRV value is calculated by applying a five fold application factor to the Oral LD<sub>50</sub>.
- <sup>2</sup> Selected sublethal TRVs are boxed. The sublethal TRV corresponds to the NOAEL when available. When a NOAEL is not available, the sublethal TRV value is calculated by applying a ten fold application factor to the sublethal LOAEL.
- <sup>3</sup> Converted to dose per kilogram body weight by multiplying the reported value by ingestion rate and dividing by body weight. Body weights for birds obtained from Dunning, 1984. Ingestion rates were calculated using the following regression equation (for all birds) from USEPA, 1993c: Food Ingestion (kg/day) = 0.00582 \* Body Weight<sup>0.851</sup> (kg). Ingestion rates for the chicken from NRC, 1984.

Notes: mg/kg = milligrams per kilogram.

BW = Body weight.

LD<sub>50</sub> = Dose resulting in 50% mortality in test population.

LOAEL = lowest observed adverse effect level.

NOAEL = no observed adverse effect level.

NR = not reported

LC<sub>20,10</sub> = lethal concentration for 20% or 10% of the population.

> = greater than.

RBC = risk-based concentration.

% = percent

gest. = gestation.

References:

ATSDR, 1991, "Toxicological Profile for Beryllium," Agency for Toxic Substances and Disease Registry, U.S. Public Health Service.

Berg, L.R., G.E. Bearse, and L.H. Merrill, 1963, "Vanadium Toxicity in Laying Hens," Poultry Science, Vol. 42, pp. 1407-1411.

Domingo, J.L., J.L. Paternain, J.M. Lobet, and J. Corbella, 1986, "Effects of Vanadium on Reproduction, Gestation, Parturition, and Lactation in Rats Upon Oral Administration," Life Sciences, Vol. 39, pp. 819-824.

Hill, E.F., and M.B. Camardese, 1986, "Lethal Dietary Toxicities of Environmental Contaminants and Pesticides to Coturnix," Technical Report No. 2, U.S. Fish and Wildlife Service, Washington, D.C.

Registry of Toxic Effects of Chemical Substances (RTECS), 1993-1995, On-line database search.

Susic, D., and D. Kentera, 1986, "Effect of Chronic Vanadate Administration on Pulmonary Circulation in the Rat," Respiration, Vol. 49, pp. 68-72.

USEPA, 1985a, "Environmental Profiles and Hazard Indices for Constituents of Municipal Sludge: Beryllium," Office of Water Regulations and Standards, Washington, D.C.

**Table D - 3**  
**Selected Wildlife Ingestion TRVs [a]**  
Units (mg/kg-BW/day)

Remedial Investigation and Feasibility Study  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analytes	Small Mammal		Small Bird		Predatory Mammal [b]		Predatory Bird [c]	
	Lethal	Sublethal	Lethal	Sublethal	Lethal	Sublethal	Lethal	Sublethal
<b>Volatile Organic Compounds</b>								
Chloroform	164	26	NA	NA	164	26	NA	NA
<b>Semivolatile Organic Compounds</b>								
bis(2-Ethylhexyl)phthalate	160	3.5	NA	NA	160	3.5	NA	NA
<b>Inorganic Compounds</b>								
Beryllium	2	0.085	NA	NA	2	0.085	NA	NA
Vanadium	6.2	8.4	19.2	1.1	6.2	8.4	19.2	1.1

[a] Lethal TRVs correspond to the boxed lethal TRV presented in Table D-2. Lethal TRVs correspond to the lowest NOAEL, or one-tenth of the lowest LOAEL, or one-fifth of the lowest LD<sub>50</sub>.

Sublethal TRVs correspond to the boxed TRV. When a NOAEL value is not available, one-tenth of the sublethal LOAEL is used as a surrogate.

[b] When no data is available, the small mammal TRV value is used as a surrogate.

[c] When no data is available, the small bird TRV value is used as a surrogate.

Notes:

NA = Not available

TRV - toxicity reference value

mg/kg - milligrams per kilogram

LD<sub>50</sub> - dose resulting in 50% mortality in test population

LOAEL - Lowest Observed Adverse Effect Level

NOAEL - No Observed Adverse Effect Level

BW - Body weight

**Table D - 4**  
**Summary of Toxicity Data for Plant Receptors**

**Remedial Investigation/Feasibility Study**  
**Site 2 - Northwest Open Disposal Area**  
**Naval Air Station Whiting Field**  
**Milton, Florida**

Analyte	Reference	TRV in soil [a] (mg/kg)
<b>VOLATILE ORGANICS</b>		
Chloroform	Hulzebos <i>et al.</i> , 1993 (b)	> 1000 [c]
<b>SEMI-VOLATILE ORGANICS</b>		
bis(2-Ethylhexyl)phthalate	Hulzebos <i>et al.</i> , 1993 (b)	> 1,000
<b>INORGANICS</b>		
Beryllium	Will and Suter, 1994	10
Vanadium	Will and Suter, 1994	2
<p>Notes:</p> <p>[a] TRVs in soil are equal to chemical concentrations in soil that are not expected to result in adverse effects to plants.</p> <p>[b] Value represents 14-day growth EC<sub>50</sub> for <i>Lactuca sativa</i> in soil.</p> <p>[c] Value for tetrachloroethylene used as a surrogate.</p> <p>TRV = Toxicity reference value.  mg/kg = milligrams per kilogram.  EC<sub>50</sub> = Media concentration resulting in 50% mortality in test population.</p>		
<p>References:</p> <p>Hulzebos, E.M., D.M.M. Adema, E.M. Dirven-van Breemen, L. Henzen, W.A. van Dis, H.A. Herbold, J.A. Hoekstra, R. Baerselman, and C.A.M. van Gestel. 1993. "Phytoxicity Studies with <i>Lactuca sativa</i> in Soil and Nutrient Solution." <i>Environ. Toxicol. and Chem.</i></p> <p>Will, M.E., and G.W. Suter. 1994. <i>Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants.</i> 1994 Rev. (September). Environmental Sciences Division. Oak Ridge, Tennessee: Oak Ridge National Laboratory.</p>		

**Table D - 5  
Summary of Toxicity Data for Terrestrial Invertebrates**

**Remedial Investigation/Feasibility Study  
Site 2 - Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida**

Analyte	Test Type	Test Duration	Test Species	Effects Concentration (mg/kg)	Effect	TRV (mg/kg)	Reference
<b>VOLATILE ORGANIC COMPOUNDS</b>							
Chloroform	Soil Test	14 day	<i>E. foetida</i>	740	LC <sub>50</sub>	148	[a] Neuhauser <i>et al.</i> , 1985.
<b>SEMIVOLATILE ORGANIC COMPOUNDS</b>							
bis(2-Ethylhexyl)phthalate	Soil Test	14 day	4 test species	2,390	LC <sub>50</sub>	478	[a] Neuhauser <i>et al.</i> , 1985.
<b>INORGANIC ANALYTES</b>							
Beryllium	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA

[a] Conservative factor of 0.2 applied to endpoint; resultant value should be protective of 99.9% of the exposed population from acute effects (USEPA, 1986).

**NOTES:**

NA = Not available

mg/kg = milligrams per kilogram.

LC<sub>50</sub> = Media concentration resulting in 50% mortality in test population.

**References:**

Neuhauser, E.F., R.C. Loehr, M.R. Malecki, D.L. Milligan, and P.R. Durkin. 1985. "The Toxicity of Selected Organic Chemicals to the Earthworm *Eisenia fetida*." *J. Environ. Qual.* 14:383-388.

USEPA, 1986, Hazard Evaluation Division Standard Evaluation Procedure: Ecological Risk Assessment, Office of Pesticide Programs, EPA 540/9-85-001, Washington, D.C.

Table D-6  
 Exposure Parameters and Assumptions for Representative Wildlife Species [a]  
 Site 2  
 Naval Air Station  
 Milton, Florida

Representative Wildlife Species		Percent Prey in Diet					Home Range (acres)	ED [b]	Site Foraging Frequency [c]	Food Ingestion Rate (kg/day)	Body Weight (kg)
		Inverts	Plants	Small							
				Mammals	Birds	Soil					
<i>Cotton mouse</i>	(Small herb. mammal)	10%	88%	0%	0%	2%	0.147	1	1.00E+00	0.0029	0.021
<i>Eastern meadowlark</i>	(Small omn. bird)	75%	20%	0%	0%	5%	5	1	1.00E+00	0.0119	0.087
<i>Short-tailed shrew</i>	(Small carn. mammal)	78%	12%	0%	0%	10%	0.96	1	1.00E+00	0.0024	0.017
<i>Red fox</i>	(Predatory mammal)	20%	10%	57%	10%	3%	250	1	4.80E-02	0.24	4.69
<i>Great-horned owl</i>	(Predatory bird)	0%	0%	80%	19%	1%	15	1	8.00E-01	0.078	1.5

NOTES:

SITE AREA: 12.0 acres

[a] Documentation of exposure parameters presented in: Table 7-5

[b] ED = Exposure Duration (percentage of year receptor is expected to be found at study area)

[c] SFF = Site Foraging Frequency (calculated by dividing site area by receptor home range (cannot exceed 1.0))

Table D-7

Estimated Exposure from Ingestion of Food and Soil containing the Maximum Exposure Point Concentration of ECPCs: Lethal Effects  
 Site 2  
 Naval Air Station  
 Milton, Florida

**EXPOSURE CONCENTRATION DATA**

ANALYTE	MAXIMUM EXPOSURE POINT CONCENTRATION (mg/kg)
Chloroform	0.005
bis(2-Ethylhexyl)phthalate	0.105
Beryllium	0.45
Vanadium	20.3

**ESTIMATED CONCENTRATIONS**

**IN PRIMARY FOOD ITEMS**

Concentration in Invert Invertebrate Tissue [b] BAF [a] (mg/kg)		Plant BAF [a]	Concentration in Plant Tissue [c] (mg/kg)
NA	NA	NA	NA
5.0E-02	5.3E-03	8.7E-03	9.1E-04
5.0E-02	2.3E-02	2.0E-03	9.0E-04
NA	NA	1.1E-03	2.2E-02

**BAF VALUES FOR**

**OTHER FOOD ITEMS**

Small Mammal BAF [a]	Small Bird BAF [a]
NA	NA
1.9E-01	NA
5.0E-02	NA
1.2E-01	NA

ECPC = Ecological Chemical of Potential Concern

[a] Bioaccumulation data presented in: Table D-1

NA = not available

[b] Invertebrate tissue concentration is the invertebrate BAF multiplied by the EPC.

[c] Plant tissue concentration is the plant BAF multiplied by the EPC.

Table D-7

Estimated Exposure from Ingestion of Food and Soil containing the Maximum Exposure Point Concentration of ECPCs: Lethal Effects  
 Site 2  
 Naval Air Station  
 Milton, Florida

POTENTIAL DIETARY EXPOSURE (mg/kg-BW/day) [d]

ANALYTE	<i>Cottus meurus</i>	<i>Eastern meadowlark</i>	<i>Short-tailed shrew</i>	<i>Red fox</i>	<i>Great-horned owl</i>
Chloroform	1.4E-05	3.4E-05	7.1E-05	3.7E-07	2.1E-06
bis(2-Ethylhexyl)phthalate	4.7E-04	1.3E-03	2.1E-03	1.3E-05	1.0E-04
Beryllium	1.7E-03	5.4E-03	8.8E-03	4.7E-05	2.5E-04
Vanadium	5.9E-02	1.4E-01	2.9E-01	1.7E-03	1.3E-02

[d] Calculated by summing the concentration derived from each pathway (multiplying pathway concentration, percent in diet, SFF, and ingestion rate, and then dividing by body weight).

SFF = Site foraging frequency

Table D-8

Risk for Representative Wildlife Species from Maximum Exposure Concentrations of ECPCs: Lethal Effects

Site 2

Naval Air Station

Milton, Florida

ANALYTE	<i>Cotton mouse</i>			<i>Eastern meadowlark</i>			<i>Short-tailed shrew</i>			
	PDE	TRV	HQ	PDE	TRV	HQ	PDE	TRV	HQ	
Chloroform	1.4E-05	1.6E+02	8.6E-08	3.4E-05	NA	NA	7.1E-05	1.6E+02	4.4E-07	
bis(2-Ethylhexyl)phthalate	4.7E-04	1.6E+02	3.0E-06	1.3E-03	NA	NA	2.1E-03	1.6E+02	1.3E-05	
Beryllium	1.7E-03	2.0E+00	8.3E-04	5.4E-03	NA	NA	8.8E-03	2.0E+00	4.4E-03	
Vanadium	5.9E-02	6.2E+00	9.5E-03	1.4E-01	1.9E+01	7.3E-03	2.9E-01	6.2E+00	4.6E-02	
<b>SUMMARY HAZARD INDEX</b>			<b>1.0E-02</b>				<b>7.3E-03</b>			

PDE = Potential Dietary Exposure (mg/kg-BW/day)

NA = not available

TRV = Toxicity Reference Value (mg/kg-BW/day) = NOAEL or 1/10 of lowest reported LOEL or 1/5 of the lowest reported LD<sub>50</sub> for closest related species.

Table D-8

Risk for Representative Wildlife Species from Maximum Exposure Concentrations of ECPCs: Lethal Effects

Site 2

Naval Air Station

Milton, Florida

ANALYTE	<i>Red fox</i>			<i>Great-horned owl</i>		
	PDE	TRV	HQ	PDE	TRV	HQ
Chloroform	3.7E-07	1.6E+02	2.3E-09	2.1E-06	NA	NA
bis(2-Ethylhexyl)phthalate	1.3E-05	1.6E+02	8.1E-08	1.0E-04	NA	NA
Beryllium	4.7E-05	2.0E+00	2.4E-05	2.5E-04	NA	NA
Vanadium	1.7E-03	6.2E+00	2.8E-04	1.3E-02	1.9E+01	7.0E-04
SUMMARY HAZARD INDEX			3.0E-04			7.0E-04

PDE = Potential Dietary Exposure (mg/kg-BW/day)

TRV = Toxicity Reference Value (mg/kg-BW/day) = NOAEL or 1/10 of the lowest LOAEL or 1/5 of the lowest reported LD<sub>50</sub> for closest rel

HQ = Hazard Quotient (calculated by dividing PDE by TRV)

Table D-9

Estimated Exposure from Ingestion of Food and Soil containing the Maximum Exposure Point Concentration of ECPCs: Sublethal Effects  
 Site 2  
 Naval Air Station  
 Milton, Florida

**EXPOSURE CONCENTRATION DATA**

ANALYTE	MAXIMUM EXPOSURE POINT CONCENTRATION (mg/kg)
Chloroform	0.005
bis(2-Ethylhexyl)phthalate	0.105
Beryllium	0.45
Vanadium	20.3

ECPC = Ecological Chemical of Potential Concern

[a] Bioaccumulation data presented in: Table D-1

**ESTIMATED CONCENTRATIONS IN PRIMARY FOOD ITEMS**

Concentration in Invert		Concentration in Plant	
BAF [a]	Invertebrate Tissue [b] (mg/kg)	BAF [a]	Plant Tissue [c] (mg/kg)
NA	NA	NA	NA
5.0E-02	5.3E-03	8.7E-03	9.1E-04
5.0E-02	2.3E-02	2.0E-03	9.0E-04
NA	NA	1.1E-03	2.2E-02

[b] Invertebrate tissue concentration is the invertebrate BAF multiplied by the EPC.

[c] Plant tissue concentration is the plant BAF multiplied by the EPC.

**BAF VALUES FOR OTHER FOOD ITEMS**

Small Mammal	Small Bird
BAF [a]	BAF [a]
NA	NA
1.9E-01	NA
5.0E-02	NA
1.2E-01	NA

Table D-9

Estimated Exposure from Ingestion of Food and Soil containing the Maximum Exposure Point Concentration of ECPCs: Sublethal Effects  
Site 2

Naval Air Station  
Milton, Florida

POTENTIAL DIETARY EXPOSURE (mg/kgBW/day) [d]

ANALYTE	<i>Cotton mouse</i>	<i>Eastern meadowlark</i>	<i>Short-tailed shrew</i>	<i>Red fox</i>	<i>Great horned owl</i>
Chloroform	1.4E-05	3.4E-05	7.1E-05	3.7E-07	2.1E-06
bis(2-Ethylhexyl)phthalate	4.7E-04	1.3E-03	2.1E-03	1.3E-05	1.0E-04
Beryllium	1.7E-03	5.4E-03	8.8E-03	4.7E-05	2.5E-04
Vanadium	5.9E-02	1.4E-01	2.9E-01	1.7E-03	1.3E-02

[d] Calculated by summing the concentration derived from each pathway (multiplying pathway concentration, percent in diet, SFF, and ingestion rate, and then dividing by body weight).

SFF = Site foraging frequency

Table D-10

Risk for Representative Wildlife Species from Maximum Exposure Concentrations of ECPCs: Sublethal Effects

Site 2

Naval Air Station

Milton, Florida

ANALYTE	<i>Cotton mouse</i>			<i>Eastern meadowlark</i>			<i>Short-tailed shrew</i>			
	PDE	TRV	HQ	PDE	TRV	HQ	PDE	TRV	HQ	
Chloroform	1.4E-05	2.6E+01	5.3E-07	3.4E-05	NA	NA	7.1E-05	2.6E+01	2.7E-06	
bis(2-Ethylhexyl)phthalate	4.7E-04	3.5E+00	1.4E-04	1.3E-03	NA	NA	2.1E-03	3.5E+00	5.9E-04	
Beryllium	1.7E-03	8.5E-02	2.0E-02	5.4E-03	NA	NA	8.8E-03	8.5E-02	1.0E-01	
Vanadium	5.9E-02	8.4E+00	7.0E-03	1.4E-01	1.1E+00	1.3E-01	2.9E-01	8.4E+00	3.4E-02	
<b>SUMMARY HAZARD INDEX</b>			2.7E-02				1.3E-01			

PDE = Potential Dietary Exposure (mg/kg-BW/day)

TRV = Toxicity Reference Value (mg/kg-BW/day) = NOAEL or 1/10 of the lowest reported LOAEL for closest related species.

Table D-10

Risk for Representative Wildlife Species from Maximum Exposure Concentrations of ECPCs: Sublethal Effects

Site 2

Naval Air Station

Milton, Florida

ANALYTE	<i>Red fox</i>			<i>Great-horned owl</i>		
	PDE	TRV	HQ	PDE	TRV	HQ
Chloroform	3.7E-07	2.6E+01	1.4E-08	2.1E-06	NA	NA
bis(2-Ethylhexyl)phthalate	1.3E-05	3.5E+00	3.7E-06	1.0E-04	NA	NA
Beryllium	4.7E-05	8.5E-02	5.5E-04	2.5E-04	NA	NA
Vanadium	1.7E-03	8.4E+00	2.0E-04	1.3E-02	1.1E+00	1.2E-02
<b>SUMMARY HAZARD INDEX</b>			7.6E-04			1.2E-02

PDE = Potential Dietary Exposure (mg/kg-BW/day)

TRV = Toxicity Reference Value (mg/kg-BW/day) = NOAEL or 1/10 of the lowest reported LOAEL for closest related species.

HQ = Hazard Quotient (calculated by dividing PDE by TRV)

Table D-11

Estimated Exposure from Ingestion of Food and Soil containing the Average Exposure Point Concentration of ECPCs: Lethal Effects  
 Site 2  
 Naval Air Station  
 Milton, Florida

**EXPOSURE CONCENTRATION DATA**

ANALYTE	AVERAGE EXPOSURE POINT CONCENTRATION
	(mg/kg)
Chloroform	0.005
bis(2-Ethylhexyl)phthalate	0.105
Beryllium	0.32
Vanadium	11.3

**ESTIMATED CONCENTRATIONS**

**IN PRIMARY FOOD ITEMS**

Invert BAF [a]	Concentration in Invertebrate Tissue [b]	Plant BAF [a]	Concentration in Plant Tissue [c]
	(mg/kg)		(mg/kg)
NA	NA	NA	NA
5.0E-02	5.3E-03	8.7E-03	9.1E-04
5.0E-02	1.6E-02	2.0E-03	6.4E-04
NA	NA	1.1E-03	1.2E-02

**BAF VALUES FOR**

**OTHER FOOD ITEMS**

Small Mammal BAF [a]	Small Bird BAF [a]
NA	NA
1.9E-01	NA
5.0E-02	NA
1.2E-01	NA

ECPC = Ecological Chemical of Potential Concern

[a] Bioaccumulation data presented in: Table D-1

[b] Invertebrate tissue concentration is the invertebrate BAF multiplied by the EPC.

[c] Plant tissue concentration is the plant BAF multiplied by the EPC.

Table D-11

Estimated Exposure from Ingestion of Food and Soil containing the Average Exposure Point Concentration of ECPCs: Lethal Effects

Site 2

Naval Air Station

Milton, Florida

POTENTIAL DIETARY EXPOSURE (mg/kgBW/day) [d]

ANALYTE	<i>Cottontail mouse</i>	<i>Eastern meadowlark</i>	<i>Short-tailed shrew</i>	<i>Red fox</i>	<i>Great horned owl</i>
Chloroform	1.4E-05	3.4E-05	7.1E-05	3.7E-07	2.1E-06
bis(2-Ethylhexyl)phthalate	4.7E-04	1.3E-03	2.1E-03	1.3E-05	1.0E-04
Beryllium	1.2E-03	3.8E-03	6.3E-03	3.3E-05	1.8E-04
Vanadium	3.3E-02	7.8E-02	1.6E-01	9.5E-04	7.4E-03

[d] Calculated by summing the concentration derived from each pathway (multiplying pathway concentration, percent in diet, SFF, and ingestion rate, and then dividing by body weight).

SFF = Site foraging frequency

Table D-12

Risk for Representative Wildlife Species from Average Exposure Concentrations of ECPCs: Lethal Effects

Site 2

Naval Air Station

Milton, Florida

ANALYTE	<i>Cotton mouse</i>			<i>Eastern meadowlark</i>			<i>Short-tailed shrew</i>			
	PDE	TRV	HQ	PDE	TRV	HQ	PDE	TRV	HQ	
Chloroform	1.4E-05	1.6E+02	8.6E-08	3.4E-05	NA	NA	7.1E-05	1.6E+02	4.4E-07	
bis(2-Ethylhexyl)phthalate	4.7E-04	1.6E+02	3.0E-06	1.3E-03	NA	NA	2.1E-03	1.6E+02	1.3E-05	
Beryllium	1.2E-03	2.0E+00	5.9E-04	3.8E-03	NA	NA	6.3E-03	2.0E+00	3.1E-03	
Vanadium	3.3E-02	6.2E+00	5.3E-03	7.8E-02	1.9E+01	4.1E-03	1.6E-01	6.2E+00	2.6E-02	
SUMMARY HAZARD INDEX			5.9E-03				4.1E-03	2.9E-02		

PDE = Potential Dietary Exposure (mg/kg-BW/day)

TRV = Toxicity Reference Value (mg/kg-BW/day) = NOAEL or 1/10 of the lowest LOAEL or 1/5 of the lowest reported LD<sub>50</sub> for closest related species.

Table D-13

Estimated Exposure from Ingestion of Food and Soil containing the Average Exposure Point Concentration of ECPCs: Sublethal Effects

Site 2

Naval Air Station

Milton, Florida

**EXPOSURE CONCENTRATION DATA**

ANALYTE	AVERAGE EXPOSURE POINT
	CONCENTRATION (mg/kg)
Chloroform	0.005
bis(2-Ethylhexyl)phthalate	0.105
Beryllium	0.32
Vanadium	11.3

**ESTIMATED CONCENTRATIONS**

**IN PRIMARY FOOD ITEMS**

Invert BAF [a]	Concentration in Invertebrate Tissue [b] (mg/kg)	Plant BAF [a]	Concentration in Plant Tissue [c] (mg/kg)
	NA		NA
5.0E-02	5.3E-03	8.7E-03	9.1E-04
5.0E-02	1.6E-02	2.0E-03	6.4E-04
NA	NA	1.1E-03	1.2E-02

**BAF VALUES FOR**

**OTHER FOOD ITEMS**

Small Mammal BAF [a]	Small Bird BAF [a]
NA	NA
1.9E-01	NA
5.0E-02	NA
1.2E-01	NA

ECPC = Ecological Chemical of Potential Concern

[a] Bioaccumulation data presented in: Table D-1

[b] Invertebrate tissue concentration is the invertebrate BAF multiplied by the EPC.

[c] Plant tissue concentration is the plant BAF multiplied by the EPC.

Table D-13

Estimated Exposure from Ingestion of Food and Soil containing the Average Exposure Point Concentration of ECPCs: Sublethal Effects

Site 2

Naval Air Station

Milton, Florida

**POTENTIAL DIETARY EXPOSURE (mg/kgBW/day) [d]**

<b>ANALYTE</b>	<i>Cottus meurus</i>	<i>Eastern meadowlark</i>	<i>Short-tailed shrew</i>	<i>Red fox</i>	<i>Great horned owl</i>
Chloroform	1.4E-05	3.4E-05	7.1E-05	3.7E-07	2.1E-06
bis(2-Ethylhexyl)phthalate	4.7E-04	1.3E-03	2.1E-03	1.3E-05	1.0E-04
Beryllium	1.2E-03	3.8E-03	6.3E-03	3.3E-05	1.8E-04
Vanadium	3.3E-02	7.8E-02	1.6E-01	9.5E-04	7.4E-03

[d] Calculated by summing the concentration derived from each pathway (multiplying pathway concentration, percent in diet, SFF, and ingestion rate, and then dividing by body weight).

SFF = Site foraging frequency

Table D-14

Risk for Representative Wildlife Species from Average Exposure Concentrations of ECPCs: Sublethal Effects

Site 2

Naval Air Station

Milton, Florida

ANALYTE	<i>Red fox</i>			<i>Great-horned owl</i>		
	PDE	TRV	HQ	PDE	TRV	HQ
Chloroform	3.7E-07	2.6E+01	1.4E-08	2.1E-06	NA	NA
bis(2-Ethylhexyl)phthalate	1.3E-05	3.5E+00	3.7E-06	1.0E-04	NA	NA
Beryllium	3.3E-05	8.5E-02	3.9E-04	1.8E-04	NA	NA
Vanadium	9.5E-04	8.4E+00	1.1E-04	7.4E-03	1.1E+00	6.8E-03
SUMMARY HAZARD INDEX			5.1E-04			6.8E-03

PDE = Potential Dietary Exposure (mg/kg-BW/day)

TRV = Toxicity Reference Value (mg/kg-BW/day) = NOAEL or 1/10 of the lowest reported LOAEL for closest related species.

HQ = Hazard Quotient (calculated by dividing PDE by TRV)

**APPENDIX E**

**MONITORING WELL BORING LOGS**

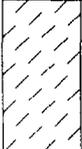
TITLE: NAVAL AIR STATION WHITING FIELD		LOG of WELL: WHF-2-1	BORING NO.
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: RI PHASE IIA	
CONTRACTOR: Groundwater Protection Inc.		DATE STARTED: 7/16/93	COMPLTD: 7/17/93
METHOD: MUD ROTARY	CASE SIZE: 2"	SCREEN INT.: 70-85 FT	PROTECTION LEVEL: D
TOC ELEV.: 150.80 FEET.	MONITOR INST.: OVA	TOT DPTH: 87 FEET.	DPTH TO $\nabla$ 78.1 FEET.
LOGGED BY: N. Roka	WELL DEVELOPMENT DATE:		SITE: 2- Land fill

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
5		22/24	BKG	SILTY SAND - red, fine, poorly graded, loose, damp.		SM	3,3,4,3	
10		24/24	BKG	SAND - red, fine, some silt, poorly graded, loose, dry, subrounded.		SP	4,3,2,2	
15		19/24	<1	Same as above.		SP	7,6,8,8	
20		24/24	BKG	Same as above., little silt. Same as above, inter layered medium sand with some fine, tan, poorly graded, medium dense, dry, subangular.		SP	7,6,7,9	
25		24/24	BKG	Same as above. SILTY SAND - red to light orange to light tan, fine, poorly graded, medium dense, dry.		SM	11,6,7,9	
30		22/24	1	Same as above. SAND - white, fine, poorly graded, medium dense, moist, subangular.		SP	15,9,10,12	
35		22/24	BKG	Same as above, grade to fine to medium.		SP	14,11,9,16	
40		16/24	1	Same as above, white, fine to medium, poorly graded, dense, moist, subangular.		SP	17,18,19,22	
45			BKG			SP	15,15,21,24	

TITLE: NAVAL AIR STATION WHITING FIELD		LOG of WELL: WHF-2-1	BORING NO.
CLIENT: SOUTHNAVFACENCOM		PROJECT NO: RI PHASE IIA	
CONTRACTOR: Groundwater Protection Inc.		DATE STARTED: 7/16/93	COMPLTD: 7/17/93
METHOD: MUD ROTARY	CASE SIZE: 2"	SCREEN INT.: 70-85 FT	PROTECTION LEVEL: D
TOC ELEV.: 150.80 FEET.	MONITOR INST.: OVA	TOT DPTH: 87 FEET.	DPTH TO $\nabla$ 78.1 FEET.
LOGGED BY: N. Roka	WELL DEVELOPMENT DATE:		SITE: 2- Land fill

DEPTH F.	LABORATORY SAMPLE ID.	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
Continued from PAGE 1								
		20/24		Same as above.		SP		
50		20/24	BKG	Same as above.		SP	19,22,23,26	
55		20/24	BKG	Same as above, fine grade to medium, small dark staining spots.		SP	27,18,18,22	
60		18/20	BKG	Same as above, light pink, trace silt.		SP	12,8,9,20	
65		18/24	BKG	SAND - whitish tan with dark green mottling and light pink layering, fine to medium, poorly graded, very dense, dry, subrounded.		SP	23,26,30,19	
70		18/24	BKG	Same as above.		SP	19,19,30,40	
75		20/24	3	Same as above, dark green spotting, light pink layering, dense, wet.		SP	20,20,26,29	
80		24/24	2	SAND - light tan with rust stain, fine to medium, moderately well graded, medium dense, saturated, subrounded to subangular.		SP/SW	8,10,11,11	
85								
90								

TITLE: NAVAL AIR STATION WHITING FIELD		LOG of WELL: WHF-2-2	BORING NO.
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: RI PHASE IIB	
CONTRACTOR: Groundwater Protection Inc.		DATE STARTED: 3/13/96	COMPLTD: 3/14/96
METHOD: HOLLOW STEM AUGER	CASE SIZE: 2"	SCREEN INT.: 73-88 FT	PROTECTION LEVEL: D
TOC ELEV.: 159.16 FEET.	MONITOR INST.: OVA	TOT DPTH: 90 FEET.	DPTH TO $\nabla$ 78.6 FEET.
LOGGED BY: J. Beauchamp	WELL DEVELOPMENT DATE:		SITE: 2- Land fill

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
5				0	SAND - light brown, fine, loose, dry.		SM	NA	
10				0	SAND - same as above			NA	
30				0	SAND - light orange, very fine, some silt, loose, dry.		SM	NA	

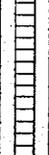
TITLE: NAVAL AIR STATION WHITING FIELD		LOG of WELL: WHF-2-2	BORING NO.
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: R1 PHASE IIB	
CONTRACTOR: Groundwater Protection Inc.		DATE STARTED: 3/13/96	COMPLTD: 3/14/96
METHOD: HOLLOW STEM AUGER	CASE SIZE: 2"	SCREEN INT.: 73-88 FT	PROTECTION LEVEL: D
TOC ELEV.: 159.16 FEET.	MONITOR INST.: OVA	TOT DPTH: 90 FEET.	DPTH TO $\nabla$ 78.6 FEET.
LOGGED BY: J. Beauchamp	WELL DEVELOPMENT DATE:		SITE: 2- Land fill

DEPTH FT.	LABORATORY SAMPLE ID.	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
Continued from PAGE 1								
50								
55			0	SAND - light orange, very fine, some silt, loose, dry.		SM	NA	
60			0	SAND - light brown, fine, loose, dry.			NA	
65			0	SAND - yellowish orange, fine, loose, dry.			NA	
70								
75								
80								
85		24/24	0	SAND - very pale orange, medium dense, saturated.		SP/SW	12,16,14,16	
90								

TITLE: NAVAL AIR STATION WHITING FIELD		LOG of WELL: WHF-2-3	BORING NO.
CLIENT: SOUTHNAVFACENGCOM		PROJECT NO: RI PHASE IIB	
CONTRACTOR: Groundwater Protection Inc.		DATE STARTED: 3/12/96	COMPLTD: 3/13/96
METHOD: HOLLOW STEM AUGER	CASE SIZE: 2"	SCREEN INT.: 73-88 FT	PROTECTION LEVEL: D
TOC ELEV.: 160.63 FEET.	MONITOR INST.: OVA	TOT DPTH: 90 FEET.	DPTH TO $\nabla$ 78.0 FEET.
LOGGED BY: R. Protzman	WELL DEVELOPMENT DATE:		SITE: 2- Land fill

DEPTH FT.	LABORATORY SAMPLE ID.	SAMPLE	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
0					SAND - yellow to brown, fine, loose, moist.		SM	NA	
5									
10					SAND - light orange, fine, little silt, loose, moist.			NA	
15									
20									
25									
30									
35					SAND - greyish orange, fine, little silt, loose, moist.		SM	NA	
40					SILT - light orange, some fine sand, moist.			NA	
45								NA	

TITLE: NAVAL AIR STATION WHITING FIELD		LOG of WELL: WHF-2-3	BORING NO.
CLIENT: SOUTHNAVFACENCOM		PROJECT NO: RI PHASE IIB	
CONTRACTOR: Groundwater Protection Inc.		DATE STARTED: 3/12/96	COMPLTD: 3/13/96
METHOD: HOLLOW STEM AUGER	CASE SIZE: 2"	SCREEN INT.: 73-88 FT	PROTECTION LEVEL: D
TOC ELEV.: 160.63 FEET.	MONITOR INST.: OVA	TOT DPTH: 90 FEET.	DPTH TO $\nabla$ 78.0 FEET.
LOGGED BY: R. Protzman	WELL DEVELOPMENT DATE:		SITE: 2- Land fill

DEPTH FT.	LABORATORY SAMPLE ID.	RECOVERY	HEADSPACE (ppm)	SOIL/ROCK DESCRIPTION AND COMMENTS	LITHOLOGIC SYMBOL	SOIL CLASS	BLOWS/6-IN	WELL DATA
Continued from PAGE 1								
50				SILT - very pale orange, some fine sand, well sorted, loose, moist.		SM		
55								
60								
65								
70			0	SILT - light brown, some fine sand, well sorted, loose, moist.		SM	NA	
75								
80			0	SILT - greyish, some fine sand, well sorted loose, moist.		SM	NA	
85			0	SAND - very pale orange, fine, very well sorted, little silt, medium dense, saturated.		SM/SW	12,16,24,28	
90								

**APPENDIX F**

**EVALUATION OF BACKGROUND ARSENIC CONCENTRATIONS  
FOR COVERED LANDFILL SITES, NAVAL AIR STATION  
WHITING FIELD, MILTON, FLORIDA**

## Appendix F

### Evaluation of Background Arsenic Concentrations for Covered Landfill Sites

#### Naval Air Station (NAS) Whiting Field, Milton, Florida

At NAS Whiting Field nine soil types, as identified by the U. S. Department of Agriculture, Soil Conservation Service (USSCS), are present. The Remedial Investigation (RI) sites at NAS Whiting Field are associated with seven of the nine soil types. The background surface soil data set for each RI site was initially determined to be comprised of background surface soil samples from the same USSCS soil types as occur on the individual sites. However, available information and review of historical aerial photographs indicated that in the construction of landfills at the facility, a borrow pit was dug to an approximate depth of 10 to 15 feet below land surface (bls) and the excavated soil was piled to the side. Following landfill operations, the borrow materials comprised of undifferentiated surface and subsurface soils, were used for the landfill cover. Any additional soils required to complete the landfill cover are believed to have been obtained from other borrow pits located at the facility.

If a mix of surface and subsurface soils were used in the cover for landfills, it would be appropriate to use the combined data set of surface and subsurface soil samples as the background screening value. However in order to be protective of human health and the environment, it is proposed that the background surface and subsurface data set be combined to a single value as be used as the "Industrial Use Soil Cleanup Goal". This modified "Industrial Use Soil Cleanup Goal" is specifically limited to the covered landfill sites including: Site 1, 2, 9, 10, 11, 13, 14, 15, and 16 and to the inorganic analyte arsenic.

Tables 3-8 through 3-18 in the General Information Report present the detected concentrations and summarize the analytical data for the individual background soil samples collected at NAS Whiting Field. A summary of the arsenic background data set and the modified "Industrial Use Soil Cleanup Goal" for arsenic is presented Table G-1. As indicated on the table the modified "Industrial Use Soil Cleanup Goal" for arsenic to be used at covered landfill sites is 4.62 mg/kg.

**Table F-1**  
**Summary of Arsenic Detected in**  
**Surface and Subsurface Background Soil Samples**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Analyte	Frequency of Detection Surface Soil Samples <sup>1</sup>	Mean of Detected Concentrations Surface Soil Samples <sup>2</sup>	Frequency of Detection Subsurface Soil Samples <sup>1</sup>	Mean of Detected Concentrations Subsurface Soil Samples <sup>2</sup>	Frequency of Detection Surface and Subsurface Soil Samples <sup>1</sup>	Mean of Detected Concentrations Surface and Subsurface Soil Samples <sup>2</sup>	Surface and Subsurface Soil Background Screening Concentration (modified Industrial Use Cleanup Goal)
<b>Inorganic Analytes (mg/kg)</b>							
Arsenic	15/15	1.54	14/14	3.14	29/29	2.31	4.62
<sup>1</sup> Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed. <sup>2</sup> The mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples in which the analyte was not detected.							
Note: mg/kg = milligram per kilogram.							

**Table F-2  
 Comparison of Detected Arsenic Concentrations in Surface and Subsurface Soil Samples  
 to Florida Soil Cleanup Goals**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Mean of Detected Concentrations	Soil Cleanup Goals for Florida (Residential) <sup>1</sup>	Soil Cleanup Goals for Florida (Industrial) <sup>1</sup>	Modified Industrial Use Cleanup Goal <sup>2</sup>
<b>Inorganic Analytes (mg/kg)</b>						
Arsenic	0.52	6.3	2.31	0.8	3.7	4.62
<sup>1</sup> Source: FDEP Memorandum from John Ruddell, Director Division of Waste Management, to District Directors and Waste Program Administrators. Subject: Applicability of Soil Cleanup Goals for Florida, January 19, 1996. <sup>2</sup> The modified Industrial Use Cleanup Goal for arsenic is twice the mean of detected concentrations in the surface and subsurface soil samples.						
Note: mg/kg = milligram per kilogram.						

**APPENDIX G**

**COMMENTS AND RESPONSES IN THE DRAFT REMEDIAL INVESTIGATION  
REPORT, SITE 2, NORTHWEST OPEN DISPOSAL AREA,  
NAVAL AIR STATION WHITING FIELD, MILTON, FLORIDA**

## RESPONSE TO REVIEW COMMENTS

### Remedial Investigation Report for Site 2, Northwest Open Disposal Area June, 1998

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U.S. Environmental Protection Agency

#### GENERAL COMMENTS

In general, the RI report primarily focuses on whether State of Florida standards have been exceeded while neglecting federal standards. A comparison to federal standards should be accomplished and addressed in the text of the RI report at each occurrence where a similar comparison to State standards takes place.

*Response:* Agreed, the text will be amended to incorporate federal standards.

#### SPECIFIC COMMENTS

1. **Page iv, Bullet No. 8.** The Executive Summary presents information on the results of Central Tendency risk exposures meeting the Florida risk criteria of  $1 \times 10^{-6}$ . However, the USEPA Region IV does not accept Central Tendency evaluations except for information purposes for risk managers. Therefore, the results of the Central Tendency evaluations should not be considered in the RI Report when the results are used as decision criteria.

*Response:* The Central Tendency Risk Exposures will be deleted from the Executive Summary and Conclusions section of the report. However, the discussion of Central Tendency Risk Exposures in the body of the report will remain unchanged for FDEP's evaluation and general information purposes.

2. **Page v, Bullet No. 11.** The Executive Summary indicates that vanadium concentrations were within the range found in the eastern United States; however, a more valid comparison would be to relate vanadium concentrations to facility specific background concentrations.

*Response:* The Navy agrees that the use of the Shacklette (1984) soil survey data may not be appropriate due to differences in soil type. Consequently, background surface soil data collected from NAS Whiting Field will be used to qualitatively evaluate risks from vanadium.

3. **Page xii.** The abbreviation CPC should be changed to COPC to reflect the standard abbreviation for referring to chemicals of potential concern.

*Response:* The text of the document refers to Human Health Chemicals of Potential Concern (HHPCs) and Ecological Chemicals of Potential Concern (ECPC). These designations are used to be more specific as to the types of Chemicals of Potential Concern but also for brevity. No text revisions will be made.

4. **Page 1-4, Section 1.4, First Paragraph.** The RI report is organized into ten chapters, not nine as reported in the text.

*Response:* Agreed, corrections will be made to the text.

**RESPONSE TO REVIEW COMMENTS (continued)**

**Remedial Investigation Report for Site 2, Northwest Open Disposal Area  
June, 1998**

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5. **Page 3-1, Section 3.1, Second Paragraph.** The reference to the "Phase I" soil sample (2-SB01) in the first sentence needs to be changed to "Phase II." The Phase I investigation was completed in 1992 and consisted of one groundwater sample.

*Response:* Agreed, corrections will be made to the text.

6. **Page 3-1, Section 3.1, Second Paragraph.** The text states that soil sample 2-SB01 "was biased based on the observation of the surface conditions at the site." There is no further discussion to explain this observation. Therefore, a more detailed explanation for selecting the sample location should be provide in order to support this statement.

*Response:* The sample was collected from the center of the site and was not located based on observed contamination on site. The sentence will be removed from the text.

7. **Page 5-8, Eighth Paragraph.** Reference is made to the "sand and gravel aquifer" but a geologic cross-section of the area has not been included. A proper assessment of the hydrogeology for the aquifer system should include a geologic cross-section and a topographic map of the area.

*Response:* Geologic cross sections and a topographic map of the facility area are provided in the NAS Whiting Field General Information Report (GIR; HLA, 1998). The GIR was developed to stream line the remedial investigation and risk assessment review process. The information will not be repeated in the individual Remedial Investigation reports.

8. **Page 5-15, Section 5.3, Seventh Paragraph.** The text states that arsenic concentrations in surface soil samples exceed Federal and State industrial soil clean up goals. According to the data presented in Table 5.8, the arsenic concentrations also exceed the Federal and State residential soil cleanup goals. The RI Report needs to be corrected.

*Response:* Agreed, corrections will be made to the text.

9. **Page 5-27, Subsection 5.5.2, Fourth Paragraph.** The reference to Table 5-11 needs to be changed to Table 5-12.

*Response:* Agreed, corrections will be made to the text.

10. **Page 5-32, Table 5-13.** The title for Table 5-13 should be changed to indicate that the analytical data evaluates only data collected from Phase IIB.

*Response:* Agreed, corrections will be made to the text.

11. **Page 5-31, Second Paragraph.** The reference to Table 5-7 needs to be changed to 5-13.

*Response:* Agreed, corrections will be made to the text.

**RESPONSE TO REVIEW COMMENTS** (continued)

**Remedial Investigation Report for Site 2, Northwest Open Disposal Area  
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12. **Page 5-31, Second Paragraph.** The text states that the 1993 Phase IIA groundwater samples are not considered to be representative of groundwater conditions due to sample turbidity and, therefore, are not presented in the RI Report. The only groundwater data evaluated is a single round of samples collected from three monitor wells in 1996 during the Phase IIB investigation. Since only the 1996 Phase IIB groundwater data is evaluated, it may be insufficient to make a decision on the quality of the groundwater for Site 2. Typically, four quarters of groundwater samples are collected to evaluate the variability of groundwater conditions. To adequately access the groundwater conditions at Site 2, additional groundwater samples are recommended to support the results of the 1996 Phase IIB groundwater data and to address potential variations in groundwater contaminant concentrations that may occur over time. The need for additional groundwater samples can be addressed during future sampling events for the groundwater operable unit.

*Response:* Comment noted. As indicated in the comment, groundwater facility wide has been identified as a separate site and will be independently investigated in the future.

13. **Page 5-34, Second Paragraph.** The RI Report compares groundwater contaminant concentrations at Site 2 with upgradient groundwater analytical data from Site 1, the Northwest Disposal Area. The upgradient groundwater data is not presented in the RI Report, but is referenced in an earlier report for Site 1. The RI Report should be a stand-alone document with all pertinent data provided. Therefore, the upgradient groundwater sample data from the Site 1 report should be included in the RI Report for comparison.

*Response:* Agreed, a table including analytes detected in the Site 1 groundwater samples will be included in the report.

14. **Page 5-34, Forth Paragraph.** The text states that groundwater sample 02G00101F is a filtered sample. To assist in the review of the analytical data, Table 5-12 (Page 5-29), presented earlier in the RI Report, should also identify groundwater sample data for 02G00101F as being obtained from a filtered sample.

*Response:* Agreed, the suggested revisions will be made to Table 5-12.

15. **Page 6-2, Section 6-2, First Paragraph.** In the first paragraph the text states that human health chemicals of potential concern (HHPCs) were selected using methods described in the GIR. However, the second paragraph states HHPCs were selected using USEPA Region IV criteria. This discrepancy should be corrected.

*Response:* The methods described in the GIR are from USEPA Region IV guidance. The first sentence in the second paragraph will be deleted for clarity.

## RESPONSE TO REVIEW COMMENTS (continued)

### Remedial Investigation Report for Site 2, Northwest Open Disposal Area June, 1998

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16. **Page 9-1, Section 9.1.** The text should state that risk was within EPA's range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  as well as FDEP's target level of  $1 \times 10^{-6}$ .

*Response:* Agreed, the suggested revisions will be made to the text.

17. **Page 9-2, First Bullet.** The reference to Central Tendency should be removed. See specific Comment No. 1.

*Response:* The suggested correction to the text will be made. See response to specific comment No. 1.

The following comments were generated during the risk review of the Site 2 RI Report:

#### GENERAL COMMENTS

1. In general, the ERA conclusions are consistent with what would be anticipated based on the nature and extent of contamination presented in the ERA. However, the ERA needs to be strengthened in order to sufficiently justify the recommendation for no further action. Specific items for revision are discussed in the specific comments.

*Response:* Comment noted. The language of the ERA will be strengthened per the revisions discussed in the specific comments below.

#### SPECIFIC COMMENTS

1. **Figure 6-1, Page 6-11.** This figure presents the complete exposure pathways for human receptors at Site 2. Surface soil and subsurface soil are not distinguished from each other. The receptors identified in the figure are not assessed for exposure to both subsurface and surface soil in this RI Report. To distinguish which receptors are assessed for which media, subsurface and surface soil should be shown separately on the diagram.

*Response:* Figure 6-1 will be revised to distinguish between surface soil and subsurface soil receptors.

2. **Subsection 6.3.4, Page 6-14.** This section discusses the derivation of exposure point concentrations. The methodology behind the derivation of exposure point concentrations is not provided in this section, or elsewhere in the RI Report. Instead, the General Information Report (GIR) is provided as a reference for this information. The RI Report should be a stand-alone document. Therefore, the methodology behind the derivation of exposure point concentrations should be briefly summarized in this section.

## RESPONSE TO REVIEW COMMENTS (continued)

### Remedial Investigation Report for Site 2, Northwest Open Disposal Area June, 1998

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*Response:* The General Information Report (HLA, 1998) was developed to streamline the risk assessment process. The exposure point concentrations will not be presented in the RI. No text revisions will be made.

- 3. Section 6.4, Page 6-14. This section discusses the toxicity assessment. The methodology behind the toxicity assessment is not provided in this section, or elsewhere in the RI Report. Instead, the GIR is provided as a reference for this information. The RI Report should be a stand-alone document. Therefore, the methodology behind the toxicity assessment should be summarized in this section.**

*Response:* The General Information Report (ABB-ES, 1997) was developed to streamline the risk assessment process. The toxicity assessment will not be presented in the RI. No text revisions will be made.

- 4. Section 6-4, Page 6-17. The text states, "Appendix C to this report contains brief toxicity summaries for HHCPs (human health contaminants of potential concern) identified in surface soil, subsurface soil, and groundwater." However, no HHCPs were identified in subsurface soils. The text should be amended accordingly. Secondly, the toxicity summaries provided in Appendix C do not include the metal thallium, which was identified as a HHCP in groundwater. Thallium is one of the more toxic metals, and toxicity information should be provided in the Appendix C toxicity summaries.**

*Response:* The text will be revised to state that "Appendix C to this report contain brief toxicity summaries for HHCPs (human health contaminants of potential concern) identified in surface soil and groundwater". In addition, the toxicity summaries will be revised to include thallium.

- 5. Figure 6-2, Page 6-22. The figure presents a graphical representation of the current land use carcinogenic risks for adult and child residents. However, the current residential land use scenario was not evaluated as part of the human health risk assessment. The values represented in the graph do not appear to relate to the future residential scenario risk values. Therefore, it appears that the figure may have been inadvertently carried over from another investigation, or the figure was erroneously labeled. The figure should be revised to include correct information, or the figure should be deleted if it was included in error.**

*Response:* Figure 6-2 will be revised to present a graphical representation of current land use carcinogenic risk for adult and adolescent trespassers.

- 6. Figure 7-1, Page 7-4. The contaminant pathway model inappropriately references Site 18 on the figure and in one of the footnotes. The contaminant pathway model figure should specify Site 2.**

*Response:* The contaminant pathway model in Figure 7-1 will be revised to specify Site 2 rather than Site 18.

## RESPONSE TO REVIEW COMMENTS (continued)

### Remedial Investigation Report for Site 2, Northwest Open Disposal Area June, 1998

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7. **Table 7-1, Page 7-6.** Table 7-1 presents very specific assessment endpoints. Several problems exist with the assessment endpoints as stated in this table. First, the terrestrial plant and invertebrate assessment endpoints presented in Table 7-1 are not adequately measured by the measurement endpoints also presented in Table 7-1. In order to assess a "25% decline in biomass of forage materials," one would need to do a series of quantitative vegetative surveys. No quantitative vegetative surveys were performed as part of the ERA. The invertebrate assessment endpoint, a "25% decline in abundance of earthworms," is difficult to measure, and would require field measurements of earthworm populations. However, no attempt to quantify earthworm abundance was made in the ERA. Secondly, the assessment endpoints presented in Table 7-1 are too narrow to fully address the testable hypotheses provided on page 7-5 in Section 7.2.3. The ERA assessment presented in this RI is consistent with the testable hypotheses presented on page 7-5. Therefore, to improve the correspondence between the measurement endpoints and the assessment endpoints and to address the testable hypotheses presented on page 7-5, the terrestrial plant and invertebrate assessment endpoints should be revised to clearly reflect these hypotheses. At a minimum, the "25% decline" needs to be deleted from these assessment endpoints.

The ERA would be strengthened if the wildlife assessment endpoint, presented in Table 7-1, of "survival and maintenance of wildlife populations" was revised to specifically correspond to the two measurement endpoints for wildlife applied in this ERA. If the assessment endpoint was divided into the following two example assessment endpoints there would be better correlation with the testable hypotheses and the method of evaluation used in this ERA: 1) protection of small mammals and birds that forage on soil invertebrates, 2) protection of predators that prey on small mammals. The wildlife assessment endpoint should be revised to better reflect the testable hypotheses.

*Response:* The terrestrial plant and invertebrate assessment endpoints listed in Table 7-1 will be revised to clearly reflect the hypotheses provided on page 7-5 in Subsection 7.2.3.

The terrestrial wildlife assessment endpoint in Table 7-1 will be revised into the following two example assessment endpoints to better correlate the testable hypotheses with the method of evaluation used in the ERA: 1) protection of small mammals and birds that forage on soil invertebrates and terrestrial plants; and 2) protection of top predators that prey on small mammals and birds.

8. **Table 7-1, Page 7-6.** The examples of measurement endpoints for the wildlife species receptors provided in this table are based on LD50 values. The Toxicity Reference Values (TRVs) used in this ERA are based on NOAELs. Therefore, it would be more appropriate to provide examples of NOAEL studies as opposed to LD50 studies in the wildlife measurement endpoint.

*Response:* The measurement endpoint for terrestrial wildlife will be revised as follows: "Oral chemical doses (mg/kg-BW/day) based on measured adverse effects on growth, reproduction, or

**RESPONSE TO REVIEW COMMENTS (continued)**

**Remedial Investigation Report for Site 2, Northwest Open Disposal Area  
June, 1998**

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survival (i.e., NOAEL, LOAEL, or LD<sub>50</sub> studies) of mammalian and avian laboratory test populations."

9. **Table 7-3, Page 7-13.** This Table provides the equations used to calculate potential chemical exposures for wildlife species. The variable entitled "secondary prey item concentration" needs to be better defined. The equation to derive secondary prey item concentrations is not standard. It is unclear whether the "tissue concentrations of prey items" used in the equation to derive the "secondary prey item concentration" is meant to be the "primary prey item concentration" or another concentration. This point should be clarified

*Response:* The "tissue concentrations of prey items" term used in the equation to derive the "secondary prey item concentration" will be revised to "tissue concentrations of primary prey items."

10. **Section 9.1, Page 9-2, third bullet.** The conclusion that "symptoms consistent with vanadium toxicity were not apparent in plants at the site" is not supported in the ERA. A discussion of phytotoxic symptoms related to vanadium toxicity is not provided in the ERA. At a minimum a summary of field observations related to screening for vegetative stress and a summary of vanadium phytotoxic effects are needed to support the conclusion as stated.

*Response:* The conclusion will be revised as follows: "The maximum EPC for vanadium exceeded its phytotoxicity benchmark; however, vanadium concentrations detected in surface soil were completely within the range found in background surface soil collected from NAS Whiting Field. Additionally, stressed vegetation was not apparent at the site; therefore, risks to terrestrial plants are not predicted."

11. **Section 9.1, Page 9-2, fourth bullet.** This bullet discusses the interaction of four COPCs in sediment. The site characterization in Section 7.1 states that there are no areas of standing water or hydrophytic vegetation at Site 2. The ERA does not evaluate aquatic ecological receptors nor does it provide data on contaminants detected in sediment or surface waters. Therefore, it is unclear why the conclusions in Section 9.1 state that the COPCs listed "... adsorb readily to sediments..." and that "sediment transport is not likely to occur from Site 2 due to site topography." The statements relating to the interaction of COPCs in sediment, a medium absent from this site, should be deleted.

*Response:* The fourth bullet will be deleted as requested.

**RESPONSE TO REVIEW COMMENTS** (continued)

**Remedial Investigation Report for Site 2, Northwest Open Disposal Area  
June, 1998**

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**Florida Department of Environmental Protection**

**SPECIFIC COMMENTS**

1. **Based on the data presented in the report, significant risks are predicted for future residents, trespassers, and occupational workers due to arsenic and beryllium in surface soils. The Navy has recently evaluated surface soil at Site 1, which is similar to the conditions at Site 2, and has proposed an elevated level of soil screening for arsenic and land use restriction which excludes residential use. These actions have direct bearing on Site 2 and this action should be evaluated for possible application at Site 2.**

*Response:* The site report will be rewritten to reflect the FDEP approved site-specific Soil Cleanup Goal for arsenic at Covered Landfill sites, NAS Whiting Field. The approach will be similar to the Site 1 report.

2. **I suggest that the recommendations in Section 9.2 be withheld until the excess cancer risks (primarily Arsenic in surface soils) are adequately addressed, either through remediation or by application of an acceptable alternative SCG, as previously conducted at Site 1. It may be that a land use restriction is the most suitable recommendation if cleanup to residential SCGs is not pursued.**

*Response:* The comment is noted. Revisions to the recommendations section that reflect the decisions at Site 1 will be incorporated into the final edition of the report.

**Southern Division, Naval Facilities Engineering Command**

**SPECIFIC COMMENTS**

1. **Comment: The document should be written in a more positive and conclusive tone not in a non-conclusive tone. In most case in the executive summary, chapters 6, 7, & 9 phrases like "thought to be, easily, primarily etc.," should be taken out. Another example of this is the whole paragraph on 8-8 stating "It is important.....an actual transport route. Also do a word search for "that' and "which" and delete them from your sentences.**

*Response:* The document is written in a tone that expresses the inconclusive nature of any and all Remedial Investigations. Phrases such as "thought to be, easily, primarily etc.," express the fact that although the site conditions indicated are believed to be accurate other conditions may be present and contributing to interpretations. Without unlimited funds and time all conditions can not be fully explored nor should be explored.

## **RESPONSE TO REVIEW COMMENTS (continued)**

### **Remedial Investigation Report for Site 2, Northwest Open Disposal Area June, 1998**

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The referenced paragraph on page 8-8 (actual page 8-9) will be deleted. ABB-ES editors will perform a word search for the occurrence of "that" and "which" and evaluate the appropriate usage of each occurrence. If the appropriateness of the occurrence is questionable, the word will be deleted and the sentence will be reworded.

2. **Comment: Change Section 7.1: Site Characterization to reflect the information in the Nature Conservancy Report 1997.**

*Response:* Section 7.1 will be revised as follows: "Observations made during an ecological survey of NAS Whiting Field indicate that no State or federally listed rare, threatened, or endangered species or species of concern are known to inhabit Site 2 (Nature Conservancy, 1997).

3. **Comment: The 1993 groundwater data should not be used in any data set including risk assessment. In some places in the document you say the data is not used and in other places you say it is used.**

*Response:* Agreed. The 1993 groundwater data was not used in the risk assessment and any references to such in the text will be deleted.

### **Response to Review Comments Discussion and Approval**

The response to Review Comments for Remedial Investigation Report for Site 2, Northwest Open Disposal Area, were discussed by the Naval Air Station Whiting Field Partnering Group during the June 1998 meeting. Specifically, responses to comments included the following: EPA Specific comments 1, 3, 12, and General Comments 2 and 3; FDEP Comments 1 and 2; and SOUTHNAVFACENGCOM Comments 1, 2, and 3. The Partnering Group concurred that the response to Review Comments for the Remedial Investigation Report for Site 2 were adequate.

**APPENDIX H**

**CONSIDERATION OF EFFECT OF RULE CHANGE FOR 62-785,  
FLORIDA ADMINISTRATIVE CODE, ON SITE 2, NORTHWEST OPEN DISPOSAL  
AREA, SURFACE SOIL DATA EVALUATION AND RISK ASSESSMENT**

## Appendix H

### Consideration of Affect of Rule Change for 62-785, Florida Administrative Code on Site 2, Northwest Open Disposal Area, Surface Soil Data Evaluation and Risk Assessment

At the request of the Florida Department of Environmental Protection (FDEP), this appendix provides a comparison of the affect of the policy change from use of screening values based on the Soil Cleanup Goals for Florida (memorandum dated September 29, 1995, from John Ruddell, Director, Division of Waste Management to District Directors, Waste Program, FDEP) to screening values based on the Soil Cleanup Target Levels for Chapter 62-785, Florida Administrative Code (FAC).

Table H-1 summarizes the analyte concentrations detected in the Site 2 surface soil samples and provides background screening concentrations, U.S. Environmental Protection Agency (USEPA) Region III Risk-Based Concentrations (RBCs), Soil Cleanup Goals for Florida, and Soil Cleanup Target Levels (SCTLs) for Chapter 62-785, FAC. The human health risk assessment for Site 2 was completed prior to FDEP's implementation of the SCTLs for Chapter 62-785, FAC. Based on screening levels from USEPA Region II RBCs and Soil Cleanup Goals for Florida, the risk assessment identified two surface soil contaminants of potential concern (CPCs), arsenic and beryllium. The CPCs were identified based on exceedances of screening values for residential use soils. The detected analyte concentrations did not exceed soil screening values for industrial use soils.

As indicated on Table H-1, if the SCTLs for Chapter 62-785, FAC, had been used as the screening values, one additional analyte, vanadium, would have been identified as a CPC. Similar to those of arsenic and beryllium, detected concentrations of vanadium exceed the screening values for residential use soils but not screening values for industrial use soils. Therefore, the overall impact of the use for the SCTLs for Chapter 62-785, FAC, at Site 2 is negligible. The recommendations of the Remedial Investigation Report at Site 2 is that a Focused Feasibility Study be completed to address exceedances of Florida's target risk ( $1 \times 10^{-6}$ ) for potential future resident, current and future trespasser, and occupational workers. The addition of vanadium to the risk assessment would not likely change the overall risk results or recommendations and, therefore, will not be completed.

**Table H-1**  
**Comparison of Analytes Detected in Surface Soil Samples**  
**Benchmark Concentrations Including Florida Soil Cleanup Target Levels**

Remedial Investigation Report  
Site 2, Northwest Open Disposal Area  
Naval Air Station Whiting Field  
Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Range of Detection Limits	Range of Detected Concentrations <sup>2</sup>	Background Screening Values <sup>3</sup>	USEPA Region III RBCs <sup>4</sup> Residential/Industrial	Soil Cleanup Goals for Florida Residential/Industrial <sup>5</sup>	Soil Cleanup Target Levels for Chapter 62-785, FAC Residential/Industrial
<b>TCL Volatile Organic Compounds (µg/kg)</b>							
Chloroform	1/6	10 to 11	5 to 5	--	<sup>6</sup> 100,000/940,000	600/800	400/600
<b>TCL Semivolatile Organic Compounds (µg/kg)</b>							
bis(2-Ethylhexyl)phthalate	1/6	350 to 3,600	105*	--	<sup>6</sup> 46,000/410,000	48,000/110,000	75,000/230,000
<b>Pesticides and PCBs (µg/kg)</b>							
Dieldrin	2/6	3.5 to 18	8.2* to 12*	--	<sup>7</sup> 40/360	70/300	70/300
4,4'-DDT	1/6	3.5 to 18.5	3.7*	--	<sup>7</sup> 1,900/17,000	3,100/12,000	3,200/13,000
alpha-Chlordane	1/6	1.8 to 9.5	5.4*	--	<sup>7</sup> 1,800/16,000	800/3,000	300/11,000
gamma-Chlordane	1/6	1.8 to 9.5	3.2*	--	<sup>7</sup> 1,800/16,000	800/3,000	300/11,000
<b>Inorganic Compounds (mg/kg)</b>							
Aluminum	6/6	40 to 40	1,150 to 9,230	13,500	<sup>7</sup> 7,800/100,000	75,000/--	72,000/1.0 × 10 <sup>6</sup>
Arsenic	6/6	2 to 2	0.82* to 3.95*	2.6	<sup>7</sup> 0.43/3.8	<sup>8</sup> 0.8/ <sup>10</sup> 4.62	0.8/3.7
Barium	6/6	40 to 40	1.7 to 27.1	18.8	<sup>7</sup> 550/14,000	5,200/84,000	105/87,000
Beryllium	4/6	0.11 to 1	0.11 to 0.45	0.36	<sup>8</sup> 0.15/1.3	0.2/1.0	120/700
Calcium	5/6	1,000 to 1,000	982* to 12,500	446	--/--	--/--	--/--
Chromium	6/6	2 to 2	1.5 to 13.8*	10	<sup>7,8</sup> 39/1,000	<sup>11</sup> 290/430	<sup>11</sup> 290/430
Cobalt	2/6	10 to 10	0.59 to 2.8*	2.8	<sup>7</sup> 470/12,000	4,700/110,000	4,700/110,000
Copper	3/6	5 to 5	3.6 to 4.8	8	<sup>7</sup> 310/8,200	<sup>9</sup> 2,900/72,000	105/1.4 × 10 <sup>4</sup>
Iron	6/6	20 to 20	799 to 3,950*	7,740	<sup>7</sup> 2,300/61,000	--/--	23,000/490,000
Lead	6/6	0.6 to 0.6	1.4 to 15.8*	10.2	<sup>12</sup> 400	500/1,000	500/920
Magnesium	6/6	1,000 to 1,000	11.3 to 1,890	244	--/--	--/--	--/--
Manganese	6/6	3 to 3	4 to 176*	324	<sup>7</sup> 180/4,700	370/5,500	1,600/20,000
Mercury	4/6	0.03 to 0.1	0.01 to 0.04*	0.12	<sup>7</sup> 2.3/61	23/480	3.7/28

See notes at end of table.

**Table H-1 (Continued)**  
**Comparison of Analytes Detected in Surface Soil Samples**  
**Benchmark Concentrations Including Florida Soil Cleanup Target Levels**

Remedial Investigation Report  
 Site 2, Northwest Open Disposal Area  
 Naval Air Station Whiting Field  
 Milton, Florida

Analyte	Frequency of Detection <sup>1</sup>	Range of Detection Limits	Range of Detected Concentrations <sup>2</sup>	Background Screening Values <sup>3</sup>	USEPA Region III RBCs Residential/Industrial <sup>4</sup>	Soil Cleanup Goals for Florida Residential/Industrial <sup>5</sup>	Soil Cleanup Target Levels for Chapter 62-785, FAC Residential/Industrial
<b>Inorganic Compounds (mg/kg) (Continued)</b>							
Nickel	4/6	4.8 to 8	1.3* to 4.4	6.8	<sup>7</sup> 160/4,100	1,500/26,000	105/28,000
Potassium	3/6	1,000 to 1,000	250 to 570	177	--/--	--/--	--/--
Sodium	1/6	1,000 to 1,000	168*	382	--/--	--/--	--/--
Vanadium	6/6	10 to 10	3.2 to 20.3	19	<sup>7</sup> 55/1,400	490/4,800	15/7,700
Zinc	5/6	4 to 4	6.2 to 12.8*	15.8	<sup>7</sup> 2,300/61,000	23,000/560,000	23,000/560,000
Cyanide	2/6	0.05 to 0.5	0.1 to 0.2*	0.28	--/--	1,600/40,000	30/5,000

<sup>1</sup> Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed (excluding rejected values).

<sup>2</sup> Value indicated by an asterisk is the average of a sample and its duplicate. If the target analyte is not detected in either the environmental sample or associated duplicate, the value used for the nondetection is one-half the reporting limit.

<sup>3</sup> The background screening value for organics is the mean detected concentration and will not be used for screening purposes in the risk assessment. The background screening value for inorganics is two times the mean detected background concentration and will be used for screening purposes in the risk assessment.

<sup>4</sup> Source: Memorandum dated February 17, 1997, from Roy L. Smith, Technical Support Section. USEPA Region II to RBC Table Mailing List. Subject: Risk-Based Concentrations Table.

<sup>5</sup> Source: Memorandum dated September 29, 1995, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, Florida Department of Environmental Protection (FDEP). Subject: Soil Cleanup Goals for Florida.

<sup>6</sup> The values correspond to a human cancer risk level of 1 in 1,000,000.

<sup>7</sup> The calculated values correspond to a noncancer hazard quotient of 0.1.

<sup>8</sup> Source: Updated Memorandum dated January 19, 1996, from John M. Ruddell, Director, Division of Waste Management to District Directors, Waste Program, FDEP. Subject: Applicability of Soil Cleanup Goals for Florida.

<sup>9</sup> Source: Updated Memorandum dated April 5, 1995, from Ligia Mora Applegate, Director, Technical Review Section, Bureau of Waste Cleanup, FDEP, to Tim Barr, Technical Review Section, Bureau of Waste Cleanup. Subject: Cleanup Goals for Military Sites in Florida.

<sup>10</sup> Value is an FDEP-approved site-specific soil cleanup goal for arsenic at covered landfill sites, NAS Whiting Field (Appendix F, FDEP, 1998).

<sup>11</sup> Values are for hexavalent chromium.

<sup>12</sup> USEPA memorandum dated July 14, 1994, from Elliott P. Laws to Regional Administrators. Subject: Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. (USEPA, 1994c).

Notes: USEPA = U.S. Environmental Protection Agency.  
 RBC = risk-based concentration.  
 FAC = Florida Administrative Code.  
 TCL = target compound list.  
 µg/kg = micrograms per kilogram.

-- = criteria not available.  
 PCB = polychlorinated biphenyl.  
 DDT = dichlorodiphenyltrichloroethane.  
 mg/kg = milligrams per kilogram.  
 \* = average of a sample and its duplicate.